FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT
SCHOOL OF ARCHITECTURE AND PLANNING (SOAP)

RESEARCH TOPIC: INDUSTRIAL SYMBIOSIS IN CLIMATE CHANGE MITIGATION: ROLE OF EFFECTIVE FACILITATION IN THE GAUTENG CITY REGION

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A research report submitted to the School of Architecture and Planning in the Faculty of Engineering and Built Environment, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements of the degree of Masters of Urban Studies

September 2, 2022

Declaration

I declare that this research report is my own, unaided work. It is being submitted for the degree Master of Urban Studies (Sustainable Energy Efficient Cities) at the University of the Witwatersrand, Johannesburg. I further declare that this research report has not been submitted before for any degree or examination at any other University.

Signature:  Date: September 2, 2022

Abstract

Under the Gauteng Industrial Symbiosis Programme (GISP) of the National Clean Production Centre of South Africa (NCPC-SA), facilitators assist industries in diverting waste from landfill sites through reuse as input in other industries. The programme aimed at diverting 300 000 tonnes of waste through an initial annual target of 40 synergies (relationships between two or more companies where they reuse waste). Facilitation primarily entails series of workshop engagements for synergy-identification and follow up sessions to ensure implementation. As elaborated in this study, when such waste resources are reused, Greenhouse Gas (GHG) emission is mitigated because use of virgin materials is reduced and waste transportation to landfill sites is avoided. The study therefore applied a qualitative study approach to assess GISP's facilitation process and its impact on mitigation of climate change. Semi-structured interviews were conducted with officials from NCPC-SA and the Gauteng Province Department of Agriculture and Rural Development (GDARD). The study also collected secondary data from various GISP reports as well as related academic articles to analyse facilitation issues and challenges. The study finds that GISP facilitators play an important role in recruiting companies to attend the Business Opportunity Workshops (BOWs) where reusable waste resources are identified and recorded. Waste exchange partnerships are facilitated by GISP facilitators and follow up engagements are conducted in order to ensure that synergy partnerships are pursued so that the exchange of waste resources is achieved.

The study also finds that through the GISP facilitation process approximately 111 000 tonnes of waste were diverted between 2014 to 2018, which contributed to mitigation of 139 351,62 tonnes of GHG emissions. Despite GISP's success, the study identified several critical challenges related to facilitation which in turn undermined optimal contribution to climate change mitigation. As a result, GISP failed to meet its annual target of landfill waste diversion (300 000 tons of waste) mainly due to inadequate financial resources for companies to pursue synergies as well as limited number of GISP facilitators to conduct follow up engagements. In order to strengthen its facilitation, GISP launched an online synergy platform to allow companies to share data on waste resources they generate or waste resources they require. This facilitates faster matching of companies as well as better alignment in waste resource exchange. The GISP facilitators can then conduct follow up engagements to record the impacts in terms of tonnes of waste diverted and GHG emissions mitigated.

Keywords: Climate Change Mitigation, Industrial Symbiosis, Synergies, Industrial Ecology, Information sharing.

Acknowledgments

First, I would like to express my sincere gratitude to my supervisor Dr Gerald Chungu and Prof Daniel Irurah for their effort and assistance throughout this research project. This report is a reflection of his zealous commitment and passion for the subject matter. I would further like to thank the Wits-TUB scholarship for funding this research project.

My gratitude is extended to the National Cleaner Production Centre of South Africa (NCPC-SA) and the Gauteng Department of Agriculture and Rural Development (GDARD) for assisting me with information regarding the subject matter. I would also like to thank my previous supervisor Shane Gertze from the Eastern Cape Parks and Tourism Agency for the moral support for pursuing my studies. To all my friends and members of the Ndovela family, thank you for being such a supportive structure and always encouraging me whenever I felt overwhelmed.

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List of Abbreviations

Abbreviation	Definition
AWARD	Association of Water and Rural Development (AWARD)
BOW	Business Opportunity Workshops
CHP	Combined Heat and Power
CO2	Carbon Dioxide
CO2eq	Carbon Dioxide Equivalent
CSBP	Centre for Sustainable Resource Processing
CSIR	Council of Science and Industrial Research
DEA	Department of Environmental Affairs
DFFE	Department of Forestry Fisheries and Environment
DTI	Department of Trade and Industry
EMM	Ekurhuleni Metropolitan Municipality
GDARD	Gauteng Department of Agriculture and Rural Development
GHG	Greenhouse Gas
GISP	Gauteng Industrial Symbiosis Programme
GL	Gigalitre
IE	Industrial Ecology
IS	Industrial Symbiosis
KG	Kilogram
KIC	Kwinana Industries Council
KISP	KwaZulu-Natal Industrial Symbiosis Programme
NCPC-SA	National Production Centre of South Africa
NWMS	National Waste Management Strategy
PFA	Pulverised fuel ash
RLF	Recycled Liquid Fuel
T	Tonnes
TIPS	Trade & Industrial Policy Strategies
TPA	Tonnes Per Annum
UK-NISP	UK-National Industrial Symbiosis Programme
WEEE	Waste from Electrical and Electronic Equipment
WISP	Western Cape Industrial Symbiosis Programme

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CHAPTER 1 – BACKGROUND AND MOTIVATION FOR THE STUDY

1.1 Introduction

Ayres & Ayres (2002) and Hart & Dowell (2011) suggested that Industrial Ecology (IE) focuses on product design and manufacturing processes and views firms (businesses) as agents for environmental (as well as economic) improvement. They linked IE with questions of carrying capacity and ecological resilience, asking to what extent is technological society perturbing or undermining the ecosystems that provide critical services to humanity. They also alluded to a broader definition of IE given by White (1994) which defines IE as "the study of the flows of materials and energy in industrial and consumer activities, of the efffects of these flows on the environment and of the influences of economic, political, regulatory, and social factors on the flow, use and transformation of resources."

Gaura *et al*. (2020) and Ericson & Larsson (2000) state that industries consume energy and produce waste and this contributes to Greenhouse Gas (GHG) emissions. According to Ahuti (2015) industrial waste is sometimes sent to landfill sites for disposal through various processes which all consume additional operational energy and release polluting gases. The processes that consume operational energy include transportation and storage of waste. Sariatli (2017), Singh & Chandra (2019), Sharma *et al*. (2020) and Ravindran *et al*. (2018) state that landfill waste disposal results in a linear industrial structure, where each industry uses raw materials and disposes byproducts in the landfill sites, even in cases where some of this waste could have been re-used to make other products.

Industries need to be connected and linked so that they can exchange information regarding the waste resources they have amongst themselves. Chopra & Khanna (2014), Fan *et al.* (2017) and Soratana (2011) state that when waste resources are identified they can then be exchanged so that other industries could reuse it as raw material or waste-resources. Pearce (2008) and Gibbs & Deutz (2007) argue that this creates a cyclical structure which ultimately reduces the waste sent to landfill as well as the operational energy used for landfill disposal. This creates a symbiotic relationship between industries (Sariatli, 2017). The concept of Industrial Symbiosis (IS) is explored further within Section 2.4.

Two of the major concepts in this research are IS and IE. These two concepts are important because the Gauteng Industrial Symbiosis Programme (GISP) is focused on bringing two or more industries together to share waste resources. Seager & Theis (2002),Socolow *et al*. (1994) and Ayres & Ayres (2002)define IE as a process where industries mimic natural ecosystems by re-using their waste materials to protect the environment and minimize waste pollution. Mirata *et al*. (2017) and Massard *et al*. (2012) indicate that IS is a subdivision of the school of IE which seeks to promote sustainable waste management. IS is seen as a process where information about available waste material is exchanged between industries so that waste can be used as inputs for other industries.

The main research theme is centred on understanding the impact of the facilitation process in establishing an effective and sustainable IS Programme in Gauteng and how it contributes to climate change mitigation and energy efficiency. According to Wouter (2016) Republic of South Africa (2004) and United Nations Industrial Development Organization (2015) there is proof that around the world there are various state agencies, industries and Non-governmental Organizations that aim to develop systems that promote IS within their production systems. O'Carroll *et al*. (2017) argue that in South Africa, an IS programme was established under the custody of the National Production Centre of South Africa (NCPC-SA).

According to the Cosmetic Export Council of South Africa (CECOSA) (2012), Shah *et al*. (2021) Smittenberga *et al*. (2005) and NCPC-SA is hosted by the Council of Science and Industrial Research (CSIR) and its role is to help industries within South Africa (Gauteng, Western Cape, Western Cape) to be competitive through sustainable production. Reig *et al*. (2013) and Taghilou *et al*. (2021) state that sustainable production can take place when industries reuse waste materials from other industries. GISP is a programme under the NCPC-SA and has a specific aim of connecting industries for landfill waste diversion. When industries reuse waste materials from other industries GHG emissions are reduced because waste materials is no longer transported to the landfill site.

1.2 Background

Throughout history industries had a negative impact on the environment. According to Ahuti (2015) there has been an increase in industrial waste – which found itself in landfills which further contributed to various environmental problems. O'Carroll *et al.* (2017) state that waste disposal

activities require energy and resources. In some cases, burning of waste within incinerators contributes further to CO2 emissions. Additionally industries were not connected and this led to little to no cooperation and knowledge sharing on sustainable waste management practices.

Sariatli (2017) highlight that hazardous Industrial waste is toxic and needs to be safely disposed and non-hazardous industrial waste can be used by other industries to make new products through IS. Baldassarre *et al*. (2019), Chertow (2007) and Lawal *et al*. (2021) indicate that the concept of IS attempts to create an industrial structure which establishes symbiotic relationships amongst industries with the objective of reducing waste disposal through the reuse by other industries waste materials. IS aims to mimic nature by promoting the reuse of industrial waste resources as indicated in Section 2.4. This can be achieved through the creation of IS programmes.

Wouter (2016) and Maama *et al*. (2021) highlight that during the 20th century IE as a field of study became popular because industries wanted to reuse their waste materials and reduce their GHG emissions. According to Frosch & Gallopoulos (1989) and Lifset & Graedel (2002), the intent behind IE was to reduce the impact of industries on the environment by reusing waste materials. Industries should be more like natural ecosystems where there is zero waste.

Seymore *et al*. (2014) and Department of Environmental Affairs (2020) state that South Africa is one of the most industrialized countries in Africa. South Africa is one of the largest emitter of GHGs. World Wildlife Fund South Africa (2016) and Department of Environmental Affairs (2020) argue that there are several key activities that make South Africa one of the largest emitters of GHGs such as burning coal for electricity, transportation services as well as industrial processes. The high emissions profile of South Africa can be attributed to the economic production and growth of the country. South African industries produce goods and service by using energy in the form of electricity and the energy is mostly produced by burning coal.

The Trade & Industrial Policy Strategies (2016) indicate that Gauteng is the economic hub and industrial centre of South Africa. Gauteng has other important economic sectors such as mining services, manufacturing and tertiary services as well. Gauteng accounts for approximately 33% of South Africa's economic activity. Bobbins (2013) argue that industries have operated individually and are not connected to create opportunities to share information and different kind of waste produce in case other industries might use it as a raw material. Association of Water an

Rural Development (2019) highlight that when industries do not share information about waste resources that can be re-used the waste ends up going to land fills.

Dyer & Nobeoka (2000), Kilduff & Tsai (2003) and Paquin & Howard-Grenville (2009) argue that facilitators can gather information about the waste materials that are present among industries and create platforms where industries can meet and exchange waste resources. Paquin & Howard-Grenville (2012) illustrates that IS is a branch of IE where facilitators can encourage businesses/industries to share their waste resources or products. Facilitators connect industries for the sole purpose of encouraging sustainable production for landfill waste diversion and possibly climate change mitigation which is further explored in a number of case studies (Kalundborg, Kwinana and Forth Valley) in Section 2.5.1 to 2.5.3.

In South Africa, the National Clean Production Centre of South Africa (NCPC-SA) was established to be the key driver facilitating IS Programme. According to Vladimirova *et al.* (2018), the NCPC-SA has GISP facilitators who coordinate and facilitate GISP. The programme has been running since 2014. The programme has an annual target of approximately 40 actualised synergies and diverting 300 000 tonnes of waste annually. NCPC-SA (2017) state that GISP has existed for 7 years and has an annual target of 40 synergies per year – this means over a 7-year period they should have 280 synergies. During 2016 it was found that only 7 synergies were completed instead of 40. The researcher investigated the facilitation process and the challenges that NCPC-SA is facing in terms of reaching their targets.

1.3 Problem Statement

Nahman & Godfrey (2010) Dinka *et al*. (2019), Ginindza & Muzenda (2016) state that in South Africa in general and Gauteng in particular industries generally lack coordination when It comes to waste management. The lack of coordination comes in the form of insufficient waste minimization and recycling initiatives, a lack of waste information and lack of regulation and enforcement of legislation. This results in each industry disposing waste in landfills. Makgae (2011) indicate that the disposal of waste has various impacts which include energy consumption as well as pollution and GHG emissions. Section 1.2 has highlighted that disposal of waste consumes energy via transportation and storage processes. Non-harzadous waste has the potential to be used as a raw material in various industries. For this to happen industries need a

programme or platform where they can co-operate and get to know what the other is producing as waste and find recycling opportunities.

IS facilitation is supposed to play an important role in establishing an interface where industries will share and exchange information. GISP was set up to facilitate this symbiosis – however it has not been very successful. Nahman (2018) argues that in Gauteng, out of a target 300,000 tonnes of waste per annum that was supposed to be diverted from landfills by GISPs IS initiatives only less than 111,000 tonnes was diverted. This suggests a failure in the creation of effective symbiotic relationships between industries. Section 1.2 has shown that GISP has not meet its target in terms of synergies.These failures raise issues around the role and effectiveness of the facilitation of IS and how such failures impact on GHG emissions, climate change and energy consumption.

1.4 Rationale

The facilitation process of IS programmes needs to be studied and evaluated so that it is improved over time. Patala *et al*. (2020) indicate that research that assesses the effectiveness of facilitation in IS contributes towards developing best practice guidelines for the IS implementation. The research therefore will assist the NCPC-SA to facilitate GISP effectively. This research, therefore, investigates the potential challenges that NCPC-SA face in the facilitation of IS: The researcher intends to further evaluate longer-term plans of intermediation that seek to keep different partners committed to a network, and how they may overcome these challenges. The aim to understand the longer-term prospects of GISP when it comes to climate change mitigation.

There is a lack of academic research that has been done to show the connection between GISP , GHG emission reductions and climate change mitigation. The researcher tried to address this existing research gap when it comes to the GISP. Zhang, *et al*. (2016) and Liu *et al.* (2017) indicate that “there is a lack of literature evaluating the potential GHG emission reductions that result from a comprehensive implementation of industrial symbiosis”. There is no available literature illustrating a mechanism for IS to be implemented specifically for GHG mitigation, nor any insight for developing IS strategies to specifically address GHG emission mitigation. The academic literature that is available on GISP mostly focuses on waste diversion targets rather than GHG emissions. The research gap is further discussed in detail within the literature review in Section 2.7.

1.5 Research questions, aim and objectives

1.5.1 Primary research question

How does the Gauteng Industrial Symbiosis Programme Contribute to Climate Change Mitigation??

1.5.2 Sub- research questions

1. What is the Gauteng Industrial Symbiosis Programme?
2. How effective is the Gauteng Industrial Symbiosis Programme in terms of landfill waste diversion and reducing greenhouse gas emissions?
3. What is the role of effective communication and information exchange in industrial symbiosis?
4. What are the prospects of and the long-term sustainability plans of the Industrial Symbiosis Programme in contributing to climate change mitigation?

1.5.3 Aim

- To highlight aims and objectives of the Gauteng Industrial Symbiosis Programme
- To determine if the Gauteng Industrial Symbiosis Programme is effective in terms of landfill waste diversion and reducing greenhouse gas emissions?
- To investigate role of effective communication and information exchange in industrial symbiosis.
- To learn what aspects would make an effective facilitation process in industrial symbiosis

1.5.4 Objectives

- To showcase the impact of GISP on landfill waste diversion and greenhouse gas emissions.

- To determine the link between effective communication and landfill waste diversion and climate change mitigation.
- To determine the most effective tools and techniques for information exchange between participants of the Industrial Symbiosis Programme and Facilitators

1.6 Hypothesis

The researcher predicts that landfill waste diversion in GISP contributes to the significant reduction of GHG Emissions despite failing to divert 300 thousand tonnes waste annually.

1.7 Limitations of the study

Access to information was an issue in this research. There were various types of information that were not provided upon request. The researcher did not have access to information on number of synergies that were “completed and finalized" per year between 2014 to 2019 and the GHG emissions that were reduced per year from GISP. Information on methods and tools used by officials to calculate GHG emissions on GISP was not made available upon request. The GISP contact database only had the name of the industry but there was no information on the type of industry and the potential waste that can be reused per industry.

The research faced various challenges during the data collection process. There were few interviews (6) that were conducted which only spanned between two organisations namely NCPC-SA and GDARD. There is a lack of research studies on GISP therefore the researcher had limited insight on the topic. The researcher could not conduct in-person observations in Business Opportunity Workshops (BOW) due to COVID-19 regulations.

1.8 Organization of the report

The first chapter looked at the background of the study. The second chapter which is the literature review gives an overview of the study by expanding on a key concept called IS. IS is concerned with connecting two or more companies so they can exchange waste resources that can be reused. It highlights that GISP is under the National Clean Production of South Africa and it aims to drive IS. The chapter further elaborates on the connection between landfill waste diversion and

GHG emission reductions. The second chapter further shows the conceptual framework which identifies the link between IS programmes and climate change mitigation.

The third chapter contains the research methodology that was be used by the researcher to conduct the research. The third chapter went into detail about how the researcher used interviews and reports in order highlight the connection between GISP facilitation and climate change mitigation.

The fourth and the fifth chapter contains the findings and analysis. The fifth chapter is focused on GISP's facilitation and its contribution to climate change mitigation in response to the sub-questions articulated in Section 1.5.2. The fifth chapter evaluates the performance and effectiveness of GISP communication platforms.

The last chapter contains the conclusion and recommendations. The conclusion covers four themes that are focused on the secondary research question namely GISP's purpose and intended outcomes, GISP impact on climate change mitigation, the successes and challenges of the facilitation process and the long-term plans for GISP n relation to mitigation of GHG-emissions.

CHAPTER 2 – LITERATURE REVIEW

2.1 Introduction

The research is primarily based on understanding the impact of the facilitation process in establishing an effective and sustainable IS Programme in Gauteng and how it contribute to climate change mitigation. The literature review is thematic because it covers several key themes such as IS, circular economy, climate change mitigation and facilitation. The themes in the literature review should not be viewed as separate components but they should be seen as interdependent and interrelated components of the study which are further displayed in the conceptual framework. The literature draws some connections between IS and climate change mitigation and energy efficiency.

2.2 Industrial Symbiosis and Climate Change Mitigation

Fawzy *et al*. (2020) and United Nations Environment Programme (2019) indicate that climate change is defined as the shift in climate patterns mainly caused by GHG emissions from natural systems and human activities. So far, anthropogenic activities have caused about 1.0 °C of global warming above the pre-industrial level and this is likely to reach 1.5 °C between 2030 and 2052 if the current emission rates persist. According to the Centre for Research on the Epidemiology of Disasters (2019) in 2018, the world encountered 315 cases of natural disasters which are mainly related to the climate. Approximately 68.5 million people were affected, and economic losses amounted to $131.7 billion, of which storms, floods, wildfires and droughts accounted for approximately 93%.

Intergovernmental Panel on Climate Change (1990) and Moberg *et al.* (2005) indicate that most of the GHG emissions from waste management activities are from disposal and anaerobic biodegradation of wet waste in landfills. This result in the generation and emission of landfill gas, primarily methane (CH4) and carbon dioxide (CO2). Whereas incineration has substantial emissions of CO2, landfilling has enormous impacts on the environment due to GHG emissions such as CH4 and CO2. Although CH4 production due to biological anaerobic process can be

recovered from landfills for power generation, inefficiency in the CH4 collection system exacerbates the situation

According to the World Economic Forum (2021) and Hashimoto *et al*. (2010) IS plays an important role in mitigating climate change. IS keeps valuable resources in use for as long as possible by identifying cross-sectoral business opportunities for utilising them. It can play a big role in helping industrial clusters achieve net-zero, particularly by addressing GHG emissions. This calls for a radical zero waste resource efficiency and strategies for elimination, by recycling, rather than managing waste; a consequence that will result in many benefits for slowing down climate change. Zero Waste is a goal for responsibly managing materials and the energy required to make them. Zhang *et al*. (2013) and Eneh & Oluigbo (2012) argue that waste minimization, recycling and re-use represent an important and increasing potential for indirect reduction of GHG emissions through the conservation of raw materials, improved energy, resource efficiency and fossil fuel avoidance.

2.3 Circular Economy and Industrial Symbiosis

According to Saavedra *et al*. (2018) and Ellen MacArthur Foundation (2015) the circular economy approach seeks to offer a solution through the promotion of reuse and recycling interventions. Resources are effectively and efficiently used throughout the product value chain. Baldassarre *et al*. (2019) further supports Saavedra *et al.* (2018) by arguing that the circular economy engages industries to rethink their processes and come up with sustainable means of producing their products. Kirchherr *et al.* (2017) indicates that in the circular approach a products life is extended through recycling and reuse of materials for industrial purposes. An industrial process in the circular economy require less raw materials from the environment and there is a decrease of waste being produced.

Ludeke-Freund et al. (2019)indicates that the Circular Economy can be understood as “a recovery process where waste materials are used as resource inputs, therefore GHG emissions are reduced by slowing and closing material loops. There are various ways in which a Circular Economy Approach can be promoted such as encouraging durable design of facilities, promoting upkeep of machinery, reusing material and recycling”

2.4 The Conceptualization of Industrial Symbiosis

Frosch & Gallopoulos (1989) indicates that IS is a subdivision of IE that can be understood as a process where two or more industries share waste resources so that they can be turned into finished products that can be re-used by consumers. Wolf (2007), Chertow (2007) and Chertow & Lombardi (2005) argue that the fundamental aim of IS is to encourage industries to consume their resources responsibly whether it be waste or energy resources. In light of these statements, industries are drawing inspiration from nature where waste forms as inputs for other natural processes.

The IS approach follows a circular economy approach. IS forms closed resource loops because waste is not discarded into the landfill sites. Industrial waste is treated and recycled so that it can create new products. Recycled products can be sold in the economy. Baldassarre *et al*. (2019) and Kirchherr *et al.* (2017) state that the circular economy engages industries to rethink their processes and come up with sustainable means of producing their products. One can conclude that In the circular approach a product's life is extended through recycling and reuse of materials for industrial purposes. Ludeke-Freund *et al.* (2019) argues that an industrial process in the circular economy requires less raw materials from the environment and there is a decrease of waste being produced and GHG emissions.

Yu *et al*. (2015), Marchi *et al.* (2018), Bonoli *et al*. (2020) and Chen & Shi, (2016) state IS may have a positive effect on GHG emission reductions. IS initiatives can assist businesses/industries to reduce carbon emissions through the effective use of resources and energy. Carbon emission reduction primarily results from by-product exchange and energy symbiosis. Zhang *et al*. (2016) and Marconi *et al*. (2018) further supports Yu *et al.* (2015) by arguing that industries can reduce their carbon emissions when they consume fewer resources by reusing their waste. Branca *et al.* (2021), Ansari (2017) and Lutje & Wohlgemuth (2020) argues argue that energy consumption is reduced when materials are re-used. One can conclude that one of the important indicators for evaluating the effectiveness of IS should be the amount of GHG emissions that are being reduced through IS activities.

Section 2.5 goes into detail about how IS is being implemented in different parts of the world. The next Section will also explore some of the key outcomes of IS such as GHG emission reduction and waste diversion within various IS programmes.

2.5 Industrial Symbiosis in Practice

This Section goes into detail on how IS has been implemented in different regions of the world. Only 3 case studies were chosen for the literature review namely Kalundborg (Denmark) in Section 2.5.1, Kwinana (AUS) in Section 2.5.2 and Forth Valley (Scotland, UK) in Section 2.5.3. Harris, (2007) indicates that in Kalundborg, Kwinana and Forth Valley industries decided to come together to address similar issues about wasteful consumption of resources and reducing GHG emissions through by-product exchanges . The networks then grew in number because industries could identify other industries that wanted to exchange waste resources. In these regions, IS is facilitated by increasing access to information on industrial waste resources to companies and fostering collaboration (Vladimirova, *et al*., 2018).

Harris (2007) argues that IS networks may be facilitated by the state through programmes that function at a regional or national level. The Kwinana Industries Council (KIC) facilitates IS across the Kwinana. The UK-National Industrial Symbiosis Programme (UK-NISP) coordinates the IS programme in Kalundborg through a series of workshops and waste information exchange sessions. The Scottish Industrial Symbiosis Programme bring together industry members, local authorities, regional developers and environmental regulators to form a steering group for IS in the Forth Valley region. One can conclude that regional steering committees play a significant role in developing and maintaining IS among industries.

2.5.1 Kalundborg

In the 1960's Kalundborg was one of the first places where IS was implemented. National Academy of Engineering (1997), Ehrenfeld & Gertler (1997) and Desrochers (2001) indicate that there are several key industrial businesses in Kalundborg such as the large power station, a refinery, a pharmaceutical and biotechnology company and various other companies. One can conclude that the region offers a fertile ground for IS because it has these different industries within its locality. The UK-NISP coordinates and facilitates synergies among the different industries in Kalundborg. Ehrenfeld & Chertow (2002) state that workshops are used as platforms where businesses are encouraged to exchange waste resources.

The IS interventions that were implemented in Kalundborg have resulted in significant GHG emission reductions. Harris (2007), Ehrenfeld & Chertow (2002) and Jacobsen (2006) state that “Asnaes Power Station in Kalundborg produces fly-ash as a byproduct which is reused in the cement making industries. This business venture subsequently decreasing emissions”. National Academy of Engineering (1997) indicate that in Kalundborg GHG emissions are reduced when waste products such as fly ash, sulphur, biological sludge, and gypsum have been converted into raw materials for production. Table 2.2 below shows some of the GHG emission reductions that were realized in 2007.

2.5.2 Kwinana

Kwinana is one of the key regions where IS has taken place. It has the largest concentration of heavy industries in Western Australia. IS emerged during the late 1980s in the Kwinana region. Industries in the region decided to come together and form partnerships to reuse their waste resources and byproducts. Van Beers *et al*. (2007) and Bossilkov *et al*. (2005)indicate that the industries formed the KIC to facilitate the synergies that have already been existing in the area. Harris (2007) argues that the industrialized area has developed approximately forty-nine resource synergy projects which focused on the recovery of previously discarded by-products or shared use of water and energy infrastructure.

Several IS syernegies have resulted in GHG reductions in the Kwinana industrial area. According to Harris (2007:4) “the Centre for Sustainable Resource Processing (CSBP) is a major chemical manufacturer in Kwinana and this facility supplies the Alcoa alumina refinery with its waste resource which is CO2 and that will assist the alumina refinery to neutralise the alkalinity in its bauxite residue”. Through IS, industries can also share technologies that can reduce GHG emissions. Harris (2007), Van Beers *et al*. (2007) and Harris *et al*. (2008) argue that the HiSmelt plant uses smelting technology that allows for a simpler and more flexible iron making process that avoids cooking ovens and sinter plants. When industries use the technology it results in the reduction of emissions such as CO2 and nitrogen oxide.

2.5.3 Forth Valley

Harris & Pritchard (2004) indicate that IS has been implemented in the Forth Valley, which is located in the central belt of Scotland and houses the largest industrial area in Scotland. There

are 26 synergies within the industrializing area. Harris *et al*. (2008) and Golev & Corder (2012) argue that IS exchanges within the region include power station ash reuse, energy recovery from sewage sludge and the development of a biomass power station. The synergies within the area are being driven by the Scottish Industrial Symbiosis Programme. The programme allows industries to share information on the waste resources they have through several key workshops and information sharing sessions.

Krese *et al*. (2019), Lopes (2013) and Ruiz-Puente (2021) argue that the IS exchanges in Forth Valley have reduced GHG emissions. ScotAsh is a partnership between LaFarge cement and Scottish Power. Harris (2007) state that the partnership focuses on reusing approximately 500,000 tonnes per annum (TPA) of Pulverised fuel ash (PFA). Each tonne of PFA used in cement products results in a reduction of 900 Kilogram (kg) of CO2 emissions. In the same region, the LaFarge Dunbar uses recycled liquid fuel (RLF) and scrap tyres for fuel and ash (from ScotAsh) and recycled glass/sand as alternative raw materials". According to Nakomcic-Smaragdakis *et al.* (2016) the use of waste as alternative fuels will help reduce energy expenses and subsequently production costs and this will increase a cement industry's competitive advantage.

Table 2.1 below summarises the information on sustainability benefits for the three IS regions from Harris's (2007) research on *"The Potential Role of Industrial Symbiosis in Combating Global Warming"*. The majority of the information reported relates to environmental information, e.g. energy savings or waste materials diverted from landfill.

Table 2 1: Industrial Symbiosis Programmes and GHG Impacts

Region	**Reported Sustainability Results – from Harris (2007) study on "The Potential Role of Industrial Symbiosis in Combating Global Warming"**
Kalundborg (DK)	• "170,000 tonnes of CO2 • Energy savings equivalent to 30,000 tpa coal and 19,000 tpa oil • 280,000 tpa diverted from landfill (fly-ash, scrubber sludge etc) • Replaced 200,000 tpa gypsum use and 2,800 tpa sulphur use

Kwinana (AUS)	• 170,000 tpa CO2 emission reduction from Combined Heat and Power (CHP) • 70,000 tonnes CO2 absorbed in alumina residue • 463 tonnes CO2 saved from reduced transport • 10,000 tpa by-product gypsum recovered for reuse • 6 Gigalitre (GL) high grade industrial water recovered from treated waste water • 260,000 tons diverted from landfill
Forth Valley (UK)	• 33,000 CO2 saved using pulverised fly-ash in cement production • 17-18,000 CO2 recovered from distillery and sold to food industry • 164,000 tpa various sludge diverted from landfill • 11,000 tpa poultry litter, avoiding disposal; 81GWh/yr (renewable) • 500,000 tpa fly-ash diverted from landfill • 22,000 tpa tyres and 20,000 tpa RLF substituting for 40,000 tpa coal • 4000 tpa off-spec polymer, and 60,000 tpa other plastics recycled • 7500 solvents/tar for fuel • Other materials (compost etc) 25,000”

Source: Harris (2007, page 8)

The successful implementation of IS within the international arena such as Kalundborg may have assisted developing countries such as South Africa to develop their IS programmes. According to O’Carroll *et al*. (2017), the success of South Africa’s IS programme can be attributed to the lessons learned from the United Kingdom Industrial Symbiosis Programme (UK-NISP). The Western Cape Industrial Symbiosis Programme (WISP) drew some of its guidelines for implementation from the Kalundborg case studies. Section 2.6 gives an overview of IS in the context of South Africa.

2.6 The Emergence of Industrial Symbiosis in South Africa

In 2013 the GreenCape (which is a state entity) successfully piloted WISP. WISP was funded by the Department of Economic Development and Tourism in the Western Cape Province. O'Carroll *et al*. (2017) state that during 2013 approximately 60 tonnes of waste was diverted from the landfill sites which translated to 5.7 million Rands in savings and 4 permanent jobs were created. The programme was then established for full implementation in 2014. Table 2.2 below shows that most of the success of WISP was attributed to landfill waste diversion rather than GHG emissions or energy savings. More studies are needed to reflect on the GHG reduction potential of IS. Further studies are also needed to investigate the reduction of embodied energy in materials that comes from IS.

Table 2 2: Synergies implemented in WISP during 2013 and 2014

Table 3: Summary of WISP synergies implemented during the 2013-2014 pilot year*

	Synergy Description	Benefits	Once-off/ Continuous**
1	Label Manufacturer's wood pallets returned to various suppliers for reuse	– Landfill diversion	Continuous
2	New Logistics Service Provider selected by Plastic Injection Moulding Company through increased networking opportunities	– Cost savings	Continuous
3	Pharmaceutical company and consulting company collaborate to increase the efficiency of waste management in a manner that benefits eight companies	– Landfill diversion – Additional sales – Cost savings – Additional investment	Continuous
4	Wood pallets exchanged* between Waste Management Company and Wood Pallet Refurbisher	– Landfill diversion – Additional sales – Cost savings	Once-off
5	Wood Pallet Refurbisher internally investing due to increased networking opportunities	– Additional investment	Once-off
6	Plastic pallets exchanged between a Wood Pallet Refurbisher and a Plastic Pallet Refurbisher	– Landfill diversion – Additional sales – Cost savings	Once-off
7	Broken fishing nets exchanged between a Marine Fishing Company and the City of Cape Town	– Landfill diversion	Once-off
8	Replacement of LED Lights at a Foundry by an Energy Efficient Lighting Company - following a relationship facilitated at a WISP workshop.	– Additional sales – Cost savings – Energy savings	Once-off
9	X-ray film and litho fixer exchanged between a Label Manufacturer and a Metal Recovery Company	– Additional sales – Cost savings	Once-off
10	Increased LDPE recycling by Label Manufacturer and Waste Management Company	– Landfill diversion – Cost savings	Once-off

** A synergy is described as the transaction or movement of materials between participating companies enabled by the active facilitation of WISP. This could be one way or two way flow between participating partners.*

Source: O'Carrolla *et al*. (2014, page 238)

WISP success can also be attributed to the facilitation mechanisms that were put in place by Greencape. O'Carrolla *et al.* (2014) and O'Carroll *et al*. (2017) note that WISP had facilitators who actively built an IS network to identify under-utilised resources which could lead to business opportunities or "synergies" for the member companies. The IS synergies were identified during BOWs and business meetings. Through the network 529, under-utilised resources were identified and 1205 potential synergies were created.

Despite the successes of WISP, there were several key challenges in the uptake of IS. Based on Table 2.2 only 10 synergies were implemented so there is a huge gap between the synergies identified in a workshop to the ones that are implemented. Kasese *et al* (2016) state that The barriers to IS implementation range from lack of access to finance, lack of access to information on waste resources, the distance between industries and lack of staff to process waste etc.

After the pilot of the IS programme in the Western Cape, it was spread across two other provinces namely Gauteng and KwaZulu-Natal. O'Carroll *et al*. (2017) indicate that The provincial programmes are called GISP, WISP and KwaZulu-Natal Industrial Symbiosis Programme (KISP) . For this research, the researcher focuses on GISP which is run by the National Clean Production Centre of South Africa as indicated in Section 1.1.

2.7 The implementation of the Gauteng Industrial Symbiosis Programme

Gauteng offers a fertile ground for the implementation of the IS. According to Van Zyl (2010)The province is regarded as an industrial hub in South Africa. Oelofse *et al*. (2018) state that the Gauteng Province occupies approximately less than 2% of South Africa's surface but it produces more than 45% of the country's 45% of the total municipal waste. Recycling Projects (2013) argues that the landfill sites in the province are near full capacity therefore there is a need for waste resources to be reused

The NCPC-SA uses several facilitation structures to increase waste resource exchanges between Gauteng industries. Resource exchange workshops are used to drive IS in the province. The workshops kickstarted GISP in 2014. International Synergies (2015) indicates that the resource exchange workshops attracted various businesses and assisted the NCPC-SA to identify potential resource exchanges. Facilitators would set up follow up sessions and meetings with

industries to facilitate some of the resource exchanges and record the impact of the synergies which is further discussed in Section 4.2 and Section 5.4.

According to Oguntoye *et al*. (2018) there is a lack of academic research that focuses on the impact of the GISP and climate change mitigation. Most of the sources that show the connection come from industry-related materials such as NCPC-SA brochures and newspaper articles on GISP. There is also a lack of research that shows the direct link between IS and energy efficiency. These are some of the key aspects that are addressed in this research in Section 4.3.

2.8 Conceptual Framework: Defining Industrial Symbiosis Networking

IS is a process where companies exchange waste resources as shown in the literature review. According to Oguntoye *et al*. (2018) and NCPC-SA (2017) for IS to be a success it needs to be facilitated by certain institutions such as the NCPC-SA. NCPC-SA (2020) indicates that the NCPC-SA has GISP facilitators would guide industries on how to exchange waste resources among themselves. The conceptual framework in this Section highlights the complex machinery of facilitated IS that is evaluated in the research.

Figure 2.1 shows that a facilitated IS programme can drive waste resource exchanges. Industries would dispose of their waste in the landfill site if there is no facilitated IS programme as shown with the black arrows. A facilitated IS programme on the other hand would engage with industries and get them to reveal information about the different types of waste they might have (see the green arrows). The IS programme facilitators create a database of all the waste information from the different companies and from the database partnerships are identified that could be developed for the re-use of waste materials. Once these partnerships are established and developed their progress is monitored when it comes to waste diversion, GHG emissions and cost savings which is further discussed in Section 4.3.

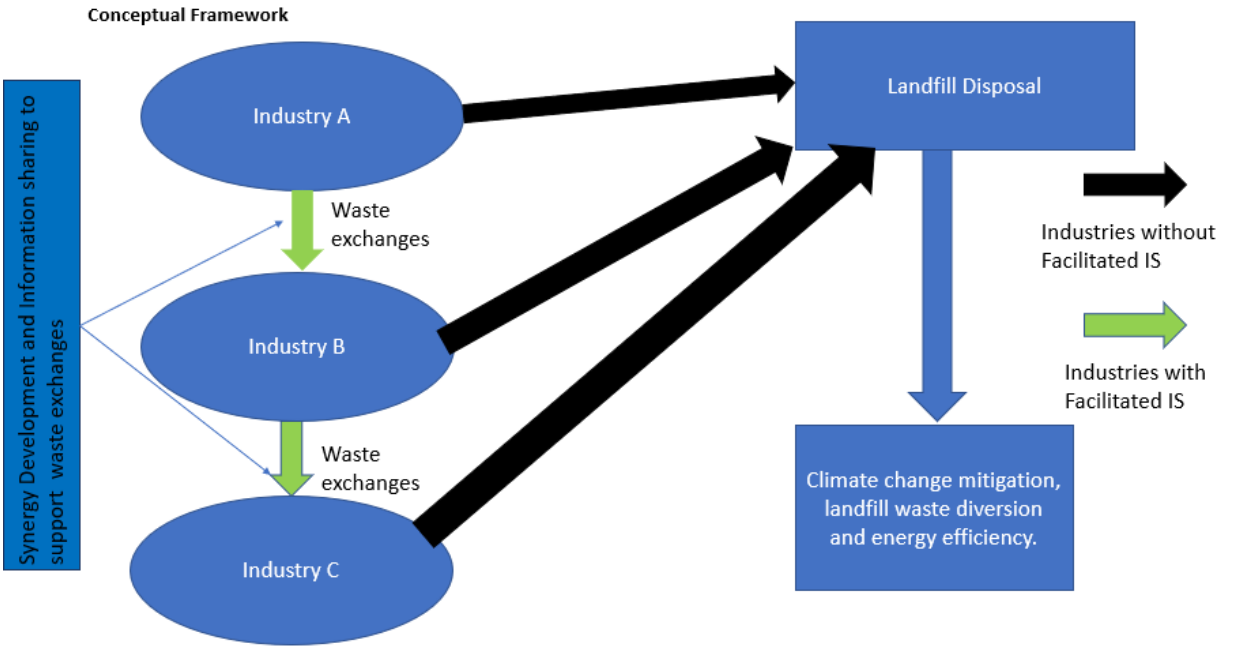


Figure 2 1: Conceptual Framework

Guided by the above diagram one can see that are several crucial components that need to be discussed for the research and these components include information sharing in Section 2.8.1, synergy development in Section 2.8.2, climate change mitigation and energy efficiency in Section 2.8.3.

2.8.1 Information Sharing and Initial Engagements

Arguably the first step of an IS programme is the information exchange stage. Sodergren & Palm (2021) argue that during the information sharing/exchange stage stakeholders are invited to workshops or conferences and they are told about the importance of waste resource exchanges and how industries might benefit from such interactions or engagements. According to Oguntoye *et al.* (2018) in the GISP context, the first BOW was held in November 2014. During the business opportunity BOWs, stakeholders are told about the importance of IS and how they could benefit from it such as revenue generation, waste diversion and GHG emission reduction. Yeo *et al*. (2019) and Cutaia *et al*. (2015) indicate that stakeholders are encouraged to share information on the waste materials that they have generated within their respective companies and a database

is created to identify potential resource exchange partnerships. Synergy development is further discussed in Section 2.8.2.

There are a number of key drawbacks when it comes to information sharing within GISP. The shortfall that comes with the information sharing in the IS network is that there are simplistic descriptions of industrial resources. For example one of the participants in the BOW had only indicated “Plastic” as their waste resources without indicating the type of plastic or what state or from which product or process the plastic in view was obtained. Oguntoye *et al*. (2018) argues that there are three facilitators in the region therefore this might have an impact on the number of follow-ups that can be done for clarifications.

2.8.2 Synergy Development and Resource Exchanges

The second possible stage after information sharing is the synergy development and resource exchange stage. . Kasese *et al*. (2016) and Paquin & Howard-Grenville (2009) indicates that IS begins when two or more organizations are matched because they want to trade in a particular waste resource. One organization has waste resources that they are not using, and the other organization needs the waste resource for its industrial processes. Chertow (2007) and Zhang *et al*. (2015) argue that once the synergy has been identified it is recorded within the IS database . Once the synergy has been identified it moves along different processes that are highlighted by International Synergies Limited such as:

- Synergy identification – organizations are paired for a resource exchange
- Discussion and negotiation on the dynamics of the resource exchange which touch on legal matters, contractual obligations, and expenses.
- The companies draft an agreement on the exchange and sign the necessary paperwork. The transactions are also processed.
- The resource is exchanged between businesses and the exchange and the benefits reported to the programme.

Oguntoye *et al*. (2018) state that several key issues can arise during the synergy development and resource exchange phase. There can be a small number of facilitators within a particular region that covers approximately 400 companies that are part of the IS network. Capacity amongst facilitators can therefore be an issue when it comes to conducting follow-ups with

regards to synergy development and establishing processes for resource exchanges.. After the synergy has been render operational the facilitators have to record the success of the synergy and this forms part of Section 2.8.3.

2.8.3 Reporting on Waste Diversion and Climate Change Mitigation

Hashimoto *et al*. (2010) argue that facilitators and businesses need to record the benefits after the synergy development and resource exchange phase. Domenech *et al*. (2019), Santos & Magrini (2018) and Costa *et al.* (2010) argue that IS partnerships were developed because of their potential benefits such as resource savings, obtaining economic benefits and meeting environmental requirements such as reducing GHG emissions. To show that the purpose has been achieved the benefits need to be recorded and a report needs to be published for the public.

An IS facilitator can fail to gather information on the benefits that are derived from the IS synergies. In the South African context, some environmental consultants might attend workshops organized by coordinators of the programme and pose as regular companies with a genuine interest in the exchange of some waste resources with other companies. Oguntoye *et al*. (2018) indicates that The environmental consultants would however use GISP to recruit private clients while refusing to disclose the realized synergies or resource savings to the facilitators.

2.9 Conclusion

The literature review, therefore, highlighted several key issues when it comes to facilitating IS. IS is a subdivision of the school of IE. IS has the potential to mitigate climate change and promote energy efficiency. There are numerous barriers and enablers of facilitating IS and facilitators are at the core of navigating both issues. The researcher identified the structure that promotes the facilitation of IS and evaluated its effectiveness based on the outcomes.

The literature review that was conducted is relevant for the third chapter since it highlights the key stakeholders that the researcher needs to engage with pertaining to the study and some of the knowledge gaps that the researcher explored within the data collection process.

CHAPTER 3 – RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter has different sections that address issues about research methodology, data collection and data analysis that were used for the research. Firstly, the chapter introduces the reader to the research methods and sampling techniques or strategies. The second part of the chapter touches on the data collection and analysis process. The semi-structured interviews and documents were the data collection tools. The research methods that were used were guided by the main research question and secondary research questions, followed by the fourth Section which summarizes the data analysis processes. Lastly, the chapter covers the ethical considerations including the limitations of the study.

The researcher used a qualitative approach for the research. Taylor *et al*. (2015), Silverman (2020) and Patton (2014) argue that qualitative research analyzes data from interviews and written documents. Social scientists use qualitative research when studying real-world settings to develop case studies. According to Merriam & Grenier (2019) a researcher used inductive analysis in order to identify patterns and themes related to the research questions in the data. The researcher uses thematic analysis when it comes to analyzing research data in the upcoming chapters.

3.2 Research Design

The research design is a strategic framework that guides the researcher when it comes to connecting the research questions and the implementation of the research project. Blanche *et al.* (2006) Ram (2010) and Borwankar (1995) state that the the research design is a guideline that sets the conditions for the collection and analysis of data in a manner of answering a particular research question. Lelissa (2018) argues that the research design clearly outlines the procedure for data collection, the methods that are used to collect data and how the researcher will analyze this data to answer the research question .

The research design is exploratory. Swedberg (2018) state that exploration in research can be understood as a process where the researcher wants to discover something new concerning a

certain topic . In this research, the researcher tried to find a connection between IS, climate change mitigation and energy efficiency through programmes such as GISP as discussed in Section 2.7. To explore the connections, the researcher used several research instruments such as documents and semi-structured interviews which are further discussed in Section 3.4. Nassaji (2015) and Jeet & Kumar (2015) indicates that the fundamental aim of exploration was to gain a deeper understanding of individual participants, including their opinions, perspectives, and attitudes.

The researcher used case studies during data collection in order to highlight that GISP has an impact on GHG emission reductions. The BOW case studies in particular were also used to determine if there was a decline or increase in the number of participants, waste resources and synergies that are part of GISP.

3.3 Sampling Method

Etikan & Bala (2017) and Thompson (2012) indicate that sampling is regarded as a process of selecting the sample from a specific population to obtain research data. Polit *et al*. (2001) highlights that a sampling method assists the researcher to select the population eligible for the study. Considering the recent statement, the researcher chose a specific sampling method based on the research question. To support this action sampling is defined by Bhardwaj (2019) as a procedure to select a sample from an individual or a large group of the population for a certain kind of research purpose.

The researcher used the purposive sampling method. Guarte & Barrios (2006), Bernard (2002) Omona (2013) and Creswell (2002) argue that the purposive sampling method is known as a selection of sampling units within the segment of the population with the most information relevant to the study. It is the most appropriate method for this research, as the researcher applied their knowledge of the research problem to handpick the participants from the list of members and stakeholders who were part of GISP interventions. The burden of the judgment of who should be included in the sample remained with the researcher. Table 3.1 shows some of the organizations that were approached for interviews. Only six interviews were conducted.

Table 3. 1: GISP Research Interview Update

No	Organization	No. of Respondents	Request Sent for interview
01	NCPC-SA	2	Completed
02	GDARD	4	Completed
03	Department of Trade and Industry (DTI)	0	No response
04	DEAFF	0	No response
05	Ekurhuleni Metropolitan Municipality (EMM)	0	No response
06	DTI	0	No response

3.4 Data Collection

Data collection was largely driven by a qualitative research approach. According to Gall *et al*. (2007) Qualitative research involves an inductive exploration of the data to identify recurring themes, patterns, or concepts and then describing and interpreting those categories. The qualitative research is aligned with the research design Section since it is exploratory and this was discussed in Section 3.2. Grossoehme (2014) argues that qualitative research uses written texts, interview transcriptis from individuals to understand the meaning of certain experiences (Grossoehme, 2014). The researcher wanted to understand and investigate GISP's impact on climate change mitigation in Gauteng. The methods that were used to document such experiences and impacts include interviews and industry-related documents on GISP. In this section, the researcher clearly states the methods (semi-structured interview and documents) that have been used for data collection. Section 3.4.1 to 3.4.3 go into detail on the research methods that were used for the research.

3.4.1 Semi-structured interview

Merriam & Tisdell (2015) further states that in qualitative research most interviews are in a semi-structured format. Kvale & Brinkman (2009) and Flick (2009) indicate that while the interview guideline has questions that the interviewer wants to ask every participant however there are times where there will be, more open-ended questions that could be followed up with probes. The researcher can further ask the respondent to clarify certain key topics or issues.

The researcher used semi-structured interviews to gain data on GISP from GDARD and NCPC-SA as reflected in Table 3.3. The semi-structured interview had a certain logical flow. The first three questions attempted to understand the role of the official and their organization in GISP. Afterwards, the questions were focused on the effectiveness of the communication and information exchange strategies as well as requesting information on the effectiveness of the programme in terms of climate change mitigation.

While the interview was structured it was flexible because the researcher wanted to probe the interviewees on other topics that arose during the discussion. interviews were conducted for the research via online platforms. interviews were conducted with reference to ethical consideration recommendations. Verbal consent was requested before the interview process commenced. The respondents were notified that they can refuse to continue with the interview anytime during the interview.

3.4.2 GHG Emission Savings Calculations

The researcher had to follow a series of steps in order to calculate the GHG Emission Savings from GISP. The researcher first had to determine how much waste was diverted from each type of waste stream (Ash,Paper and Plastic etc). The researcher gathered the information from Nahman's (2018) report on "*Economic Benefits of Diverting Waste from Landfill through the Gauteng Industrial Symbiosis Programme".* The tonnages are listed in Table 4.2 under the column titled *"Tonnages diverted over three-year period (April 2015 – March 2018) in GISP"*.

The second step involved the collectionn of estimates via articles and online sources on the amount of GHG emissions that are avoided by recycling a tonne of specific waste stream (See Appendix A and the third column in Table 4.2). The researcher then took the tonnes of waste diverted for a specific waste stream in total and multiplied it by the amount carbon emissions that are avoided per ton of that specific waste stream (see column four in Table 4.2).

Section 4.3 and Table 4.2 shows that GISP has led to a reduction of GHG emissions in different waste streams in the Gauteng Province. O'Carroll *et al*. (2017) indicates that when industries reuse materials, they decrease the number of virgin materials that are required for industrial processes thus reducing GHG emissions and embodied energy of materials.

3.4.3 Documents

Owen (2014) and Bardach (2009) indicate that in policy research data falls into two categories namely documents and individuals. Yanow (2007) and Corbin & Strauss (2008)proposes that a researcher can assess documents in preparation for an interview. Considering this statement by Yanow (2007) and Rapley (2007) the researcher used annual progress reports from NCPC-SA on the IS Programme to develop and craft interview questions. Bowen, (2009) and Labuschagne (2009) further supports Yanow (2007) that documents can be used to develop the research project and interview guidelines.

Documents assisted the researcher in triangulating interview data; therefore the researcher was equipped with additional information that supported or challenge what was being stated by a respondent. The analysis of interview data from GISP facilitators and GDARD officials was triangulated with progress and annual reports as well as operational plans. Figure 3.1 shows that when a respondent argued that GISP contributed to a decline in GHG emissions the researcher investigated the reports and case studies to confirm if there was indeed a reduction of GHG emissions from the syerngies. Afterwords the researcher would use the landfill waste diversion figures in the reports to calculate potential GHG emissions.

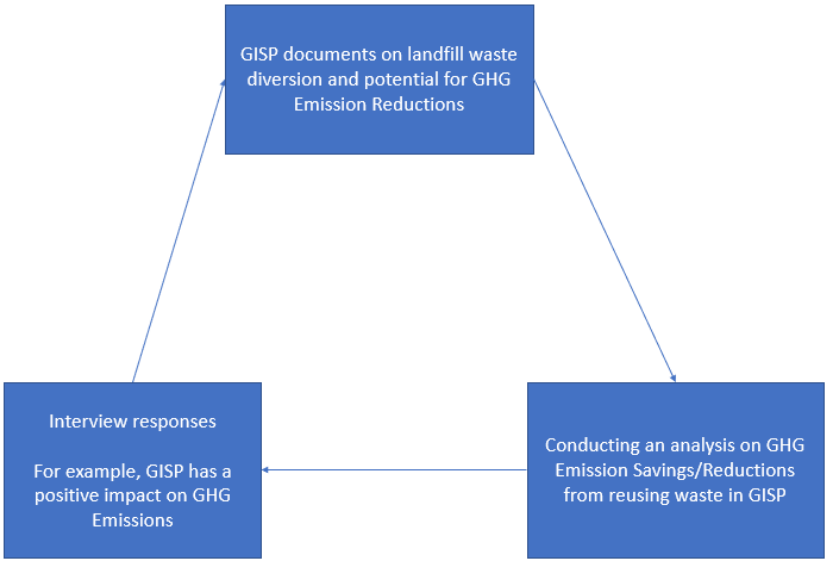


Figure 3 1: Triangulation

The NCPC-SA releases annual reports on GISP facilitation. It was therefore essential for the researcher to review the documents and to understand the progress made with regards to the programme as well as the shortcomings. The reports were used to determine the amount of waste diverted on annual basis since the inception of the programme and from those figures the researcher was able to determine the avoid GHG emissions. The reports played a crucial role in the research proposal and project stages as well as in the data collection and analysis process. Table 3.2 below shows all the reports collected by the researcher for the data analysis stage.

Owen (2014) further argues that collecting information through document analysis is not a simple task. Facts derived from history and assessments may never arrive at the researcher in a pure form because they consist of someone's reflection. The researcher was therefore wary of these facts when interrogating said information.

Interviews played a crucial role when it came to collecting relevant reports and documents from respondents. The researcher received documents via email on the progress from GISP from the NCPC-SA and GDARD during the interviews.

Table 3 2: Reports and Documents for GISP Research

No	Report Name	Year
01	ISP – Save the Date – Business Opportunity Workshop	2016
02	Workshop Announcement	2016
03	Industrial Symbiosis Programme brochure	2016
04	How to Implement Industrial Symbiosis Programme	No Date
05	Industrial Symbiosis Programme brochure	2017
06	Industrial Symbiosis Programme & Progress in South Africa An Introduction Henry Nuwarinda & Sarah O'Carroll National Programme Team Leaders	2017
07	Gauteng Industrial Symbiosis Programme progress. in nutshell	2017

08	Facilitating Industrial Symbiosis Programmes in Developing Countries: Reflections from Gauteng	2018
09	Economic Benefits of Diverting Waste from Landfill Through the Gauteng Industrial Symbiosis Programme: Final Report Anton Nahman	2018
10	Intermediaries & key enabling Technologies for the ideation and implementation of industrial symbiosis	2018
11	National Approaches to Industrial Symbiosis Programme	2019
12	Nat Waste Management Strategy 2019	2019
13	GISP GDARD Workplan 2020-2021	2020
14	Business Opportunity Workshop Summary Reports (2014 to 2018)	2014 to 2018
15	NCPC-SA Annual Highlights Reports (2014 to 2019)	2014 to 2019

Table 3.3 links the sub-questions with the types of data, data sources, data collection methods and the various forms of evidence of the research.

Table 3 3: Research Methods Table

Research Question (Sub Question)	**Data Sources**	**Data Collection Method**
• How effective is the Gauteng Industrial Symbiosis Programme in terms of landfill waste diversion and reducing greenhouse gas emissions?	• Estimation on the amount of GHG emissions that have been reduced	• GISP Reports and Estimates of GHG Emission Reductions from different Waste Streams.
• What is the role of effective communication and information exchange in industrial symbiosis?	• Secondary data (reports on the communication strategies used by NCPC-SA for GISP and the intended outcome of such communication strategies) • Primary data from interviews showing the role of communication approaches in GISP and how it drives synergy development	• NCPC-SA reports and research reports. • Interviews from NCPC-SA and GDARD
• What are the prospects of and the long-term sustainability of the Industrial Symbiosis Programme in contributing to climate change mitigation? •	• Secondary data from reports (annual and quarterly reports spelling out the prospects of and the long-term sustainability of the Industrial Symbiosis Programme in contributing to climate change mitigation? • Primary data from Interviews with project managers and coordinators highlighting the prospects of and the long-term sustainability of the Industrial Symbiosis Programme in contributing to climate change mitigation?	• NCPC-SA reports and research reports. • Interview with NCPC-SA officials

3.5 Ethical considerations

The research was subjected to the Wits Ethics Clearance Process(See Appendix D with approved ethical clearance certificate) . The researcher followed the process because data was going to collected from individuals in the form of interviews. The researcher listed various strategies and actions to protect the integrity of the research in the following paragraphs in this section.

Government officials (GDARD and NCPC-SA) had to request permission from their senior managers to be part of the research. The researcher had to share the personal information sheet and articulate to the senior managers via emails the importance of the research and that this is for a Masters Degree in Urban Studies qualification. Once the senior managers were informed of the intended purpose of the study, they were able to allow junior officials to be part of the interview process.

Government officials shared sensitive internal reports that should not be added as an Appendix in the final report. The researcher did not add the 2021/2022 Workplan for GISP since it was a sensitive document. The researcher briefly highlighted the direction of the Gauteng Industrial Symbiosis for the 2021/2022 financial year.

The interviewed respondents were first briefed of their involvement in the research and the structure of the interview as specified in Section 3.4.1. The respondents were informed that the researcher will share the research report after completion of the study. The research took place during the height of COVID-19 therefore verbal consent was received via MS Teams and Zoom meetings from the respondents.

The researcher guaranteed anonymity and confidentiality for the respondents. All names were kept hidden during and after the research and personal information was not disclosed in protection to their identities. The participant were notified that they may withdraw at any time or not answer any question if they feel uncomfortable during the interview process.

The semi-structured interview method listed in Section 3.4.1 had to undergo an ethics approval process for the researcher to conduct the interviews.

3.6 Conclusion

The research methods and the design of the study was appropriate and suitable for the study. Most of the government officials that were selected had participated in GISP therefore they could give the most relevant data about the programme. The interview guidelines addressed all the relevant questions that touched on the state facilitated GISP Chapter 4 and Chapter 5 present the findings that were collected using the data collection tools listed in Section 3.4

CHAPTER 4 – GISP IMPACT ON GHG EMISSION REDUCTION TARGETS

4.1 Introduction

Through effective communication, industrial stakeholders share waste resources and subsequently reduce greenhouse gas emissions. It was therefore, important to evaluate the communication channels and platforms within GISP to understand how waste exchange partnerships are formed. From the waste partnerships, there was a reduction of GHG emissions which was further communicated to the public and various Gauteng industries.

Two sub-questions are covered in this Section as follows:

- How does the Gauteng Industrial symbiosis program contribute to climate change mitigation?
- What is the role of effective communication and information exchange in industrial symbiosis?

Different themes were created to unpack and analyse the findings from the primary (interviews) and secondary data (reports and literature). The themes were mostly based on sub-questions mentioned above. Section 4.2 covers the GISP facilitation process, Section 4.3 covers approaches to facilitation: including their successes and challenges and Section 4.4 covers the potential of GHG reduction through industrial symbiosis.

4.2 GISP Facilitation

According to Vladimirova *et al*. (2018) the purpose of IS is to divert waste from the landfill site and use it as a resource in the production process as appraised in Section 2.4. In doing so, a company can save energy, water, travel expenses in their day-to-day business. It should be noted that making use of an already processed resource is cheaper than making use of virgin material as indicated by most respondents from the interviews. Within this context, the GISP facilitates industries to make use of waste generated from other industries to produce other products within Gauteng Province.

The GISP is regarded as a free facilitation service which promotes industrial sustainability and profitability. Vladimirova *et al*. (2018) notes that the programme has a target of 40 actualised

synergies and 300,000 tonnes of landfill waste diversion annually. The programme is funded by various institutions such as the DTI as well as GDARD.

The BOW was the first major event to kick start the programme in November 2014. Oguntoye *et al*. (2018) indicates that the workshop attracted several businesses from different sectors of the economy in Gauteng and approximately 32 businesses attended the workshop. One of the key outcomes of the workshop was the identification of 250 potential resource exchange opportunities among the participants.

GISP is primarily focused on landfill waste diversion and it does not have a specific and direct objective for climate change mitigation. An official from GDARD indicated that GISP cannot be described as a vehicle for climate change mitigation because the focus of the programme is on waste recycling. Climate change mitigation would mostly be addressed by implementing projects that encourage the use of energy efficient technologies and renewable alternative energy sources and not so much in terms of waste diversion. Concern with climate mitigationin GISP is therefore limited compared to the emphasis on waste diversion (interview 004 – in Appendix C.4).

The GISP contact data base has approximately 370 companies that want to buy or exchange waste resources under the programme. The companies range from mining, construction companies, manufacturing, steel, iron and paper industry. According to NCPC (2020) the companies that are in the database are contacted by the NCPC-SA to attend BOWs where companies present the different waste resources they might want to exchange as discussed in Section 2.8.

Nahman (2018) indicates that such companies contribute to landfill waste diversion. Table 4.1 shows that 244 tonnes of waste were diverted in the 2015/16 financial year. The quantity increased to 5 956 tonnes in 2016/17 year and 105 302 tonnes in 2017/18. As of 2018/19, the quantity was expected to grow further, as there is now a dedicated team of facilitators working on synergy progression full time, and specific attention is on industrial synergies with sizable amounts of waste streams. From these figures, one can tell that GISP is falling short of its annual target of 300 000 tonnes of waste diverted. Nahman (2018) indicates that the waste recycling has offset close to 70 000 tonnes of GHG emissions.

Table 4 1: Tonnes of Waste Diverted Per Financial Year

Financial Year	Tonnes of Waste Diverted
2015/16	244
2016/17	5 956
2017/18	105 302
Total	111 502

Source: Nahman (2018, page 11)

Nahman (2018) argues that dumping waste in landfill sites can have a disastrous impact on natural and social environments, through the release of certain emissions such as methane and CO2. Diverting waste from landfill through IS may result in mitigation of these externalities. This positive impact should also be considered as an additional benefit of GISP. One still needs to acknowledge that a considerable amount of waste is still being diverted from landfill sites as reflected in the previous paragraph. The waste diverted also contributes to mitigation of GHG emissions.

Nahman (2011) state that in addition to GHG impacts associated with landfill disposal, waste can have negative health consequences for people who reside in areas around landfills (Nahman, 2011). One can say that with appropriate management the amount of waste that goes into landfills can be reduced and avoided and consequently curbing the contribution of landfills to GHGs thereby mitigating climate change.

The National Waste Management Strategies (NWMS) identifies the connection between landfill waste diversion and the decline of GHG emissions such as methane. Department of Environment Forestry and Fisheries (2020) argues that it is crucial for the South African government to support programmes such as GISP that promote landfill waste diversion as this can reduce emissions of GHG-gases, especially methane. Nahman (2018) argues that some of the key resources that need to be reused include paper, glass, plastics, metals, construction and demolition waste. In addition, IS reduces GHG emissions through the treatment and recovery of soil nutrients and energy from organic waste by composting and energy recovery.

Department of Environment Forestry and Fisheries (2020) notes that facilitated IS creates platforms such as workshops, training, and information sessions where stakeholders can meet for by-product exchanges which result in landfill waste diversion and mitigation of GHG-emissions.

4.3 Approaches to Facilitation: Success and Challenges

While there are various approaches to IS facilitation, GISP facilitation process has three main stages namely the recruitment stage, the workshop stage and the follow-up stage. Oguntoye *et al*. (2018) argues that the stages of facilitation present a clear demarcation between activities, and facilitators are required to meet specific requirements such as set deadlines and reports submission. During the recruitment stage, GISP facilitators send invitations to various industries and stakeholders so they can explore synergies and resource exchanges in a BOW. After the workshop, GISP facilitators conduct a series of follow-ups to assist companies to implement the synergies. During the follow-up sessions, facilitators also record the amount of waste diverted and associated environmental impacts such as GHG emission reduction estimates.

NCPC-SA (2016) state that GISP has held 5-6 BOWs which have attracted various companies. There are currently 370 – 380 companies listed in the NCPC-SA database. Section 5.2 and 5.3 presents an evaluation of the performance of the BOWs.. Oguntoye *et al*. (2018) argue that it has become clear that during the workshops, companies identify waste resources and potential synergies are recorded. Each BOW has witnessed greater participation from the industries as well as an increase in the number of potential opportunities for resource exchanges, otherwise called synergies. NCPC-SA (2020) indicates that during the workshops GISP facilitators record synergies. The NCPC-SA facilitators use the workshops to highlight connections between GHG reduction and waste recycling. NCPC-SA (2016) argues that in the long term GISP will assist companies to reduce their carbon footprint through waste recycling.

According to Pigosso *et al.* (2018) and Yeoa *et al*. (2019) facilitators should appropriately screen companies that want to exchange waste resources to ensure that the venture is a success. The facilitator would evaluate the location of the industries that want to form a synergy to ensure that transport costs are low in order to increase profitability of the business venture. The facilitator would also check if the industries have the appropriate knowledge and capacity to handle, store and reuse waste materials. Additionally the facilitator will determine if the company supports sustainable practices and willing to cooperate and share information in order to facilitate waste exchanges and reuse.

Slips are used to record key information about an industry during the BOW to develop synergies. The information that is recorded include the company name, the company representative, the contact details of the company and the waste resource that a company

has or wants. The method was mirriors UK-NISP information sharing methodology and Cutaia *et al*. (2005) argue that attendees at each table shared their input-output resources using specifics slips, and then the compiled slips were sent to the other tables.

The GISP facilitation process has experienced several key challenges as cited in numerous reports. GISP facilitators do not screen stakeholders appropriately therefore facilitators and companies may not always understand the complexity of the stakeholders that attend the BOWs. Oguntoye *et al*. (2018) indicates that companies are not similar and therefore by not screening them properly, facilitators may not be able to effectively cater for their unique needs (waste exchanges). Another key challenge is that GISP facilitators use slips to record waste resources during the workshops and this has proven to be inefficient to a certain degree. The attendees only write the simplest descriptions of their resources of interest. For example, in several instances, participants at the GISP workshop had only indicated plastic as their waste resources without describing the type of plastic and the condition of that plastic.

According to NCPC (2020), GISP shares information about completed synergies emerging from BOWs so that companies know the potential synergies that exist and how they can be implemented. GISP shares case studies of successful synergies such as the partnership between EMM and Eco match (Pty) Ltd. The partnership between these two industries was formed in one of GISPs workshops. The partnership resulted in the construction and demolition waste being recycled from the Simmer and Jack Landfill Site in Germiston. The synergy resulted in GHG emissions reduction of 8 482 tonnes of CO2.

According to NCPC (2020), during the 2016 GISP BOWs, it was highlighted that under the IS Programme in various provinces resources registered grew to 2 558 from 243 companies, primarily in Gauteng (1 717 resources) and KwaZulu-Natal (65 resources). There were 7 completed synergies in Gauteng. One can see from the figures that the bulk of the recyclable waste resources come from Gauteng. The BOWs therefore play an important role in identifying resources.

In Table 4.2 it was estimated that a combined 137 909,62 ton of Carbon Dioxide Equivalent CO2eq were avoided due to recycling efforts from GISP programme between 2015 to 2018. It is worth noting that the estimate which the researcher came up with (137 000 tonnes of GHG emissions) is larger than the GISP's estimate of 70 000 tonnes of GHG emissions that Nahman's (2018) report cited.

The GDARD official did not provide his methodology for calculating the GHG emission from the GISP therefore the researcher was unable to indicate why the GHG emission reductions calculated in this study were higher than the GHG emissions offered by the official during the interview

Some of the key achievements of the programme are presented in form of case studies in Section 4.4. The case studies also highlight the GHG emissions realized through various GISP projects.

Table 4 2: GHG Emissions Reduction Achieved in GISP (2015 to 2018)

Waste Stream	**Tonnes diverted over three-year period (April 2015 – March 2018) in GISP Source: Nahman (2018)**	**GHG Emission Reductions Estimates Used**	**GHG Emission Reductions Estimates Sources**	**Estimated GHG Emissions Reductions**
Organic	872	Each ton of wet waste (organic waste) could result in the emission of 187 kg CO2eq (0.187 tonnes CO2eq)	Mohareb *et al.* (2011, Page 17)	155 tonnes of CO2eq
Metal	2 114	52.6 kg CO2-equivalents (0.0526 tonnes CO2-equivalents) per tonne recovered Metal	Damgaard *et al*. (2009, Page 52)	111 tonnes of CO2eq
Ash	76 780	The fly ash leads to reductions in GHG emissions of almost 1 tonne of CO2 per tonne of cement.	Business Recycling Planet Ark (2020, Page 1)	76 780 tonnes of CO2eq
Paper	3 553	one ton of office paper that is recycled will reduce 4.3 tonnes of CO2.	StopWaste (n.d, Page 1)	15 277,9 tonnes of CO2eq
Plastics	3 623	One ton of recycled plastic saves about 2 tonnes of CO2	StopWaste (n.d, Page 1)	7 246 tonnes of CO2eq
Wood	2 014	1 Kg of wood is holding about 1.80 Kg of CO2 which means1 ton of wood = 1.80 tonnes of CO2)	Kaltimber (2017, Page 1)	3 625,2 tonnes of CO2eq

Glass	1 359	1 tonne of recycled glass saves about 580 kg CO2 (0.580 tonnes CO2eq)	Glass Alliance Europe (2019, Page 1)	788,22 tonnes of CO2eq
Oil (Liquid)	424	73300 kg CO2 per ton of oil (which is 73.3 tonnes of CO2 per ton of Oil)	World Bank (2017, Page 1)	31 079,2 tonnes of CO2eq
Filter Dust	583	2.94 metric tonnes CO2 equivalent/ton of waste recycled instead of landfilled	Lee (2022, Page 587)	1 714 tonnes of CO2eq
CDW	20 000	72.1 kg CO2/tonne for concrete (0.0721 tonnes of CO2 per tonne of concrete)	Sustainable Concrete (2020, Page 1)	1 442 tonnes of CO2eq
Waste from Electrical and Electronic Equipment (WEEE)	0.269	One tonne of WEEE had a carbon footprint of 0.02 tonnes of CO2eq	Clarke *et al.* (2019, Page 470)	0,007 tonnes of CO2eq
Sawdust	180	6.3 ton of CO2 equivalent emissions per tonne of biomass sawdust	Lineback *et al.* (1999, Page 470)	1 134 tonnes of CO2eq
Total	111 502		Mohareb *et al.* (2011, Page 227)	139 351,62 tonnes of CO2eq

A GDARD official believes that GISP is able to reduce the amount of GHG emissions that are released in the environment through landfill waste diversion. The same official indicated that between the 2017 – 2019 period the programme achieved the following key outcomes: 57 000 tonnes of GHG emissions and diverted 100 000 tonnes of waste from the landfill site. Due to these results the GDARD official affirmed that the programme is a key success and highlighted as follows:

"I was tasked by my department to draft a list of successful programmes in terms of climate change and we identified the Gauteng Industrial Symbiosis Programme as one of the successful programmes for climate change mitigation." (Interview 006 in Appendix C.6)"

Despite this positive indication, there are disagreements on the accuracy and validity of the GHG calculations reported by the GISP facilitators pointing out that there is a need to understand the different calculation methods and indicators to come up with valid results (Interview 04 in Appendix C.4). Whether the calculations are accurate or not, one of the GDARD official points out that no one can divorce waste diversion and recycling from GHG emission reductions and consequently climate change mitigation because these three issues are connected, interdependent and interrelated (interview 06 in Appendix C.6). When waste resources are re-used this means that there is less incineration of waste which release certain GHG emissions. If there is less waste going to landfill sites, then there will be less methane being released in the atmosphere from the landfill site.

While the GISP has been able to create some valuable synergies, it has not been as successful as expected with many companies registered either being dormant or not having continued their cooperation. Several barriers prevent effective facilitation for GISP and one of them is the lack of financial resources. Some companies cannot buy equipment so they can recycle waste resources due to a lack of funding. The barrier is further emphasized in the quotation below from interviewee 001 from the National Cleaner Production Centre of South Africa:

"Companies would have a good plan when it comes to waste recycling however will not have the appropriate technology to process the waste and reuse it. The waste recycling company might have a processing facility which can accommodate a specific amount of waste and this can form as a limitation. Companies might need access to sufficient capital resources to buy technology to increase the intake of large volumes of waste, therefore the lack of access to adequate finances is an issue. *NCPC-SA cannot extend funding to companies and organizations that join the Gauteng Industrial Symbiosis Programme."* (*Interview 001 in Appendix C.1)*

Lack of trust presents itself as a barrier within the IS programme. The lack of trust can come in two forms i.e industries may not trust each other with waste information because it puts their competitive advantage at risk or industries may not trust government with their waste information because they sometimes do not comply with waste management licence requirements. The GDARD official notes that industries do not want to disclose sensitive information about waste management practices with government because they might not be in line with licensing requirements of the National Environmental Management Waste Act (see response by interview 002 below). If industries do not disclose their waste management practices, then NCPC-SA cannot assist them in finding sustainable waste management solutions, which in turn affects the outcomes of the IS programme.

Disclosure of sensitive information with regards to waste generated during processing and the other issue is companies don't have necessary licenses to operate and afraid they will be prosecuted if any official from the public sector finds out that they are unlicensed and producing a prohibited waste by-product"

(Interview 002 in Appendix C.2)

While GISP has had some progress, it has not been as successful as hoped and the impact of this has been that more waste still finds its way to landfills than intended. This situation points to the question of proper facilitation and communications. According to Oguntoye, *et al*. (2018) there are not enough facilitators to follow up on all the synergies that might have been identified in a BOW. GISP has few facilitators for the whole Gauteng Province.

GISP facilitators sometime lack capacity to follow up on all the synergies that were identified in the BOWs. In 2016, there were three facilitators who had to follow up on 632 potential synergies that were identified during the BOW in 2016. In this case there was apparently a limit to how much effort or resources can be put into individual follow-ups. "This in turn necessitated prioritization which caused difficult resource allocation dilemmas. Much of the decisions on which companies or which resource synergy to pay attention to are heavily dependent on facilitators' instinctive or crude judgments which often lead to sub-optimal results" (Oguntoye, *et al.* 2018:7).

Section 4.4 presents a comparison of estimated GHG emission reductions from this Section and the potential GHG emissions that were estimated by GreenCape.

4.4 Potential of GHG reduction through IS

IS has the potential to lower GHG emissions by promoting the re-use of residual and discarded waste resources in Gauteng and South Africa. O'Carroll *et al.* (2017) indicate that there are two ways in which GHG emissions can be lowered through IS which are:

- Avoided emissions from no longer disposing of the material that is now reused
- Emissions avoided in producing and transporting raw materials that are now no longer required because of the exchange.

When 111 502 tonnes of waste were reused and diverted from landfill sites it led to a reduction in GHG emissions thus promoting climate change mitigation. GHG emissions are reduced when waste materials substitute virgin materials as inputs in industrial processes. There are additional GHG savings when there are no trucks transporting waste to the landfill site. The researcher shown through various estimates that there are multiple GHG emission reductions opportunities in various waste streams of the GISP.

However, it can still be argued that GISP did not reach its true potential when it comes to GHG emission reductions. One can make this conclusion when looking at the annual target (300 000) and the amount of waste diverted on a year-to-year basis from 2015 to 2018. Since GISP is not meeting its target of waste diversion, some of the waste still finds its way to the landfill site and contributing to GHG emissions.

The potential of considerable impacts on reducing GHG emissions exists as outlined in O'Carroll *et al*. (2017). In the report titled *The Nature and Role of Industrial Symbiosis in South Africa,* the potential impact of GISP on GHG emissions reductions for 5 years was estimated from the annual benefits that were achieved by WISP over five years from 2014 to 2019. The estimations are highlighted in Table 4.3. Overall, the report estimates that GISP has the potential of achieving 144 000 – 163 800 tonnes of GHG emission reductions. Reducing GHG emissions by 144 000 – 163 800 tonnes of GHG emissions would be equal to removing 40 000 to 44 900 vehicles from the road. The report thus suggests the significant potential impact that GISP would have on climate change. In particular, it shows that IS activities can be used to drive climate change mitigation within South Africa. The GHG savings highlighted in the table are based on WISP's carbon calculator.

Table 4 3: Potential of each Regional Facilitated Industrial Symbiosis Programme based on WISP's Initial Impact

Table 3: Potential of each regional facilitated industrial symbiosis programme based on WISP's initial impact

Key Performance Indicator		WISP (Benefits achieved over 5 years)	KISP (potential)	GISP (potential)
Relative potential impact based on GVA and waste generated		1	0.45 – 1.38	2.25 – 2.56
Waste diverted from landfill (tonnes)		10,253	4,600 – 14,100	23,100 – 26,200
Economic benefits (R million)		45.0	20.2 – 62.0	101 – 115
Fossil GHG savings	Tonnes CO_2e	64,000	28,800 – 88,300	144,000 – 163,800
	Equal to passenger vehicles taken off the road in SA	17,500	7,900 – 24,000	40,000 – 44,900
Permanent economy wide jobs created (direct, indirect and induced)		145 (of which 20 direct)	65 – 200 (of which 9 – 28 direct)	326 – 371 (of which 45 – 51 direct)

Source: O'Carroll *et al*. (2017, page 9)

GISP is performing below the expected levels (144 000 - 163 000 tonnes of GHG emissions reduction). The research's estimate was 139 351,62 tonnes of GHG emission reductions. The potential of the programme is still yet to be realized. Once GISP meets its annual target of 300 000 tonnes of waste it would be able to surpass its potential when it comes to GHG emission reductions. Figure 4.1 and Figure 4.2 present two case studies that show that the GISP at the local level has a positive impact on Green House Gas Emission (GHG) reductions.

Figure 4 1: Case Study 1 for GISP. Source: NCPC (2020, page 12)

Figure 4 2: Case Study 2 for GISP. Source: NCPC (2020, page 13)

4.5 Conclusion

One of the sub-questions of the study was about potential contribution of GISP to climate change mitigation. GHG emission reductions are achieved from recycling material, including reduced transport (both transport of raw materials and disposal of material), and reduced extraction of virgin materials. The study estimates that approximately GHG emissions were reduced by 139 351,62 tonnes between 2015 – 2018. The estimate a higher value than the 70 000 tonnes reported by Nahman (2018). Reflections from some state officials from GDARD indicate that during 2017 to 2019 50 000 tonnes of GHG emissions that were mitigated through GISP. From 2015-2018 only 111 000 tonnes of waste was diverted which falls short of the

300 000 tonnes of waste meant to be diverted annually. If the waste diversion target were achieved more GHG emissions would have been mitigated.

The second sub-question focused on the role of effective communication and information exchange in IS. The recruitment, workshop, and follow-up session play an important role for the GISP. During the recruitment process stakeholders are notified of BOWs. During the workshops stakeholders identify resources and potential synergies. As of 2017 the database of the IS Programmes grew to 2 558 resources registered from 243 companies, primarily in Gauteng (1 717 resources) and KwaZulu-Natal (65 resources). NCPC (2020) state that there were 7 completed synergies in Gauteng. The workshops played a significant role in this achievement and follow up sessions ensured that these synergies were completed mainly by encouraging stakeholders to share their waste resources.

CHAPTER 5: EFFECTIVENESS OF FACILITATION STRUCTURES IN GISP AND FUTURE PROSPECTS

5.1 Introduction

Sections 4.3 and 4.4 indicates that GISP plays a crucial role in promoting GHG emission reductions and facilitation is an important factor behind this. GISP achieved approximately 139 351,62 tonnes of GHG emission reductions. Facilitation played an important role in driving some of these emission reductions because companies reused waste resources. Companies would meet at BOWs and identify the waste resources they can trade and reuse. This chapter assesses the performance of facilitation structures in detail.

GISP might have plans that promote the longer-term sustainability of IS for Gauteng. It is therefore essential to evaluate and interrogate these plans within this section. The plans might have a potential impact on GHG emissions in future. Two sub-questions are covered in this Section namely:

- What are the facilitation structures employed and how effective have they been in the establishment of a sustainable Gauteng Industrial Symbiosis Programme?
- What are the prospects of and the long-term sustainability of the Industrial Symbiosis Programme in contributing to climate change mitigation?

5.2 Facilitation Structures and Communication Platforms in GISP

Figure 5.1 highlights the GISP facilitation process which is structured into three stages: recruitment, workshop and the followup stages as discussed in detail in Sections 4.2 and 4.3.

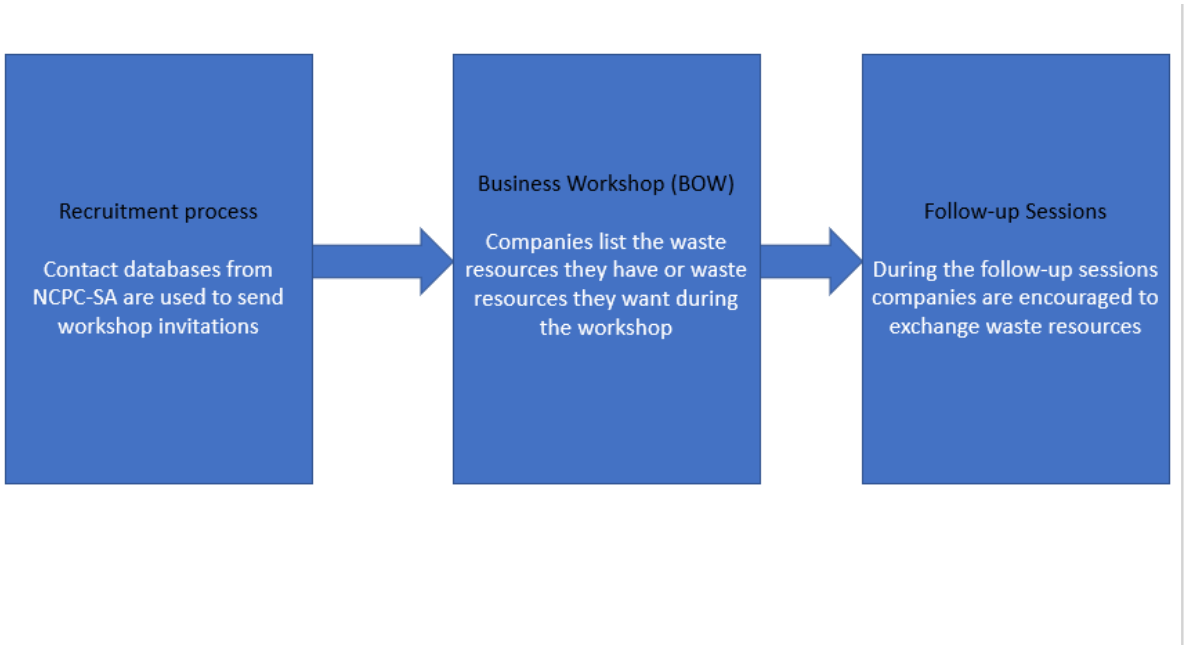


Figure 5 1: GISP Facilitation Platforms/Stages. Source Oguntoye *et al.* (2018, page 9)

5.3 Recruitment Process and Challenges

GISP uses an open approach when it comes to recruitment and this entails that the invitation is open to everyone. The open approach can be problematic for a number of reasons. Firstly companies who might not be interested in waste diversion end up attending the BOWs. The programme is publicized, and enrolment is made available to all companies through public media such as the NCPC-SA website and local and provincial waste management forums. Oguntoye *et al.* (2018) state that the problem with the openness of the recruitment process is that there is too much diversity and excessive opportunism. Industries hardly speak a common language because they are different and function differently which presents a challenge for facilitators. . Environmental service providers are also likely to use the opportunity to “hijack” the programme from the original facilitators and Oguntoye *et al*. (2018) explains that consultant hijack the session by recruiting private clients for waste disposal services while failing to disclose the realized synergies or resource savings to the GISP facilitators.

Section 5.4 covers the BOWs as the second stage after the recruitment stage. The information from BOWs case studies from Figures 5.5 to 5.9 were used to assess the successes of the BOWs as discussed in detail in Section 5.4.

5.4 Business Opportunity Workshop and Effective Communication

After every BOW, GISP facilitators determine the success of the BOWs by counting the number of attendees that came to the workshop and the number of potential waste exchanges. The results are shared with the stakeholders after the workshop. 5 BOWS were held between 2014 and 2018 and as shown in Figure 5.2 shows there has been an upward trend in the number of companies that attend the workshops. This presents a significant increase in the number of companies that are willing to engage in IS opportunities (see Table 5.1 and Figure 5.2). The biggest increase in attendance percentage-wise was in the 2016 workshop.

Case studies in Figure 5.5 to Figure 5.9 from page 47 to page 51 were used to see trends in terms of attendance in theBOW that are reflected in Table 5.1 and Figure 5.2.

Table 5 1: The Percentage Increases of Attendees in GISP

Year	**Increase**	**Percentage increase**
2015	8	25%
2016	18	45%
2017	1	1,7%
2018	4	6.7%

Source: BOW Summary Reports from Figure 5.5 to Figure 5.9 (NCPC-SA, 2014 Page 1; 2015 Pages 1; 2016 Page 1;2017 Page 1; 2018 Page 1).

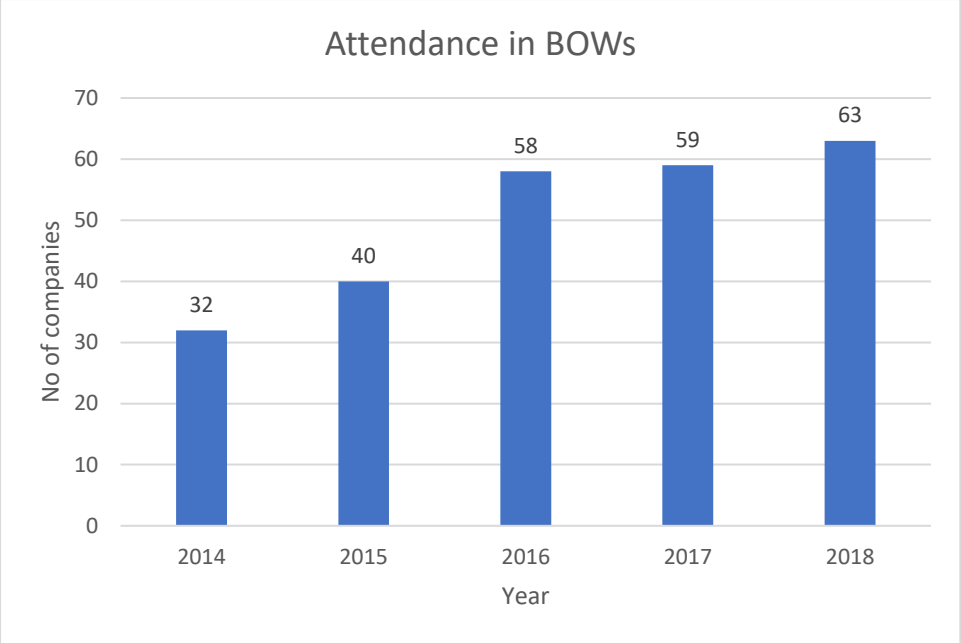


Figure 5.2: Attendance in BOWs from 2014 to 2018. Source: BOW Summary Reports from 2014 to 2018. (NCPC-SA, 2014 Page 1; 2015 Pages 1; 2016 Page 1;2017 Page 1; 2018 Page 1).

BOWs are important communication platforms where synergies and waste resources can be identified and recorded as indicated in Section 4.3. Figure 5.3 shows that there has been an increase in the number of new resources identified in BOWs between 2014 to 2016. However, there was a decrease in the number of new resources identified after 2016 more specifically in 2017. This resulted in a decrease in the number of potential synergies for 2017 even though the number of potential synergies identified have been increasing between 2014 to 2018. This means that companies are starting to see the benefit of landfill waste diversion and this is contributing to the increase in BOWs attendance. The NCPC-SA circulates a report highlighting these resources and synergies after every BOW. The results thus reinforce the importance of GISP among stakeholders that participate in the BOWs.

Case studies in Figure 5.5 to Figure 5.9 from (pages 47 to 51) were used to show trends in terms of number of waste resources and potential synergies that were identified in the BOW as reflected in Figures 5.3 and 5.4.

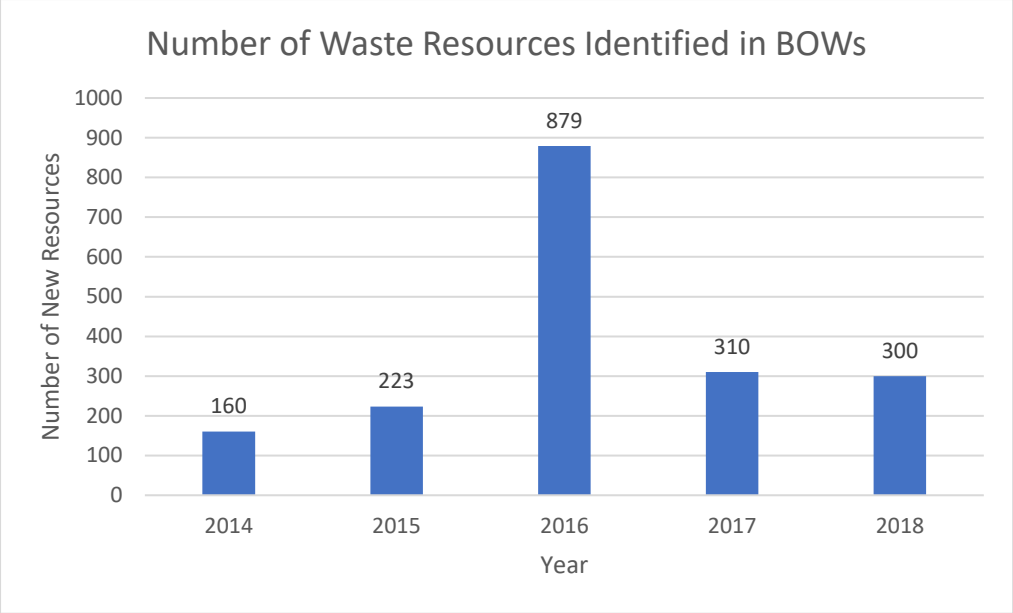


Figure 5 3: Number of Waste Resources Identified in BOWs (2014-2018). Source: BOW Summary Reports from Figure 5.5 to Figure 5.9 (NCPC-SA, 2014 Page 1; 2015 Pages 1; 2016 Page 1;2017 Page 1; 2018 Page 1).

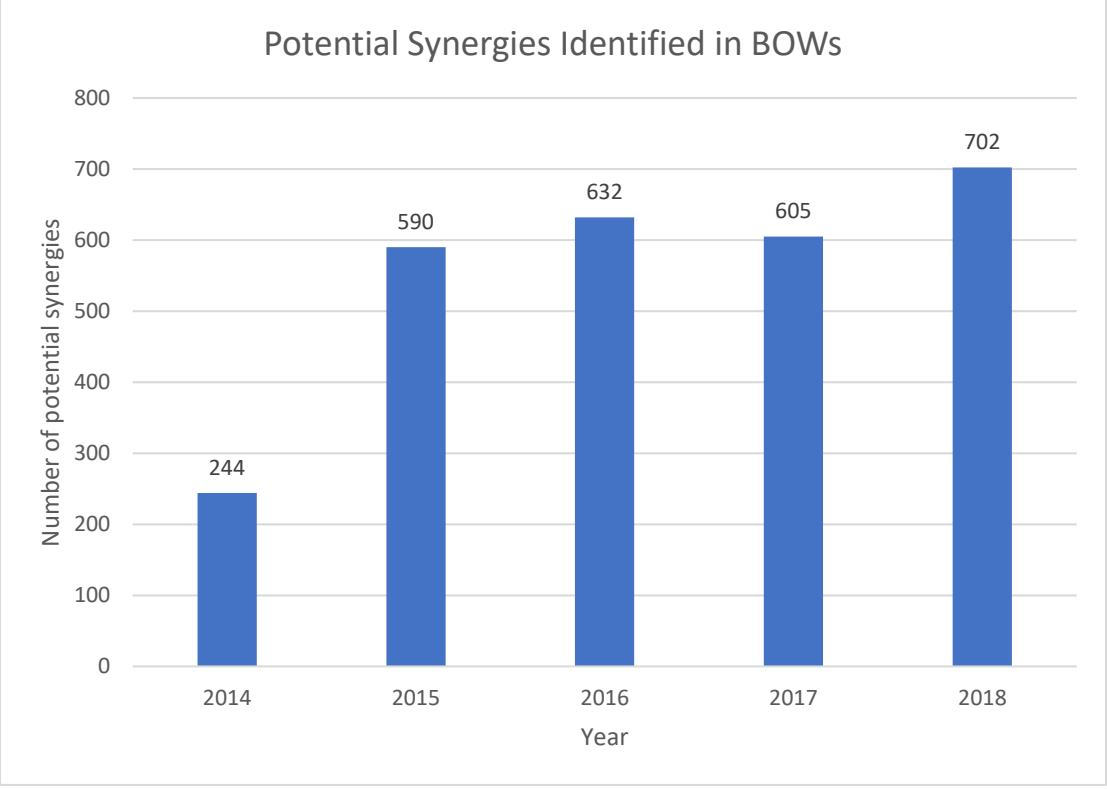


Figure 5 4: Number of Potential Synergies Identified in BOWs. Source: BOW Summary Reports from Figure 5.5 to Figure 5.9. (NCPC-SA, 2014 Page 1; 2015 Page 1; 2016 Page 1;2017 Page 1; 2018 Page 1).

From the results presented in Section 5.4 and Figure 5.4, one can conclude that there is a strong relationship between the number of companies that attend the BOWs, with the number of potential synergies. From Table 4.1 one can see that every year there was an increase in the number of waste resources that were reused from synergies identified in the BOWs (Oguntoye, *et al*., 2018). When companies attend in numbers, they can identify resource exchange with the help of the facilitators. The GISP database shows that there are 370 companies in the network and these companies have recorded various types of waste through BOWs such as metals, plastic, filter ash, biomass sawdust etc. The previous chapter has shown us that it is through the reuse of these waste materials that GHG emissions reduction of 139 351,62 tonnes of carbon are being achieved.

The data presented in this Section came from BOW summary reports from 2014 to 2018. The summary reports highlight that the increase in the number of companies that attend BOW contributes to an increase in the number of waste resources being identified. Potential partnerships are recorded, and it is up to the GISP facilitators to follow up on these potential resource exchanges.

Figure 5 5: 2014 BOW Summary Report. Source: NCPC-SA (2014, page 1).

Figure 5 6: 2015 BOW Summary Report**.** Source: NCPC-SA (2015, page 1)

Figure 5 7: 2016 BOW Summary Report. Source: NCPC-SA (2016, page 1)

Figure 5 8: 2017 BOW Summary Reports. Source: NCPC-SA (2017, page 1)

Figure 5 9: 2018 BOW Summary Reports. Source: NCPC-SA (2018, page 1).

5.5 Follow-up Engagements.

After the workshop, GISP has followup engagements to assess the feasibility of resource exchanges that were identified during the BOW. GISP facilitators have found that the number of potential synergies identified in the workshop does not always translate to synergies that can be implemented. According to Oguntoye *et al.* (2018) in 2016 25% of the 632 identified syerngies could not be implemented due to misleading information and the next paragraph goes into detail into how misleading information is provide in the BOWs from environmental consultants.

Some companies might come to the BOWs to claim synergies and not report them to GISP facilitators, and this is what GISP facilitators call predatory companies. These companies would provide misleading information on the waste resources that they have because their real intention is to identify the actual synergies, they can take from GISP. As highlighted in Oguntoye *et al*. (2018), when GISP does follow up engagements it identifies the predatory companies because they might not return their phone calls or show further interest in the programme. Additionally, predatory companies might see the GISP BOWs as a platform to gain insight from competitors or other industries without having to reveal their own information in this regard.

5.6 The Effectiveness of Communication Platforms in GISP

The data has shown that there was an increase in the number of companies that attended the workshop (see Section 5.4). This is a good indication that the invitations are attracting industries to come to the workshop and there is an interest in GISP activities. During the workshop, companies have been identifying waste resources and Section 5.4 shows that the number of these waste resources have been increasing on a year-to-year basis. Despite the challenges listed in Section 5.5 and Section 4.3, one of the GISP facilitators believes that communication and information exchange platforms are effective:

“I 100% would confirm that that the communication and information exchange platforms have provided for us a very good buy-in for the stakeholders who we have presented to present our course. There have been very good platforms in terms of updating them about the program”

Interview 001 in Appendix C.1

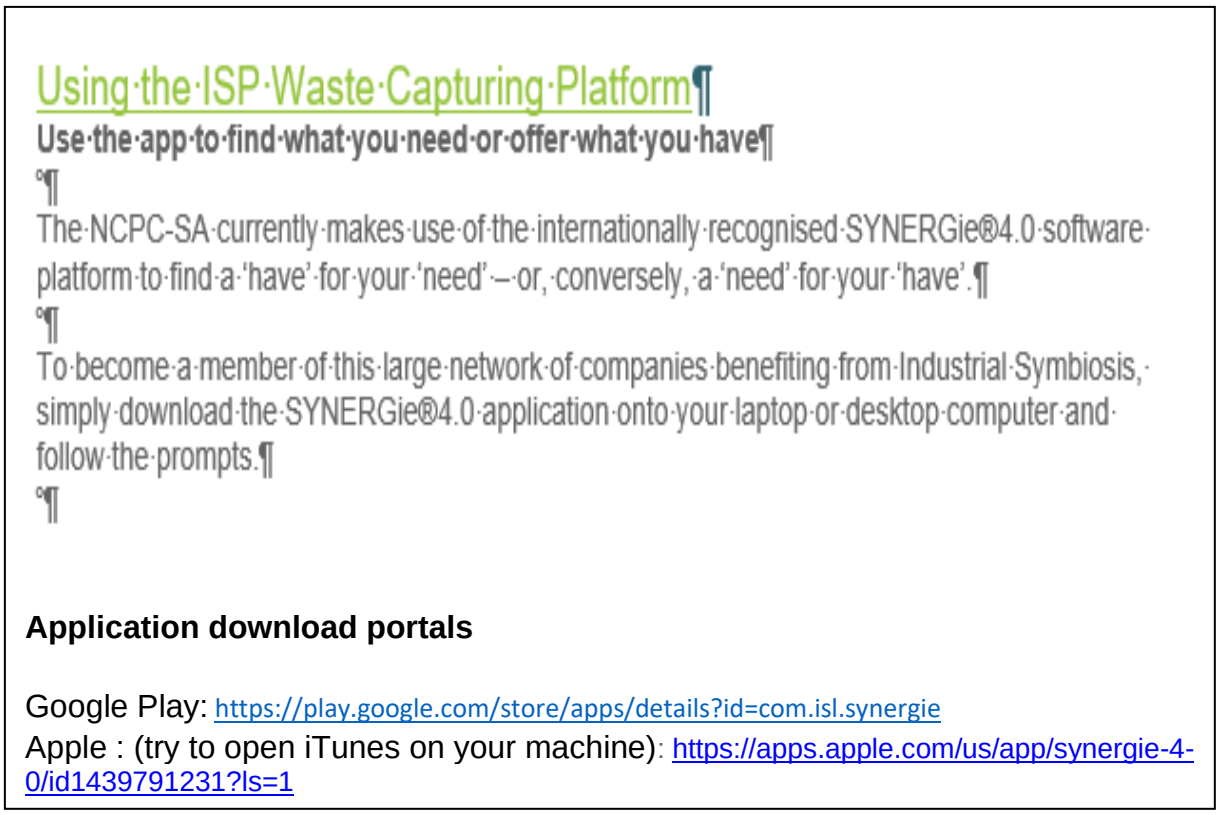
A GISP facilitator further notes that the communication and information exchange platforms all work together. Stakeholder contacts are sourced from provincial and local governments which are used to invite industries to BOW's (interview 001 in Appendix C.1). In addition, stakeholders that attend the BOW's share their information and it is recorded for further communiciation (BOW invitations and results). Provincial and local governments also assist GISP coordinators/facilitators in spreading awareness about the programme to potential clients which subsequently contributes to the increased attendance. Most of the interviewees regard the BOW platform as the best information exchange platform because it facilitates identification and follow-up on potential waste exchanges.

Follow-up sessions after the BOWs are of critical importance. During the follow-up sessions facilitators can screen synergies and see which ones can be implemented. Section 5.5 highlighted that 23% of the 632 potential synergies in 2016 were due to misleading information.. Opportunistic companies flood GISP BOWs and supply inaccurate information and it is up to the facilitators to screen the information during the follow-up stage.

5.7 Longer Term Sustainability of GISP

Interview 001 in Appendix C.1 indicates that NCPC-SA has a longer-term vision where the industries would be able to organize themselves and develop, manage and maintain IS synergies and opportunities. The key focus will be capacity building and development. The NCPC-SA would train the industry to have the capacity to identify the waste resources they have in their facilities and the potential waste solution providers/ recyclers who might find value in that waste resource. I believe that this is the next plateau for the GISP. Industries need to self-organize in order to leverage their own synergies.

The short-term strategy would be to ensure that all companies that took part in previous BOWs are captured in the online system including their waste resources [interview 002 in Appenix C.2]. The long-term strategy would be to develop an online software application where a company will be able to locate which companies have which resources. Figure 5.10 shows an extract referring to the online application in the application portal. GISP is getting ready for the 4th industrial revolution where resources will be online and companies have to trade for resources digitally. GDARD has extended funding to GISP so that NCPC-SA would be able to enhance the synergy development platform for synergy stimulation through 4IR interface software. The application was launched in 2020.



Using the ISP Waste Capturing Platform¶

Use the app to find what you need or offer what you have¶

¶

The NCPC-SA currently makes use of the internationally recognised SYNERGie®4.0 software platform to find a 'have' for your 'need' – or, conversely, a 'need' for your 'have'.¶

¶

To become a member of this large network of companies benefiting from Industrial Symbiosis, simply download the SYNERGie®4.0 application onto your laptop or desktop computer and follow the prompts.¶

¶

Application download portals

Google Play: https://play.google.com/store/apps/details?id=com.isl.synergie
Apple : (try to open iTunes on your machine): https://apps.apple.com/us/app/synergie-4-0/id1439791231?ls=1

Figure 5 10: Image: ISP Waste Capturing Platform. Source: NCPC-SA (2021, page 1)

The COVID-19 pandemic had an impact on GISP's ability to host the BOWs on a face to face basis. Gatherings were prohibited in South Africa and a workshop is considered a gathering. This has encouraged GISP facilitators to use alternative means of communication mainly through online apps and online meetings. Software applications that facilitate IS synergies will become more relevant. The NCPC-SA has the intention of launching an app where companies can register their details and start building synergies. Companies would have to be clear on what resources they have or the resources they would be looking for [interview 005 in Appendix C.5]. As indicated by interview 004 in Appendix C.4 an algorithm would match the source and intake companies instantaneously so that they can partner to form a synergy.

GISP facilitators would mostly play an oversight role within the digital platform to ensure that the synergies are progressing and outcomes are being recorded. Interview 004 in Appendix C.4 indicates that through the back end of the app GISP facilitators will be able to access information that a certain company requested waste data from another company and that they traded amongst themselves through that platform without the presence of the NCPC-SA. GISP facilitators would keep track of what is happening and ensure that the most complex cases receive a direct follow-up from the facilitators. The development of such an application is

crucial to ensure that industries can organize themselves and NCPC-SA would only intervene where necessary and therefore reserve its capacity for the more complex issues.

A GDARD official hinted that the application is still at a testing stage and NCPC-SA is still observing its functionality [interview 004 in Appendix C.4]. The NCPC-SA has identified service providers that are developing, testing, and refining the synergy software application. The NCPC-SA still needs to ensure that the app caters for all the different industries within Gauteng Province. Certain industries do not have access to internet services and may not have an understanding of how software applications work. NCPC-SA should therefore conduct market research before launching such an application.

Interview 003 in Appendix C.3 notes that it would be a great idea to have industries stand on their own and develop their synergies for waste resource exchanges using NCPC-SA databases. One must ask themselves if all the industries in Gauteng Province the have capacity to independently create their synergies. There are certain organizations at the grassroots level that do not have a proper business plan or SARs certificate and would therefore need further assistance towards exchange of waste resources.

5.8 Conclusion

This chapter presented data and analyses on facilitation structures used by the GISP and how effective have they been towards establishment of a sustainable programme. Facilitation happens in stages and it starts from recruitment stage, then the workshop stage and ends with follow-up sessions. There has been a steady increase in the number of companies that attend the BOWs from 2014 to 2018. Equally, there has been an increase in types of waste resources identified during the workshops. The second aspect covered the prospects of and the long-term sustainability of the IS Programme towards contributing to climate change mitigation.. In this case, the facilitation process needs to be improved in several ways. GISP facilitators have a short term and long-term strategy towards enhancing sustainability. For the short term strategy, facilitators focus on increasing the capacity of industries to independently identify and pursue their synergies in order to fast track resource exchanges without needing a facilitator. The development of synergy software applications is essential because companies can be instantly be matched for resource exchanges and this forms part of the long term strategy. It should be noted that there are companies without access to internet and therefore would not be able to connect to the application. The next chapter summarises the findings from Chapters 4 and 5 in relation to the research question and sub-questions. This is followed by and highlights the conclusions and recommendations of the study.

CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter presents the overall findings, conclusions and recommendations of the study in relation to the research question and sub-questions. The chapter draws some of the findings and results from Chapters 4 and 5 in order to consolidate conclusions in response to the main research question and sub-questions highlighted in Chapter 1. The main research question focused on GISP's impact on climate change mitigation through GHG-emissions reduction.

The study was also guided by several sub-questions that are listed below:

- What is the Gauteng Industrial Symbiosis Programme?
- How effective is the Gauteng Industrial Symbiosis Programme in terms of landfill waste diversion and reducing greenhouse gas emissions?
- What is the role of effective communication and information exchange in industrial symbiosis?
- What are the prospects of and the long-term sustainability plans of the Industrial Symbiosis Programme in contributing to climate change mitigation?

6.2 Key Findings and Conclusions

6.2.1 GISP Purpose and Intended Outcomes

GISP is a free facilitiation service that is offered by the National Cleaner Production Centre of South Africa (NCPC-SA). The key aim of the programme is to reduce industrial waste disposed in landfill sites by encouraging companies to form relationships towards exchanging waste for reuse. One of the secondary impacts of the programme is GHG emissions reduction since waste resources are reused and therefore less virgin materials are being extracted which inturn contributes to reduced process energy (see Sections 4.2 and 4.3). Facilitation structures play a crucial role in bringing businesses and industries together. Synergetically partnered businesses identify waste that would have been discarded and use it for their own operations. The facilitation structures also record the impact of the programme such as the tonnes of divereted landfill waste which gets reused.

6.2.2 GISP Impact on Climate Change Mitigation and Landfill Waste Diversion

GHG emissions are reduced when waste resources are reused rather than being disposed in landfill sites. There would be fewer vehicles transporting waste to the landfill and therefore this is one of the pathways by which carbon emissions are reduced. Additionally, carbon emissions are reduced because the need for virgin materials for new products is reduced. Climate change mitigation presents itself as a key outcome in the programme despite the focus of the programme being landfill waste diversion.

GISP has made significant progress on landfill waste diversion and climate change mitigation. Between 2015 to 2018 GISP diverted 111 502 tonnes of waste from landfill sites. This translates to mitigation of 139 351,62 tonnes of CO2eq. It also implies energy savings in operation of landfill sites. Whereas GISP has failed to meet its initial target of landfill waste diversion of 300 000 tonnes of waste the diversion levels achieved represent a demonstrable impact of IS on GHG emissions and energy savings. There is therefore a clear relationship between GISP outomes and climate change mitigation even though the programme leaves enormous room for improvement.

However, there are numerous challenges towards GISP impact on climate change mitigation. For example, there are state and programme officials who do not see the link between GISP and GHG emission reductions. In addition, no specific targets have been endorsed for climate change mitigation under the programme. The programme is also inadequately funded and under-staffed in view of optimal capacity for enhanced resource exchanges that would further reduce GHG emissions.

6.2.3 Facilitation Process: Successes and Challenges

Facilitation process has been key to GISP success. The process brings different companies together and this is where they declare the waste resources they have in their facilities. Once these resources are identified they can be sold or given to companies that are willing to reuse them. Once the resources are exchanged and reused the respective companies report the outcomes to GISP facilitators.

There is currently one approach to facilitation that has been adopted for GISP. The facilitation follows a particular flow starting from recruitment followed by BOW and ending with follow-up

sessions. GISP sends invitations to various companies to attend the BOWs. where companies indicate in slips the waste resource of interest or the waste resource they have. This gets recorded in a synergy platform where companies that have waste resources trade it with companies that want that resource. Follow-up sessions are done to facilitate and encourage the realisation of exchange of resources and impacts are recorded.

One of the most successful recruitment method is the BOW where participation has grown annually between 2014 to 2018. BOWs attract various companies from different sectors such as mining, manufacturing and retail. Various officials from the NCPC-SA and GDARD indicate that BOWs have been successful in attracting different companies to share their information about the waste resources they generate. Chapter 5 has gone into detail about the types of waste resources that have been recorded on a year-to-year basis.

Whereas other facilitation methods such as recruitment and follow-up sessions are viable, they were impacted by several challenges which had an impact on the overall success of GISP. For example, during recruitment, GISP facilitators do not adequately screen companies who are invited to BOWs. This poses a key challenge because companies who might not be interested in GISP end up attending the workshop and steal GISP clients without sharing the results or outcomes to GISP facilitators. Lastly, understaffing means that there are not enough human resources to conduct follow-up sessions for GISP. For example, there are only 3 GISP facilitators for the 370 companies in the network.

GISP facilitators therefore need to evaluate all participants and identify potentially rogue companies with no interest in GISP outcomes and targets. Facilitation also helps to verify the information submitted by all companies to ensure it is accurate and fully aligned with IS goals and objectives, including mitigation of GHG-emissions and climate change.

6.2.4 Long Term Sustainability

An IS programme is important in the long-term sustainability of industrial structure of a city or economy through re-orienting from a linear metabolism to a cyclical loop.. Guided by this principle, GISP aimed to divert 300 000 tonnes of waste from landfill sites for reuse and repurposing into new products that can be used by other industries or consumers. GISP's failure to reach this target provoked this study to assess prospects and plans for long-term sustainability of the programme.

GISP has a short term and long term plan/strategy to reach their landfill waste diversion target and further decrease GHG emissions. The short term plan focuses on enhancing capacity of industries to identify synergies. At present there are 3 GISP facilitators trying to cater for 370 companies in the GISP network. It is thus important for industries to be able to identify synergies on their own without the help of GISP facilitators. GISP offers training opportunities for the industries on how to create partnerships that encourages the exchange of waste resources. The long term strategy entails online synergy platform where companies are linked automatically for waste resource exchanges.

The NCPC-SA needs to explicitly adopt specific targets on climate change mitigation. While there are projects to show the potential for GHG emission reduction there is no specific annual target adopted by NCPC-SA on mitigation of GHG emissions. Once there is an adopted target, researchers will be able to evaluate if GISP interventions are making a meaningful impact on that goal.

Overall the impact of GISP has been positive thus corroborating existing findings which indicate that IS is essential in the fight against climate change. In order to sustain and enhance this impact, effective facilitation towards creation of synergies is required. This can only be achieved through effective communication based on diverse approaches. Online platforms would therefore be particularly useful for industries, recruitment and management of the overall IS programme.

6.3 Recommendations for further research.

Further research must be done to assess the performance of digital platforms for the implementation of IS. Digital synergy platforms were implemented in 2021 for GISP and therefore their performance needs to be assessed after some time. Additional research can be done to investigate the potential use of Blockchain technology on IS programs. This is important because block chain technology can increase the speed of transaction between companies and it can be validated by GISP facilitators.

Further research is also needed on GISP's method for calculating GHG emissions reduction. Carbon emissions need to be systematically and consistently assessed in terms of validity and accuracy. When methodological gaps are identified GISP facilitators would correct them in order to facilitate stakeholders within government and other entities build confidence in the reported impacts.

A broader study needs to be done to evaluate IS impact on climate change mitigation. For example, the study could fous on comparison of the impact of facilitation on climate change mitigation between KISP, WISP and GISP. GHG emission reductions can therefore be compared across the three provinces which would in turn allow for evaluation of the role of facilitation in this aspect.

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APPENDICES

A GHG Estimates and Source of Estimates

Waste Stream	GHG Emission Reductions Estimates Used	Sources of the Estimates
Organic	Each tonne of wet waste (organic waste) could result in the emission of 76 – 187 kg CO2eq	https://www.tandfonline.com/doi/full/10.3155/1047-3289.61.5.480
Metal	12.8 to 52.6 kg CO2-equivalents per tonne recovered Metal	https://backend.orbit.dtu.dk/ws/portalfiles/portal/119496311/2009_Damgaard_et_al_Metal_Recycling_article_PostPrint_Final.pdf
Ash	the re-use of fly ash leads to reductions in greenhouse gas emissions of almost 1 tonne of CO2 per tonne of cement.	https://businessrecycling.com.au/recycle/fly-ash#:~:text=Why%20Recycle%3F,dioxide%20per%20tonne%20of%20cement
Paper	A ton of office paper is reduced by 4.3 tonnes of CO2	https://www.stopwaste.org/at-work/reduce-and-reuse/recycling-business-waste/recycling-and-climate-protection
Plastics	plastic - one ton of new product saves about 2 tonnes of CO2	https://www.stopwaste.org/at-work/reduce-and-reuse/recycling-business-waste/recycling-and-climate-protection
Wood	This means 1 Kg of wood is holding about 1.65 to 1.80 Kg of CO2.	https://www.kaltimber.com/blog/2017/6/19/how-much-co2-is-stored-in-1-kg-of-wood
Glass	1 tonne of recycled glass saves about 580 kg CO2	https://www.glassallianceeurope.eu/images/para/gae-position-paper-on-decarbonisation-june-2019_file.pdf
Oil (Liquid)	73,300 kg CO2 per ton of oil	https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2019-carbon-emissions-methodology.pdf
Filter Dust	2.94 metric tonnes CO2 equivalent/ton of waste recycled instead of landfilled	https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references
CDW	72.1 kg CO2/tonne for concrete	https://www.sustainableconcrete.org.uk/Sustainable-Concrete/Performance-Indicators/CO2-Emissions-

		Production.aspx#:~:text=In%202018%20the%20standardised%20mix,year%20of%20reporting%20in%202009.
WEEE	One tonne of WEEE had a carbon footprint of 0.02 t CO2eq	http://publicationslist.org/data/david.turner/ref-20/2019%20-%20Clarke%20et%20al.%20-%20RC_R%20-%20Evaluating%20the%20carbon%20footprint%20of%20WEEE%20management%20in%20the%20UK.pdf
Sawdust	6.3 t of CO2 equivalent emissions per tonne of biomass sawdust	https://www.int-res.com/articles/cr/13/c013p221.pdf

B Interview Guideline Per Respondent Category

B.1 Interview 001 – NCPC-SA Official

1 What is your position inside the NCPC-SA?

2 What is your role inside the IS programme?

3 What are the platforms that have been created to implement GISP?

4 Has there been an increase uptake of the programme due to the various communication platforms that GISP facilitators use to programme GISP?

5 Can you please indicate what are the potential barriers that maybe you might have seen maybe facilitation?

6 What enables industries or the different companies to participate in GISP?

7 Does the facilitation off the programme play an important role in the success of the programme?

8 What are the links between GISP and the UK-NISP?

9 Which is the most effective communication or information exchange platforms in the programme?

10 Is there a strategy in place for industries to build their own synergies?

11 Are there also other departments or organizations that you have worked with on GISP and what are the various roles the organizations play?

12 How can I access yearly reports around GISP and its impact on the Greenhouse Savings and Landfill Waste Diversion?

B.2 Interview 002 – GDARD Official

1 What does your organization do? (What does it produce?)

2 What is your role in the organization that you are currently working for?

3 Does the role you play in GDARD have an influence on the outcomes of GISP? Please elaborate on your answer?

4 What is IS and how does it contribute to climate change mitigation?

5 What is the role of effective communication and information exchange in IS?

6 What are the facilitation structures that exist within the NCPC-SA and how has these structures assisted the NCPC-SA establish a sustainable GISP?

7 How does the NCPC-SA ensure the longer-term sustainability of the IS Programme without further input of facilitators?

8 How does the NCPC-SA communicate with industries for GISP? Is the communication process efficient and effective? Please elaborate further on your answers.

9 What in your view are the main issues with industries when it comes to the uptake of GISP?

10 Is facilitation one of the issues in the GISP? Please elaborate on your answer?

11 What are the reasons that industries participate in GISP?

12 What is your position/stance as a GDARD member/employee with regards to the facilitation and coordination of GISP?

13 What do you think is the appropriate method, technique or tool when it comes to information exchange with regards to GISP? Why do you think that is an appropriate method? How would you go about implementing that method?

14 Is there a strategy in place to ensure that industries build synergies on their own without the help of facilitators in your view? If so, please highlight the interim or shorter-term and long strategies for facilitating IS Programme?

15 Are there other departments/ organizations that work with you on this issue and if so what are the various roles; how does the interaction work?

B.3 Interview 003 – GDARD Official

1 Which organization did you work for? of course during the time of the IS and what was your role in the organization?

2 What was your role in your organization?

3 Did your previous role in GDARD have an influence in GISPs outcomes?

4 How does the NCPC-SA communicate with other industries about GISP?

5 Do you think that communication process was efficient and effective?

6 What attracted industries or businesses to GISP?

7 Are there any potential issues or problems that might have hindered the growth of IS program on your view?

8 Does the NCPC-SA have adequate capacity when it comes to facilitating GISP?

9 Are there are other reasons for industries to participate in the IS such as logistics?

10 As a former environmental specialist that used to work for GDARD, what are your views regarding the GISP potential for waste management in Gauteng?

11 What do you think could be an appropriate method in terms of the technique for information exchange?

12 One of the key goals for IS is to ensure that the programme is sustainable without the help of facilitators. Is there a strategy for that?

13 Are there any other departments or organizations that you worked with in the programme?

B.4 Interview 004 – GDARD Official

1 Does GISP have an impact on Climate Change Mitigation through the reduction of GHG emissions?

2 Can I contact the GDARD climate change unit and find out from them what is their take on the program?

3 What is roles and responsibility of your organization?

4 What is your current role in GDARD?

5 Does your role in the organization having an impact on GISP outcomes?

6 How does the NCPC-SA communicates with industries about GISP within the Gauteng Province?

7 What are the barriers that discourage industries from participating in GISP?

8 As the provincial authority in environmental and waste management do you relax certain regulations for industries to participate in GISP?

9 What is the most effective information and exchange platform in GISP?

10 Are there any other ways of communicating that you would recommend from the ones that they already have?

11 Is the GISP Synergy App currently at a conceptual stage or has it been developed?

12 What are the departments or organizations that you have worked on as result of the GISP?

13 Can you please share the GISP workplan?

B.5 Interview 005 – NCPC-SA Official

1 What does your organization do?

2 What is your role in the organization that you are currently working for?

3 How does NCPC-SA communicate with industries?

4 When you invite companies to attend the BOWs how do they respond?

5 When you speak about facilitation what do you mean exactly?

6 Has syrnergy identification been efficient and effective in GISP?

7 What could you say are the main barriers when it comes to industries participation in GISP?

8 Which is the most appropriate communication method that you have seen that is the most effective in getting the industries attracted to GISP?

9 How will the GISP Synergy App assist the facilitators to effectively facilitate GISP?

10 What are your views in terms of the impact of the programme on climate change?

11 Are there other departments that you work with and how does that interaction work?

B.6 Interview 006 – GDARD Official

1 What does your organization do?

2 What is your role in the organization you are currently working for?

3 Does the role you play in the organization have an impact on GISP outcomes?

4 How does the NCPC-SA communicate with industries for GISP? Is the communication process efficient and effective? Please elaborate further on your answers.

C Interview Transcripts

C.1 Interview 001

Researcher: What is your position inside the NCPC-SA?

Respondent: I'm a national project manager for the national IS program that is run by the National clean production center of South Africa. The programme is being implemented by National Cleaner Production Center of South Africa, KwaZulu-Natal and Gauteng. I offer extra support to my colleagues from NCPC-SA who form part of the GISP.

Researcher: What is your role inside the IS programme?

Respondent : I make sure the program is fully operational and running to ensure that it meets its target objectives and achieves its aim. The aim of the programme is to promote resource efficiency and cleaner production through the reuse of waste resources between different industries. The reuse of waste materials landfill waste diversion and that is one of the major targets of the programme. I would also make sure that the programme delivers on GHG emission reductions and job creation through the re-use of materials. Secondly, I encourage industries to collaborate and network to develop relationships that lead to waste resource exchanges and that the waste is reused in production processes. Thirdly I promote the IS programme to industries and non-industry players. Lastly I provide capacity building opportunities for provincial government so they can assist in the implementation of the programme.

Researcher: What are the platforms that have been created to implement GISP?

Respondent: The first platform is the BOW platform. In every year we run at least two IS BOWs where we bring all the different role players from industry. Industries and various stakeholders sit in the workshop and share ideas in terms of waste resource exchanges and from the workshop the facilitators identify potential synergies. We attend waste and air quality

management forums within municipalities and provincial government and during the forums we explained them about the importance of the program. We also introduce the IS concept to the municipalities via the forums and train them on how to run and implement an IS programme. We also promote IS programme via the national waste management forums at the Department of Environmental Affairs (DEA) and during the forum we provide training on the implementation of IS programme. We collect industries contact details from the BOWs and the local municipalities and provincial government via the forums.

Researcher: Has there been an increase uptake of the programme due to the various communication platforms that GISP facilitators use to programme GISP?

Respondent: I can 100 % percent confirm that that these platforms have provided for us a very good buy in from the stakeholders.

Researcher: Can you please indicate what are the potential barriers that you might have seen during the facilitation?

Respondent: There are legal barriers related to compliance issues. Industries need to have certain legal documents (e.g., waste management licence) with the processing, storage, and transportation of waste resources. The second barrier is related to financial barriers some companies might not afford to procure the technology to process a certain waste resource. The third barrier relates to location because industries might have to travel long distances to collect waste materials thus decreasing the profitability of the venture. Limited facilitation can be seen as a barrier because industries are not well connected and may not have sufficient time and knowledge to establish synergies resource.

Researcher: What enables industries or the different companies to participate in GISP?

Respondent: Industries participate in the programme because they want to comply with Waste Management Hierarchy that is promoted via the National Waste Management Act in

South Africa. Currently the participation in the programme is voluntary however government is still pushing industries to participate. Secondly companies want to saving financial resources, companies save on disposal costs because another industry is reusing their waste. Another enabler is corporate social responsibility. Some industries donate their Pulverized Fly Ash to local communities and the communities make use of PFA make bricks to build affordable houses. Communities that use PFA to make bricks will have to employ people and therefore another enabler is job creation. Some companies want to promote good environmental practices by diverting landfill waste their carbon footprint.

Researcher: Does the facilitation off the programme play an important role in the success of the programme?

Respondent: Facilitation is one of the key enablers for GISP. GISP facilitators conduct follow-ups which increases the success of the programme. Facilitators must ensure that waste resource exchanges are being implemented appropriately. During the follow-ups and facilitation stakeholders are able to able to identify where the barriers are and you are able as a facilitator to assist both industries overcome those barriers so at the exchange can be completed so that the synergy can be completed.

Researcher: What are the links between GISP and the UK-NISP?

Respondent: In 2010 and 2014 we engaged with the UK-NISP to use them as a benchmark for the GISP. GISP uses the synergy management platform from UK-NISP to capture all the data from the synergies (waste resource exchanges). The information that is captured include impacts (GHG emission savings, Job creation, landfill waste diversion).

Researcher: Which is the most effective communication or information exchange platforms in the programme?

Respondent: They all work but the BOW is the best because you can get the message across effectively to the audience and it is from the workshop that you now begin to retrieve ideas for synergies. The ideas are used to develop partnership that can lead to waste resource exchanges.

Researcher: Is there a strategy in place for industries to build their own synergies?

Respondent: We are training all these industries on how to initiate and identify IS opportunities in their production processes. When industries identify the waste resources that is normally disposed in the landfill site they can go out and look for industries that want to reuse the waste resources.

Researcher: so are there also other departments organizations that you have worked with on this issue and what are the various roles the organizations play?

Respondent: The programme is funded by the DTI. The DEA has a programme called Waste Phakisa that wants to support landfill waste diversion and sees IS as one of those initiatives that should be supported. We also work closely with provincial departments (e.g GDARD) to implement GISP. Provincial Governments attend the BOWs and assist with the facilitation.

Researcher: How can I access annual reports on GISP and its impact on the Greenhouse Savings and Landfill Waste Diversion?

Respondent: I will send you a report on our quantification of the program's contribution to the Gross Domestic Product. The report also highlights the impacts of the programme such as landfill waste diversion, GHG emission savings and cost savings.

C.2 Interview 002

Researcher: What does your organization do? (What does it produce?)

Respondent: Environmental management and protection.

Researcher: What is your role in the organization you are currently working for?

Respondent: I am an Environmental Officer: Specialised Production in the Legislative development Unit.

Researcher: Does the role you play in GDARD have an influence on the outcomes of GISP? Please elaborate on your answer?

Respondent: Yes, because it's my duty to maintain the partnership between GDARD and NCPC-SA. I am responsible to ensure that GISP is being implemented in the province and also monitor progress in terms of waste management and diversion in the province

Researcher: What is IS and how does it contribute to climate change mitigation?

Respondent: IS put simply is a process whereby one industry makes use of waste generated from another industry to produce an end product that can be used to sustain our livelihoods. The purpose of IS is to divert waste from the landfill site and use it as a resource in the production process. In doing so a company can save energy, water, travel expenses in their day to day business. It should be noted that making use of an already processed resource is cheaper than making use of virgin material.

Researcher: What is the role of effective communication and information exchange in IS?

Respondent: It is important to ensure that businesses, industries both small and large corporations understand the need to exchange waste instead of relying on virgin resources for their production processes. It is cheaper to use waste that has already been processed, than using virgin material for production. Communicating effectively means that the different companies will know the resources that are available and how to form partnerships exchange the waste resources. NCPC-SA will be there to assist the companies to negotiate when exchanging the waste resources..

Researcher: What are the facilitation structures that exist within the NCPC-SA and how has these structures assisted the NCPC-SA establish a sustainable GISP?

Respondent: NCPC-SA uses facilitation structures NCPC-SA that were adopted from the international IS Programme. NCPC-SA has internal facilitators that run the BOWs. NCPC-SA

also sends out request to sector departments such as GDARD, DTI and DEA to assist in the facilitation of the BOWs. as they are specialists in the field of environmental management and are well versed in terms of policies, programmes and plans to manage waste and promote sustainable development. NCPC-SA would train the departments that want to run the BOWs. The NCPC-SA will arrange the BOW and invite businesses and industries and relevant stakeholders. The facilitation process makes use of slips for companies to highlight the waste resource they have or want. The GISP facilitator from NCPC-SA will identify the potential relationships that can be formed for the exchange of waste resources. GISP facilitators from NCPC-SA will prepare agreements for the synergies and they will conduct followups. Once the synergy has been completed a case study is produced to showcase how the BOW has assisted in waste diversion from the landfill site.

Researcher: How does the NCPC-SA ensure the longer-term sustainability of the IS Programme without further input of facilitators?

Respondent: NCPC-SA conduct follow – up on potential synergies. They document synergies that were completed in the form of case studies. They provide companies with training on how to use water, energy and waste effectively and efficiently during their production processes. The training benefits industries even after GISP's facilitation.

Researcher: How does the NCPC-SA communicate with industries for GISP? Is the communication process efficient and effective? Please elaborate further on your answers.

Respondent: NCPC-SA uses different mediums such as online advertisements, email, telephonic calls. NCPC-SA makes use of municipal, provincial and national platforms such as environmental coordination forums to communicate with clients. I would say their communication method is effective as they have hosted several successful BOW.

Researcher: What in your view are the main issues with industries when it comes to the uptake of GISP?

Respondent: I believe that industries struggle with disclosing sensitive information with regards to waste generated within their facilities. Some of these companies don't have the necessary licenses to operate and afraid they will be prosecuted if any official from the public sector finds out that they are unlicensed.

Researcher: Is facilitation one of the issues in the GISP? Please elaborate on your answer?

Respondent: No, facilitation has never been the issue.

Researcher: What are the reasons that industries participate in GISP?

Respondent: Industries save on financial resources when they use waste as a resource in their production processes. GISP offers a platform for businesses to network with potential clients.

Researcher: What is your position/stance as a GDARD member/employee with regards to the facilitation and coordination of GISP?

Respondent: The programme has been a success and has raised awareness on the importance of using waste as a resource and highlighting the benefits of waste separation, recycling, re-use and recover.

Researcher: What do you think is the appropriate method, technique or tool when it comes to information exchange with regards to GISP? Why do you think that is an appropriate method? How would you go about implementing that method?

Respondent: I think that it is important for companies to have discussions among themselves in a comfortable setting because that always yield better results. Companies might feel comfortable talking to their peers instead of government officials and members of the NCPC-SA. We can have round table discussions with one or two facilitators and they will refrain from mentioning that they are from government departments or NCPC-SA or preferably hire external people to facilitate.

Researcher: Is there a strategy in place to ensure that industries build synergies on their own without the help of facilitators in your view? If so, please highlight the interim or shorter-term and long strategies for facilitating IS Programme?

Respondent: Yes there is an existing online platform, just that it has some issues that need to be resolved. The short – term strategy is to ensure that all companies that took part in

previous BOW are captured in the online system and their resources. The long – term strategy is that companies will be able to locate which companies have what resources using the online app.

Researcher: Are there other departments/ organizations that work with you on this issue and if so what are the various roles; how does the interaction work?

Respondent: DTI, EMM, Innovation Hub work on GISP. They mostly assist with funding, monitoring and suggesting how some of the work should be done.

C.3 Interview 003

Researcher: Which organization did you work for? of course during the time of the IS and what was your role in the organization?

Respondent: I previously worked for GDARD.

Researcher: What was your role in your organization?

Respondent: I was an Environmental Officer Specialised Production within the Legislative Sub Directorate. My key duties were basically to review and implement policies and that is how I came across the NCPC-SA.

Researcher: Did you previous role in GDARD have an influence in GISPs outcomes?

Respondent: Yes the department played a huge role in GISP because at some point I remember we funded them and assisted them in identifying industries that would form part of BOWs. We also connected them with the other sections in the Department to grow their business and we also tried to build relationship with them with municipalities and other government organizations.

Researcher: Thank you so how does the NCPC-SA communicate with other industries about GISP?

Respondent: GISP facilitators from NCPC-SA use the BOW to drive IS. They send invites to industries who are interested in recycling waste materials and they can come through to see what NCPC-SA is doing in terms of their programme. NCPC-SA would request GDARD's Environmental Impact Management and Air Quality Management units to distribute BOW invites to the relevant industries.

Researcher: Do you do you think that that communication process was efficient and effective?

Respondent: It was very efficient because it reached individuals that you would never think would attend these kinds of meetings. GISP facilitators from NCPC-SA attract small waste management businesses from Mpumalanga and businesses from Gauteng that deal with Construction and Demolition Waste. Companies that sell recyclable waste also attend the BOWs.

Researcher: What attracted industries or businesses to GISP?

Respondent: NCPC-SA was able to advertise GISP BOWs to industries, Non-Governmental Organisations and Public-Private Partnerships. Through the GISP network companies are able to network with eachother and find funding opportunities that would assist them to buy machinery to recycle waste materials.

Researcher: So, what could be maybe are there any potential issues or problems that might have hindered the growth of IS program on your view?

Respondent: Companies sometimes cannot access finances to kick start their waste recycling business. Sometimes if there is no one in the BOW who wants the waste material that you are selling then you are back at square one. At the current moment NCPC-SA cannot offer funding to assist businesses to get them established.

Researcher: Does the NCPC-SA have adequate capacity when it comes to facilitating GISP?

Respondent: I think that NCPC-SA has adequate capacity to assess individual cases in detail before they could develop synergies. If someone does not want to buy the waste material you have or no one is selling the waste material you want then NCPC-SA cannot assist you.

Researcher: Are there are other reasons for industries to participate in the IS such as logistics?

Respondent: NCPC-SA moves the BOW in different locations (Pretoria, Centurion and Johannesburg) every year so that GISP gets new industries that want to establish waste resource exchanges. The key limitation is that NCPC-SA can assist with industries in terms of travel expenses pertaining to the BOW.

Researcher: As a former environmental specialist that used to work for GDARD So what is your views regarding the GISP potential for waste management in Gauteng?

Respondent: In my view it has a great potential. Women would collect plastic items from the municipal landfill sites but do not know what to do with them or how to carry that business forward. NCPC-SA would assist the women that collect waste from the landfill site to identify the commercial value of the recyclables such as plastics and how they can turn the plastics into products that can yield better earnings. NCPC-SA would connect the waste pickers to businesses that may want to buy the recyclables. I saw people growing their business and making a significant contribution to the South African economy.

Researcher: So, what do you think maybe could be an appropriate method into the technique for information exchange?

Respondent: I think what works well in South Africa is using radio broadcasts and newspapers to create awareness around GISP. NCPC-SA should consider reaching out to grassroot organisations in different languages because they might not speak English. IS tries to partner up with government and say this is our product can you assist us this what we do and this is how we do it and then they know that government has platforms that reaches municipalities., councillors reaches iziduna at home. I think they are doing well in terms of their BOWs.

Researcher: One of the key goals for IS is to ensure that the programme is sustainable without the help of facilitators. Is there a strategy for that?

Respondent: Companies are encouraged to give feedback during BOWs on the progress of their own syerngies. NCPC-SA assist companies to draft and agreement for the waste

exchange partnership and afterwords the industry personnel take it forward. At the current moment NCPC-SA has 5 to 6 GISP facilitators and that is not sufficient to cover the whole country. It is therefore good to have industries that can stand on their own. GISP facilitators are still needed in certain cases because some people in grass root level do not even have a proper business plan, bank account or South African Revenue tax certificate.

Researcher: Are there any other departments or organizations that you worked with in the programme?

Respondent: There was DTI, City of Johannesburg , West Rand Municipalit and Innovation Hub. We had a lot of organizations that were part of the programme.

C.4 Interview 004

Researcher: Does GISP have an impact on Climate Change Mitigation through the reduction of GHG emissions?

Respondent: GISP is not a vehicle for climate change mitigation because it is focused on waste recycling. From GDARD's perspective GISP is primarly focused on landfill waste division. Climate change mitigation is addressed through interventions that focus on alternative energy sources and technologies and not so much in terms of waste diversion. The aspect of climate mitigation is little in GISP compared to the aspect of waste diversion. GDARD colleagues from the Climate Change and Research Unit are questioning the autencity and validity of the GHG emission saving calculations. There are different GHG calculators (Eskom GHG Calculator, Green Cape Carbon Calculator etc.) in the market and I will not be confident to speak on the climate change mitigation aspect. We are confident with the landfill waste diversion because there is evidence of waste exchange between them and that is feasible and quantifiable.

Researcher: This is an interesting discussion maybe I could contact climate change and also find out from them what is their take on the program?

Respondent: Please contact the Assistant Director for Climate Change in GDARD.

Researcher: What are your roles and responsibilities in the organization that you work for?

Respondent: I work for GDARD which promotes social, economic and environmental management in the Gauteng Province. In GDARD there is Chief Directorate called Sustainable Use for the Environment. In the Chief Directorate I work for the directorate called Environmental Policy Planning and Coordination (EPPC).

Researcher: So, what is your current role in GDARD?

Respondent: I am an Assistant Director for Legislative Development in GDARD.

Researcher: Does your role in the organization having an impact on GISP outcomes ?

Respondent: I think our responsibility for GISP is to manage our partnership with NCPC-SA to manage their waste programme. We are concerned with the depletion of the landfill air space in the municipalities and waste management in the province. Our responsibility is to management GISP and ensure that there is a budget for this programme and the programme continues to meet its targets.

Researcher: so how does the NCPC-SA communicate with industries about GISP within the Gauteng Province?

Respondent: GISP facilitators requests for industries contact information from City of Ekurhuleni and GDARD. GISP facilitators will phone or email industries and invite them to the BOWs.

Researcher: What are the barriers that discourage industries from participating in GISP?

Respondent: GDARD is a licensing authority for waste processing facilities and may identify some non-compliances during the BOW dileberations however we are encouraged to not to assume the role of government during the BOWs. Assuming that role would discourage the facilities from opening up on their operations and their challenges on their non-compliance.Some industries may still see GDARD as a threat during the BOWs and not disclose their information. We have tried to communicate that GDARD is coming in as NCPC-

SA partners to assist waste processing facilities to improve their waste management operations and after that I think they sort of opened up.

Researcher: As the provincial authority in environmental and waste management do you relax certain regulations for industries to participate in GISP?

Respondent: No, we just guide companies in terms of addressing non-compliances with their waste management licences. We advise industries on how to get waste management licences related to the storage, processing and transportation of waste. For companies to exchange waste resources they need to have the correct licences and be compliant and that is how we as government guide them.

Researcher: What is the most effective information and exchange platform in GISP?

Respondent: I'm not be involved in NCPC-SA operations but from the comments and feedback we received the BOWs are working. GISP facilitators are responsible for engaging with companies that showed interest in exchanging waste materials and ensure that the exchange takes place between the companies. NCPC-SA with the help of GDARD checks if the companies have the relevant licences to transport, store or process the waste .

Researcher: Are there any other ways of communicating that you would recommend from the ones that they already have?

Respondent: NCPC-SA are putting together some Apps to facilitate quicker synergies outside the BOWs. The companies will be register their needs and wants in the App. NCPC-SA will keep track of what is happening at the backend of the App and can conduct follow-ups to ensure that synergies are completed where necessary. We share BOW invitations to Small Medium Micro Enterprise's that the Waste Management Sub Directorate from GDARD works with. We upload the BOW to our website.

Researcher: Is the App at a conceptual level or has it been developed?

Respondent: I don't think it is at the conceptual stage because they know they are still testing it.

Researcher: so last question are they the sort of departments or organizations that you have worked on as result of the GISP?

Respondent: The Gauteng Department of Economic Development came on board with their own funding and work plan so that GISP assists the department with the development of the green economy sector. EMM has implemented GISP in their own local area and it has made funding available for it's own GISP initiatives. EMM would sometimes assist NCPC-SA with the venue for the BOW.

Researcher: Can you please share the workplan?

Respondent: I will share the workplan that the Gauteng Department of Eonomic Development has submitted however do not attach it to the report.

C.5 Interview 005

Researcher: What does your organization do?

Respondent: I work for NCPC-SA and we implement GISP which is funded by the DTI. NCPC-SA has a mandate of assist industries to be more competitive and lower the carbon footprint by implementing resource efficiency and cleaner production.

Researcher: What is your role in the organization that you are currently working for?

Respondent: I am a project manager that facilitates the implementation of a resource efficiency and cleaner production in the industries and one of the tools that I am responsible for is GISP. I assist companies to implement their waste resource exchanges that are highlighted in GISP.

Researcher: How does NCPC-SA communicate with these industries?

Respondent: We recently launched the IS App which will be an online platform where companies interact with each other and also with the NCPC-SA. Traditionally we held BOWs every year for companies to exchange waste resources and we train companies on IS

implementation. During training events and on our website we invite all the companies to attend BOWs.

Researcher: When you invite companies to attend the BOWs how do they respond?

Respondent: The response is always great. I was involved in the facilitations of the BOWs. People who did not even RSVP would attend the BOWs and the venue would not be sufficient. There has been an increase in attendees which has been great. We are busy planning a BOW for the last quarter of the 2020/2021 financial year.

Researcher: When you speak about facilitation what do you mean exactly?

Respondent: The main purpose of the BOWs is to get companies to engage with other companies and put their waste resources on the table. I would match the company that has a waste resource that another company wants. The match would be referred to as a synergy.

Researcher: Has matching activities been efficient and effective in GISP?

Respondent: It has been 100% effective. Once the synergies have been identified from the BOWs we plan for future engagements so that the synergy is completed. BOWs are important because new waste recycling companies get to engage with established waste recycling companies and get to brainstorm and learn.

Researcher: So what could you say are the main barriers when it comes to industries participation in GISP?

Respondent: The first barrier relates to legal barriers. Companies that have wastes the barriers expect that the company that will recycle the waste to have the correct waste management licences. Another barrier relates to transportation, some companies may want their waste to be removed from site on a weekly basis as per their licence and the other company can only afford to remove it on a monthly basis. Small recycling companies/industries may not have the finances and technologies to process waste resources.

Researcher: Which is the most appropriate communication method that you have seen that is the most effective in getting the industries attracted to GISP?

Respondent: Our biggest communication platform now is our website which is mostly attracted big companies. We send BOW invites and promotional material via our email system. I am concerned about the new waste management industries who are not aware of NCPC-SA and since they are new we may not have their contact information. Last year we started conducting radio shows and we advertise the BOWs through those channels. The radio broadcasts would bring us new entrepreneurs in BOWs.

Researcher: How will the App assist the facilitators effectively facilitate GISP?

Respondent: We sometimes do not capture all the synergies and therefore the App Is meant to fast track the identification and completion of waste exchanges. We hope that through the App companies will be able to interact with the waste recycling company that are closer to them. The App will not eliminate NCPC-SA role and responsibilities for GISP because GISP has to monitor the activity in the App.

Researcher: What are your views in terms of the impact of the programme on climate change?

Respondent: From the inception of the programme we have seen an increase in landfill waste diversion and companies are employing more people because they do not have to pay landfilling related costs. I have seen waste management at different plants getting better because they put value on our waste streams. I like the idea that through the programme young people are doing great innovative things with waste through IS e.g use plastic to make bricks. We offer training so people become waste experts who can implement synergies.

Researcher: so are there other departments that you work with and how does that interaction work?

Respondent: We are currently working with many departments in Gauteng such as DEA, GDARD and the Gauteng Department of Economic Development. GDARD funds the programme. Provincial departments such as GDARD and the Gauteng Department of Economic Development assist in addressing queries related to legal requirements for the transportation, storage and processing of waste materials. We also provide facilitation training to government departments employees who are participate in BOWs.

C.6 Interview 006

Researcher: What does your organization do?

Respondent: GDARD offers several key services to the public such as environmental management, agriculture and rural development veterinary services and climate change and coordination.

Researcher: What is your role in the organization you are currently working for?

Respondent: I am an Assistant Director for Climate Change in GDARD. I address climate change adaptation issues within the province.

Researcher: Does the role you play in the organization have an impact on GISP outcomes?

Respondent: Yes I participate in meetings with NCPC-SA in order to derive the climate change benefits from GISP.

Researcher: How does the NCPC-SA communicate with industries for GISP? Is the communication process efficient and effective? Please elaborate further on your answers.

Respondent: I do not think I am the most qualified individual to respond to the question because I am not the project administrator and it is the legislative unit that works closely with the NCPC-SA in running the programme. I assist with the review yearly results of the programme. I was tasked by my department to draft a list of successful programmes in terms of climate change and we identified GISP as one of the successful programmes for climate change mitigation. If we look at the 2017 – 2019 period there was GISP led to the reduction of 57 000 tonnes of GHG emissions and diverted 111 0000 tonnes of waste from the landfill site. When it comes to climate change mitigation waste diversion and GHG emission reduction are key outcomes from the programme. I believe that we need more programmes of this nature in the province. We have tried to request for the methods NCPC-SA uses to calculate the GHG emissions however we have not as yet received an answer from them.

D Ethics Clearance

SCHOOL OF ARCHITECTURE AND PLANNING
HUMAN RESEARCH ETHICS COMMITTEE

SCHOOL OF ARCHITECTURE & PLANNING

CLEARANCE CERTIFICATE
PROTOCOL NUMBER: SOAP076/06/2020

PROJECT TITLE:	Investigating the Impact of the Industrial Symbiosis Programme on the Recycling Sector
INVESTIGATOR/S:	Ndovela Mfundo (Student No: 743157)
SCHOOL:	Architecture and Planning
DEGREE PROGRAMME:	Master of Urban Studies (**MUS SEEC**)
DATE CONSIDERED:	05 August 2020
EXPIRY DATE:	05 August 2021
DECISION OF THE COMMITTEE:	Approved

CHAIRPERSON _____
(Dr Brian Boshoff)

DATE: Signed under lockdown: 10.8.20

cc: Supervisor/s: Gerald Chungu