Innovation for Transition to a Circular Economy: a Transdisciplinary Case Study at Distell

By
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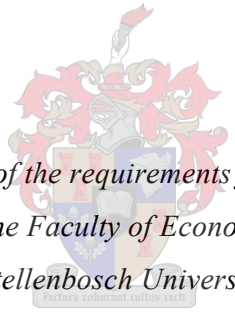

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Supervisor: Prof. Mark Swilling

March 2017

Declaration

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Date: March 2017

Abstract

The negative effects of excessive global resource use see the urge for decoupled methods of consumption. The circular economy has been acknowledged as a tool to mitigate continued resourced exploitation, and could provide a method for countries to transition towards sustainability. This thesis investigates whether the application of the circular economy may facilitate broader systemic change that provides economic, environmental and social benefits in the context of South Africa. More locally, this thesis responds to the impending closure of the Stellenbosch landfill site, and aims to explore a practical solution to help divert waste from landfill.

This thesis aims to fulfil two main objectives. First, it aims to synthesise both transitions theory and the circular economy to provide an innovative tool with which to approach sustainable transitions. Second, it aims to apply this hybrid theory in a transdisciplinary case study at Distell to uncover an innovative closed-loop waste solution. Other objectives aim to contribute to Distell's ongoing sustainability efforts, respond to Stellenbosch Municipality's target of reducing organic waste to landfill, contribute to the growing research and evidence of the circular economy and its outcomes, motivate continued theory development and empirical research into the potential synthesis of the two theories and initiate the academic discourse of the circular economy in South Africa.

The two main objectives are explored by analysing two sub-questions in two freestanding journal articles. The first article explores the potential synthesis of the fields of the circular economy and transitions theory through a literature review. Although these theories are clearly different, the argument is made that the strengths in the one theory can bolster the weaknesses in the other. The intersection between the two distinct theories has the potential to facilitate a sustainable transition towards a circular economy through innovation. The general conditions under which the circular economy may be replicable is suggested, and further research is recommended to investigate this lens in a case study.

The amalgamated theory provides the conceptual tool used to analyse the transdisciplinary case study at Distell in article two. The case study investigates the various waste stream opportunities at Distell that can demonstrate the synthesis in article one to provide a scalable intervention with environmental, social and economic benefits. The filter waste stream was chosen due its high priority given by Distell, and with the conceptual tool it was possible to design a closed loop intervention that has the potential for widespread positive environmental, economic and social effects.

Closing the loop on the cellulose filter waste entails using them to grow and sell edible mushrooms, thereafter selling or using the exhausted substrate as compost. The implications could include two

new revenue streams, reduced costs, waste diverted from landfill, reduced greenhouse gas emissions associated with landfilling, soil regeneration, increased carbon sequestration ability of soils, strategic positional advantages and semi and low-skilled job creation. Since the majority of the Western Cape wineries use the same filter method, these findings could potentially transform the Western Cape wine industry, and thus our soils. The specific conditions under which this intervention could be replicable is suggested, and further research is recommended to develop a clear strategy for implementing this project, and to continue the theory development of the amalgamation of transitions theory and the circular economy.

Opsomming

Die ontwikkeling van ontkoppelde metodes van gebruik is nodig om die negatiewe gevolge van die oormatige gebruik van die aarde se hulpbronne te bekamp. Sirkulere ekonomie word erken as ‘n manier om die volgehoue uitbuiting van hulpbronne te bekamp en ‘n metode te bied vir lande om oor te skakel na volhoubaarheid. Hierdie tesis ondersoek die moontlikheid dat die toepassing van sirkulere ekonomie ‘n breer sistemiese verandering wat ekonomiese, omgewings en maatskaplike voordele binne die Suid-Afrikaanse konteks sal bewerkstellig. Meer plaaslik is hierdie tesis ‘n ondersoek na die dreigende sluiting van Stellenbosch se stortingsterrein met die doel om ‘n praktiese oplossing te vind vir die herwinning van afval.

Hierdie tesis het twee hoof doelwitte. Eerstens het dit ten doel om sowel die teorie as die sirkulere ekonomie saam te voeg en sodoende ‘n innoverende instrument te ontwikkel vir die hantering van volhoubare oorgange. Tweedens het dit ten doel om hierdie hibriede teorie in ‘n transdisiplinere gevallestudie by Distell toe te pas en ‘n innoverende geslote lus oplossing vir afval te ontwikkel. Ander doelwitte is om ‘n bydrae te lewer tot Distell se voortgesette volhoubaarheids inisiatiewe, kommentaar te lewer op Stellenbosch Munisipaliteit se teiken vir die vermindering van organise afval gelewer aan stortingsterreine, by te dra tot die groeiende navorsing en bewyse van sirkulere ekonomie en die uitkomste daarvan, om voortgesette ontwikkeling van teorie en empiriese navorsing en ‘n sintese van die twee teoriee te motiveer en om ‘n akademiese gesprek oor sirkulere ekonomie in Suid Afrika te inisieer.

Hierdie twee hoofdoelwitte is ondersoek deur twee sub-vrae vervat in twee onfhanklike tyskrif artikels te analiseer. Die eerste artikel ondersoek die potensiele sintese tussen sirkulere ekonomie en oorgangsteorie deur ‘n literatuur oorsig. Alhoewel die twee teoriee duidelik van mekaar verskil kan die argument voorgehou word dat die sterkpunte in die een teorie die swakpunte van die ander teorie kan aanvul. Die raakpunt tussen die twee afsonderlike teoriee het die potensiaal om volhoubare oorgang na sirkulere ekonomie deur innovasie te fasiliteer. Die omstandighede waaronder sirkulere ekonomie herhaalbaar is word voorgestel en ‘n gevallestudie word aanbeveel vir verdere navorsing..

Die saamgestelde teorie bied ‘n konseptuele raamwerk vir die analise van die Transdisiplinere gevallestudie by Distell vervat in die tweede artikel. Die gevallestudie ondersoek die moontlikhede van afvalstroom by Distell wat kan demontreer dat die sintese in artikel een ‘n toepaslike haalbare ingryping met omgewings, maatskaplike en ekonomiese voordele kan bewerkstellig. Die gefiltreerde afvalstroom is gekies vanwee die hoe prioriteit wat Distell daaraan gee en met die konseptuele raamwerk was dit moonlik om ‘n geslote lus ingreep te ontwikkel wat moontlikhede bied vir uitgebreide positiewe omgewings, ekonomiese en maatskaplike effektiwiteit.

Die laaste skakel wat die kringloop vir die filtrering van sellulose afval voltooi, word bewerkstellig deur die kweek van eetbare sampioene. Daarna word die uitgeputte substrata ook as kompos verkoop. Die implikasies hiervan, kan twee nuwe inkomste bronne, verlaagte produksiekoste, verminderde afval na vullishope, verlaagde kweekhuisgasse by die vullishope, grond herlewing, verhoogde suurstofsekwestrasie vermoe, strategiese positionele voordeel en werkskepping vir semi- en laaggeskoode arbeid beteken. Aangesien die meerderheid van wynkelders in die Wes Kaap dieselfde filtreer metode gebruik, het hierdie bevindings die potensiaal om die Wes Kaapse wynindustrie te verander tot voordeel van grondgehalte. Die spesifieke toestande waaronder hierdie ingrepe herhaalbaar sou wees word voorgestel en aanbevelings vir verdere navorsing word gemaak om ‘n duidelike strategie vir die implementering van hierdie projek en voortgesette teoretiese ontwikkeling vir die samestelling van oorgangsteorie en sirkulere teorie.

Acknowledgements

Completing this thesis has been one of the hardest academic challenges I have faced and it would not have been possible without the support and guidance of many important people and institutions. I would like to express my gratitude for the funding I received, both from Stellenbosch University and the School of Public Leadership. With immense gratitude I would like to thank my father, Brian Woolls-King, who not only has provided ongoing moral support and a sense of humour, but also resourced the majority of my expenses this academic year. It is also with great appreciation that I acknowledge the guidance and mentorship of my study supervisor, Prof. Mark Swilling, who always found time to support this thesis.

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I would like to thank the entire Sustainability Institute for this wonderful opportunity, and for supporting me over the past two years. I consider it an honour to have worked with and been taught by such great researchers, thinkers and activists.

Finally, this thesis could not have been completed without the strong moral support of my friends and family. To my mother, Estelle Woolls-King, thank you for your unwavering emotional and moral support.

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List of Acronyms and Abbreviations

MLP	Multi-Level Perspective
Distell	Distell Group Limited
Product Service Systems	PSS
Socio-technical regime	Regime
Socio-technical transition	Transition
Corporate social responsibility	CSR
Johannesburg Stock Exchange	JSE
Gross Domestic Product	GDP

Key Concepts

Circular economy – An industrial economy in which resources flow in a circular manner so that no waste is produced. By design, resources are entered into one of two cycles: the abiotic (technical) cycle, in which technical nutrients are made to recirculate in the economic system without entering the biosphere, and the biotic (biological) cycle, in which biological nutrients are designed to biodegrade and enter the biosphere safely after use. The term also encompasses systems thinking, biomimicry, industrial ecology, the blue economy and cradle-to-cradle.

Cradle to cradle – A biomimetic and metabolic approach to product design, where materials mimic nature's use of nutrient cycling and no waste is produced.

Eco-industrial parks – A grouping of industries that facilitates industrial symbiosis.

Industrial ecology – The study of material and energy flows through industrial systems. Industrial ecology aims to make the ecology of industry more like ecology found in nature, where the outputs of one industry are the inputs for another (Nakajima 2000).

Industrial symbiosis – An approach where the waste resources of one industry are used by another, resulting in resource efficiency and economic, social and environmental benefits.

Information flows – The availability of information within and between companies and their competitors, clients, and staff, which can result in more tailored and efficient services, but also poses a risk of breached information that can be beneficial for competitors.

Landscape – Part of the Multi-Level Perspective, this is the wider context in which niches and regime exist. Examples include societal values and macro-economic patterns. Landscapes can exert stabilising and destabilising forces on regimes**.**

Leap Frog – A way for developing countries to accelerate development, or "catch up", by skipping old development models that may be less efficient, more expensive, and more environmental damaging, and move directly to more current technologies and sustainable practices.

Life cycle analysis – A method of assessing the environmental impacts during the life cycle of a product, from raw material extraction to processing, manufacture, distribution, use and disposal.

Lock-ins – A fixed socio-technical trajectory due to the regimes and landscapes in place. Examples include sunk-investments, scale economics and competencies (Geels 2011).

Material flows – A shortened description of material flows analysis, which is a method of quantifying and describing the way materials move through a system.

Multi-level perspective – A framework for analysing socio-technical transitions toward sustainability, which distinguishes three analytical levels: niches, socio-technical regimes and landscapes (Geels 2011).

Mycelium – The vegetative part of a fungi consisting of a root-like structure that can produce fruiting bodies such as mushrooms if imbued with a spore.

Niche – Innovative, protected projects where special demands are met by niche actors such as entrepreneurs (Geels 2011).

Niche accumulation – New technologies and innovations that diffuse into markets, and eventually permeate it.

Product service systems – A function-orientated business model that shifts the focus from providing products to providing services. Typically, products are rented instead of owned, allowing decoupled consumption.

Remanufacturing – An industrial process that includes inspection, cleaning, disassembly, testing, reprocessing and reassembly (Kurilova-Palisaitiene, Lindkvist & Sundin 2015).

Resource stewardship – An ethic that stresses responsible resource management and use to protect the biosphere.

Socio-technical regime – A semi coherent set of rules (e.g. beliefs, capabilities, competencies and user practices) that coordinate social groups and their activities into a stabilised trajectory (Geels 2011).

Socio-technical transition – The emergent deep, structural changes in socio-technical regimes. These changes can involve mega configurations such as transport or energy and are performed by multiple actors.

Sustainable Transition – The purposive transitions that address environmental problems.

Urban metabolism – The description and analysis of material and energy flows within a city.

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Chapter 1 - Introduction

1.1 Introduction

This thesis aims to fulfil two objectives. First, the thesis will present the argument that the work around the circular economy may benefit from a synthesis with sustainable transitions and the Multi-Level Perspective (MLP), as it exposes the transformative and innovative potential of the circular economy. Second, the thesis aims to explore the above concepts in the context of South Africa, and how they may to be applied to Distell Group Limited (Distell), a multinational brewing and bottling company.

This thesis will apply the combined lens of the Multi-Level Perspective (MLP) and the circular economy to a transdisciplinary case study at Distell to expose a closed-loop intervention to their waste, namely cellulose filter waste. This lens helped guide the researcher to think about the filter waste innovatively, which led to the possibility of diverting the filter waste from landfill in order to grow edible mushrooms on filter waste. This intervention revealed possible direct and indirect benefits; some foreseen and unforeseen, including reduced costs to Distell, reduced methane production at landfill, job creation, soil rehabilitation and closing the loop of nutrients in the Western Cape Wine Industry.

As such, it is the intention of this thesis to initiate and motivate continued theory development and empirical research into the potential synthesis of the principles of sustainable transitions and the circular economy to reveal the latent possibility of the circular economy as a set of niche innovations that accumulatively could facilitate a sustainable transition in resource use. It is proposed that this could help developed and developing countries decouple economic growth from resource depletion, while providing a vehicle for developing countries to leapfrog the linear resource model.

It may be important to highlight that this thesis does not aim to present a perfect solution, or unified truth, but rather to open a conceptual and empirical space for further incremental development of a potential synthesis of the two theories. The combination of sustainable transitions and the circular economy should not been seen in competition, but rather as complimentary and dependent on wider societal actors such as producers, consumers and government.

The Ellen Macarthur Foundation (2013a) states their intention to accelerate the transition from a linear to circular economic model, and use an economic and business rationale as a roadmap. This thesis aims to investigate the theoretical perspective of such a transition, where the synthesis of

sustainable transitions and the circular economy may provide a wider lens with which to understand the acceleration of the circular economy from niche to regime.

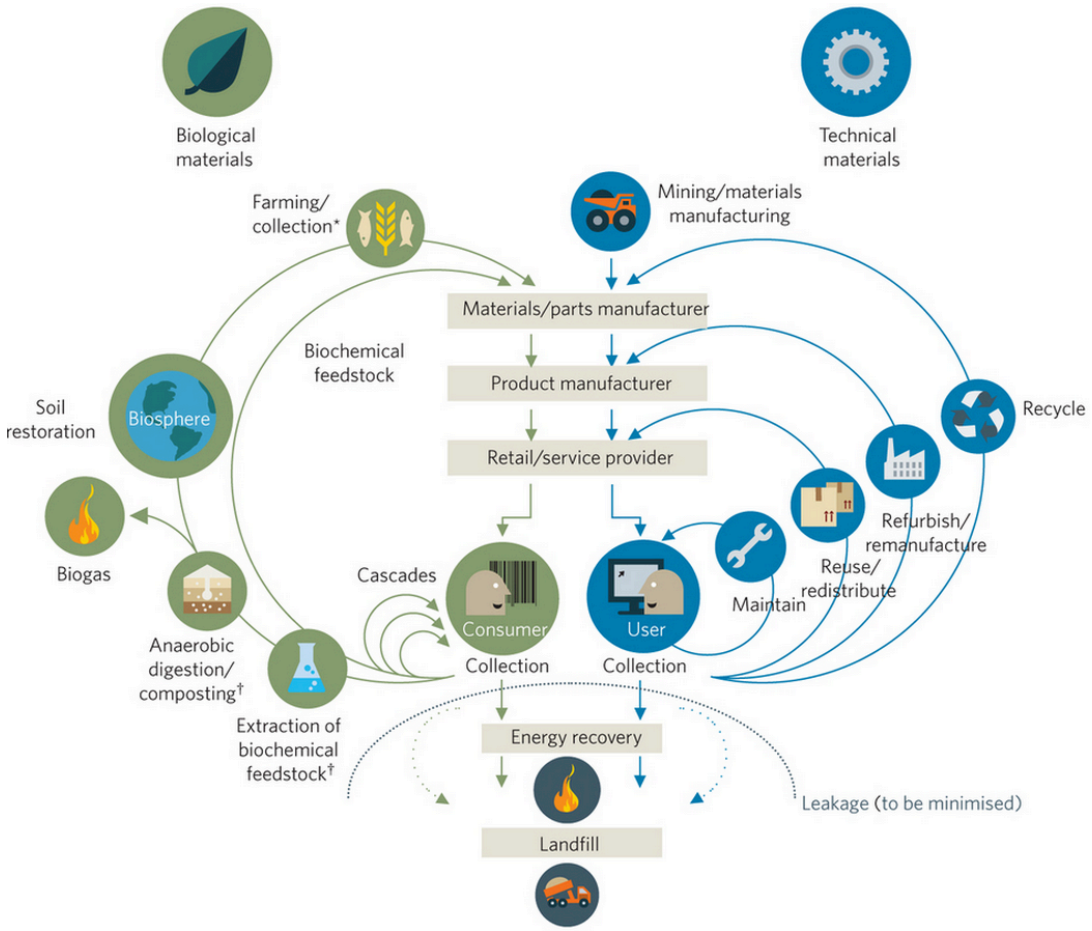
Concepts are used from the multi-level perspective to enrich our understanding of the nature of the problem with the way we currently exploit resources. These concepts are also used to explore the possible transition from a linear to a circular economy.

1.2 Background to this Study

1.2.1 The Circular Economy

The circular economy does not talk about consumers but users. The consumer-led economy is intrinsically a destroyer of value, as the traditional value chain leaks value at every link.

Figure 1 – The Circular Economy



Source: (Ellen MacArthur Foundation 2013b)

A circular economy imagines a society that produces no waste. Within a circular economy, companies sell services instead of products and access instead of ownership. Through increased utility options, products that require ownership spend an extended amount of time circulating in society, and when their end of life is reached, are remanufactured, recycled or safely returned back to the biosphere. An example of this type of servitisation is Toronto Tool Library, a library with a tool inventory of more than 5000 tools for member to use. Users may borrow tools as needed throughout the year with no extra cost. This sort of servitisation is an effective way to diminish the amount of tools needed for minimal household use, since the average drill is used for only thirteen minutes during its lifetime (Ellen MacArthur Foundation 2017).

A system such as this may seem utopic and unrealistic but in fact is based on strategies already in use. Businesses, policies and national planning goals have even been centred on the creation of a circular economy with impressive results such as reduced resource use and pollution, reduced costs, and increased profits and jobs. It should be our current economic system that is regarded as unrealistic, as it promotes inefficient and unrealistic use of resources by pricing below true costs and not considering the true value of discarded waste. It should be our societies and cities that are considered unrealistic, for they manage a linear flow of materials that is unsustainable.

Yet these are the systems we have built: systems that extract, use and discard resources. Conversely, nature produces no waste. Planet earth functions by allowing materials to flow continuously in a circular fashion, or in loops, thus eliminating waste, and continuously creating conditions that are conducive to life. By acknowledging that waste is a human phenomenon, we can shift our paradigm to align with nature's principles, creating a world without waste. The circular economy provides the lens needed to eliminate waste. A circular economy is regenerative by design, and materials are envisaged to flow in loops, thus eradicating waste.

1.2.2 Circular Economy in South Africa

This research comes at the opportune time when influential actors such as the Ellen MacArthur Foundation are bringing circular economy initiatives to the fore. The worldwide surge of circular economy thinking has come at an appropriate time when alternative economic models are needed to alleviate the extractive nature of current consumption patterns.

There is increasing interest in the circular economy in South Africa, although it is often not referred to in these terms. In the Western Cape Province alone there have been companies and government initiatives emerging such as Green Cape, the Integrated Waste Exchange (IWEX) and the Western

Cape Industrial Symbiosis (WISP). These initiatives contribute to an increasing move towards resource stewardship by manifesting industrial symbiosis between companies in Cape Town through linking waste streams of certain industries to the resource input of others. There are individuals dedicated to furthering circular economy initiatives in Cape Town, such as Susanne Karcher and Alex Lemille, who are both circular economy entrepreneurs and plan to introduce the Circular Economy Institute of Southern Africa in 2016. The discourse on the circular economy in South Africa is thus imminent and inevitable, and it is from this backdrop that this thesis emerges to initiate the circular economy discourse in South Africa. Although there are many actors and companies enrolled in circular economy ideas and initiatives in South Africa, there is a lack of academic case examples that this thesis aims to fill.

This research comes at the opportune time when the global circular economy literature is beginning to flourish. However, this does make the theory around this field nascent in nature, and many flaws may need to be addressed before this theory can be tested. As an emerging theory, the circular economy can still benefit from information sharing and the exploration of case studies across diverse contexts. Since there exists no circular economy literature in the South African context, this thesis is well positioned to initiate circular economy literature in this context.

1.2.3 Distell Group Limited

Distell Group Limited (Distell) is a Johannesburg Stock Exchange (JSE) listed, multi-national bottling and brewing company. With head quarters in South Africa, Distell produces a variety of alcoholic beverages including ciders, wine, brandy, liqueurs and whisky. Distell places great importance on their corporate social responsibility (CSR), and advocates responsible drinking, sustainability and community development. Their wide range of processes varies between their different distilleries and breweries, depending on which processes are required for each beverage. Each process is unique, and Distell has already taken measures to "close the loop" on many of their processes. Some of the grape skins are sent to Brenn-O-Kem and used to produce grape seed oil and tartaric acid (Distell 2015). Dry grape skin is used as boiler fuel, and the rest of the waste is used as compost.

Other waste produced at their Stellenbosch and Epping sites includes packaging off-cuts, water and energy usage, filter sludge and glass breakages. Distell continues to look at how to reduce their waste and negative impact. Distell has initiated re-using their glass through bottle returns, and wash the used bottles at three of their plants, Ecowash, Green Park and Port Elizabeth. A total of 154,2 million bottles were reused in 2015 alone, which is equivalent of 148, 353 tonnes of CO_2 savings (Distell

2015). Glass that cannot be reused is sent to recycling facilities where they are used to make new glasses.

Their packaging waste, such as shrink-wrap and empty plastic drums or cartons are sorted and sent to recycling companies. All solids generated by Distell's whisky distilling process are sold as animal feed. They are in the process of internally dealing with some of their effluent and wastewater through a possible anaerobic treatment facility at their Worcester facility. It is apparent that Distell is already committed to sustainability, which is in part to why they were chosen as a case study due to the inherent culture of sustainability and thus accessibility it provided the researcher.

The company's existing interest in sustainability may make the findings of this research less transferable to companies without this inherent interest. However, the outcomes of this research provide numerous benefits that even a company less concerned with sustainability may be interested in. These benefits are discussed later in more detail, and include reduced costs, better public image and two new revenue streams.

Research was conducted at the Adam Tas, Stellenbosch and Green Park, Epping facilities. Due to the scale and relative diversity of production and waste produced, Distell's Green Park facility was researched in more detail. This facility comprises of dry goods storage, bottling and packaging, final product storage and distributions and bottle washing facility. However, the findings can be applied to most of their facilities that filter wine. On a broader and international scale, these findings are transferable to any other wine producer that uses this filter method.

1.2.4 Western Cape Wine Industry

The findings of this research may have positive implications for the Western Cape Wine industry. This industry is large enough that small interventions can create widespread impact. South Africa is the world's sixth largest wine producer, accounting for 2.8% of global production (Vink & Tregurtha 2004). Figure 2 shows the total macro-economic impact of the wine industry on the South African economy. This impact is striking, showing that in 2013 a total of R36, 145 million was contributed to the country's GDP.

Figure 2 - Macro-economic impact of the wine industry

Macroeconomic Indicators	Rand millions
Impact on GDP	36 145 (26 223)
Impact on Capital Investment	62 277 (49 768)
Impact on Household Income	23 579 (17 124)
· **Low Income**	3 994 (2 908)
· **Medium Income**	4 945 (3 598)
· **High Income**	14 640 (10 618)
Fiscal Impact	11 598 (8 517)
· **National Government**	10 809 (7 945)
· **Provincial Government**	106 (76)
· **Local Government**	684 (496)
Impact on Balance of Payments	17 783 (12 704)
	Numbers
Impact on Employment	289 151 (275 606)
· **Impact on Skilled Employment**	43 644 (36 551)
· **Impact on Semi-Skilled Employment**	84 769 (78 310)
· **Impact on Unskilled Employment**	160 738 (160 745)

Note: Figures in brackets relates to 2008 figures.

Source: (Conningarth Economists 2015)

The wine industry's operation provides 289 151 jobs throughout South Africa, of which 167 494 jobs are provided in the Western Cape Province alone. This makes the wine industry a very important industry for the South African government. The sustainability of this industry is thus important for the continued positive contributions it provides, and its sustainability should be of concern to the region.

Out of all the wine regions, Stellenbosch accounts for the largest number of vines and the largest total hectares used to produce these vines (SAWIS 2016). So, this thesis finds itself situated right at the heart of the Western Cape wine industry; a good place for a circular economic intervention that could provide economic, social and environmental benefits.

1.2.5 Soil Depletion

Life on earth above the ground depends on the health of the soils, as it is this soil which sustains the food systems on which we depend (Meterlerkamp 2013). The biological capacity of soils determine its productive capacity, and the gains afforded by the use of global, chemical agriculture over the twentieth century will be short lived as they have depleted the biological capacity of the soils on which our agricultural systems depend (Meterlerkamp 2013).

There are four areas of economic impact that arise from reduced farm productivity that arises from soil degradation (Scherr 1999): The supply, stability or price of agricultural output, the agricultural income or economic growth, the consumption by poor farm households and national wealth. This highlights the widespread negative impact that degraded soils can have; from the subsistence farmer's food security to the economic growth of the country. With the supply of food in recession (Meterlerkamp 2013), the health of our soils is becoming ever more important.

For healthy soils, the general rule is: what you take out, you need to put back in. Organic carbon, such as dead plants, provides the input needed for soils to be healthy and alive (Meterlerkamp 2013). Increasing the carbon content in soils cannot be successful on a large scale unless what has been removed from the soil (crops, biofuels and other products derived from plants) is put back in. Meterlerkamp explains that this means we need to reprocess any waste that originated from the soil to flow back in to the soil (2013). Examples would include our sewerage, kitchen waste and other waste that originated from the soil. In effect, what is needed is a circular economy intervention in agriculture.

South Africa predominantly employs industrialised commercial farming methods that rely on diminishing resources and cause environmental degradation (Swilling, Musango & Wakeford 2016). Currently, 99, 680 hectares of wine producing land are under cultivation in South Africa (Conningarth Economists 2015). To establish a vineyard usually requires the removal of indigenous vegetation, followed by deep ploughing, fumigation with various chemicals and the use of fertilisers and fungicides (Hannah, Roehrdanz, Ikegami, Shepard, Shaw, Tabor, Zhi, Marquet & Hijmans 2013). The use of chemical fertilisers leads to a decline in soil organic matter and soil life, leading to farmers using more fertilisers to remedy the situation that causes an increasingly vicious cycle of action (Swilling et al. 2016). In South Africa, an estimated 5 million hectares of cultivates land have been seriously acidified (Swilling et al. 2016).

This flow of materials can be described as a linear flow of nutrients, whereby external, chemical inputs are used to produce the food, after which the nutrients of the scrap foods lost in landfills

(Meterlerkamp 2013). Since the reliability of continued cheap fossil fuels cannot be ensured (Heinberg 2010), the eventual collapse or reinvention of South African agriculture is imminent. Roughly 60% of croplands in South Africa are moderately to severely acidic, with 11 million hectares vulnerable to erosion risk due to agricultural practices (Swilling et al. 2016)

The case study presented in this thesis, namely growing mushrooms on filter waste and thereafter using the exhausted substrate as compost, is well positioned to address the need for circular nutrient flows in agriculture. The cellulose sheets, which are derived from the soil, become heavily laden with the grape extracts during filtration. Returning these used sheets not only closes the loop of nutrients in the wine industry, but also contributes to the fungi-content in soils, the benefits of which will be described later.

1.2.6 Innovus

Innovus is the innovation company of Stellenbosch University who manage the commercialisation of the University's innovation and intellectual property. They are responsible for entrepreneurial support and development, technology transfer and innovation at the university, and perform the patenting, licensing and the formation of spinout companies. Their business incubator, LaunchLab, offers services and opportunities for entrepreneurs all under one roof that encourages collaboration and idea sharing.

During the research process, this thesis has received interest from Innovus for its potential for commercialisation. Although the idea of growing mushrooms onto filter waste is not patentable, the LaunchLab and/or Innovus have agreed to assist in the start-up of the enterprise. The author intends to accept this opportunity and begin the start up after the completion of this thesis.

1.3 Motivation for this Study

1.3.1 The Era of Resource Exploitation

It's difficult to pinpoint a specific event that exposed the unsustainability of current human activity. One crucial occurrence that did enlighten (some of) humankind was when humans were able to see the parameters of planet earth from outer space (Pretty 2013). Humans were suddenly able to visualise the earth as a finite system, with boundaries that had to be observed. This corresponded with other gains in understanding that the earth and its resources had limits in which human activities had to remain within. It is now well acknowledged by the scientific community that these limits do indeed exist, and nine planetary boundaries have since been identified that must be adhered in order

to maintain a safe operating space for humanity (Rockstrom, Steffen, Noone, Persson, Chapin, Lambin, Lenton, Scheffer, Folke, Joachum, Nykvist, de Wit, Hughes, van der Leeuw, Falkenmark, Louise, Corell, Fabry, Hansen, Walker, Liverman, Richardson, Crutzen & Foley 2009). This new perspective has enabled us to see the negative effects we are having on planet earth.

Humankind faces challenges on an unprecedented scale, the most broadly recognised of which is climate change. Other challenges, which are no less threatening, include biodiversity loss, land use change and resource depletion (Millennium Ecosystem Assessment 2005). So copious are these challenges that they can be referred to as the 'polycrisis' (Swilling 2015). The surface of the earth has been so radically changed by humans since the industrial revolution that scientists are considering calling the current geological epoch the 'Anthropocene' (Barles 2010; Swilling 2015), where 'anthrop' denotes 'human' in Greek. The industrial revolution coupled with the rise in capitalism has not only created the age of the human, but also the era of resource exploitation (Pincetl, Bunje & Holmes 2012).

1.3.2 Rising Consumption

Human activities, industries and lifestyles have fuelled the transmutation and exploitation of our planet on the presumption that resources are infinitely available. A major cause of (and perhaps *the* main cause) of climate catastrophe is the way humans consume. Each activity humans perform is an act of consumption, whether it is entertainment, energy production or food. This has been made so by the measurement of the GDP, which measures and incentivises consumption. Thus global consumption patterns have risen sharply. Each person in the European Union consumes fifteen tons of material annually and generates five tons of waste, half of which ends up in landfill (Lütkehus 2014). The past fifty years has seen more rapid ecosystem change than during humanity's entire existence, resulting in wide scale ecosystem deterioration and complete collapse (Millennium Ecosystem Assessment 2005). Nature's ability to act as a sink for our continued 'development' has been drastically altered (Nakajima 2000). This, coupled with booming human populations, may have devastating effects to our future survival. With human populations expected to rise from seven to nine billion by 2050 (Swilling 2015), competition for resources will inevitably grow, and the challenges we currently face will intensify. The challenges humankind faces are extensive, requiring deliberate changes to alter our current trajectory.

Consumption must happen without depriving future generations (Pretty 2013). Yet the challenge of reducing global consumption is made more difficult due to the fact that basic needs have still not been met globally (Hodson, Marvin, Robinson & Swilling 2012). In addition, the nature of

consumption has changed; as populations become more affluent, not only do they to consume more basic resources, but also more per capita than ever before (Pretty 2013).

Moreover, extraordinary growth is reaching developing countries which means increasingly more people are joining the globalised consumer culture (Pieterse 2015). An estimated three billion people are likely to join the global middle class by 2050 (Tukker 2015). Those that are entering the middle class aspire to live the lives of affluent societies, which fuels the use of already dwindling resources. This is what Pretty calls 'convergence' (2013); and it is this convergence that simply cannot be resourced by our finite planet. The current ways in which business and industry operate needs to be reconsidered, as must the massive rates at which we currently consume.

1.3.3 Role of Big Business

Countries around the world strive for indefinite economic growth. Societies are thus organised around their respective capitalist economies and industries. The resultant capitalism and consumer culture sees individuals, businesses, entertainment and politics being dictated by monetary objectives that has contributed to the overconsumption of planetary resources. This on-going pursuit of profits has been a major contributor to the continued ecological degradation we are faced with today (Marcus, Kurucz & Colbert 2010). What is considered good for business is often considered sacrosanct and indubitable, effectively safeguarding unsustainable practices in favour of profit.

In his book, *The Ecology of Commerce* (2009), Paul Hawkin charges business and industry as the major culprit in causing the decline of the biosphere, and the only institution large and powerful enough to make the significant changes required to overcome the multitude of crises we face globally. Business could be regarded as the opportune vehicle for archetypal mobilisation, innovation and change due to the cluster of skills, people and financial resources they often have available.

Aside from the ethical reasoning as to why firms should contribute towards sustainability, it is increasingly felt by corporates that they need to consider their effects on the biosphere if they are to sustain and grow their business practices (Hahn, Kolk & Winn 2010). The Global Risk Report (WEF 2015) gives strong evidence of what the continued transgression of socio-ecological system boundaries could hurt firms. Some of the environmental and social risks for firms to consider include rising energy prices and labour issues (Bansal & Roth 2000; Delmas & Toffel 2008; Hillman & Keim 2001; Starik & Rands 1995). Other forces that could pose a threat to business include climate change, energy and fuel, materials resource scarcity, water scarcity, ecosystem decline and deforestation (KPMG 2012).

There is a lack of review of the role of firms play in contributing to sustainability (Winn & Pogutz 2013; Whiteman, Walker & Perego 2013). This is surprising when one considers the huge amount of energy and progress made by companies towards corporate sustainability (Montiel & Delgado-Ceballos 2014). Large, multinational corporations could become key change makers in steering the economic trajectory towards sustainable consumption, since they are well positioned with regards to skills, and human and financial capital (Hawken 2009). The concept of the business model is regarded as an effective tool for achieving sustainability and the related systemic and radical innovations it requires (Boons, Montalvo, Quist & Wagner 2013).

This thesis draws from this strategic positioning in which firms exist, and deduces the significant role they could play in contributing to sustainability. In the EU, the effect that firms can have is being recognised, as large energy using product manufacturers are being enforced by legislation such as the EU directive to take more responsibility for the energy efficiency of their products (Bocken, Short, Rana & Evans 2014a). This thesis acknowledges the role that big businesses could play in steering society towards sustainable resource use, which is why Distell was chosen due to their multi-national, JSE listed status.

It is thus in the long-term interest of firms to make sense of the complex and systemic issues we face as a society, although this approach can present many challenges (Rivoli & Waddock 2011). The use of the circular economy could provide the lens and leverage needed to steer business practices towards sustainability.

1.3.4 Limit to Extractive Growth in the Developing World

The described consumption trends have had major repercussions on the future availability of resources, and worldwide resources that underpin economic growth are beginning to reach their limits. The future availability of food and water are immediate concerns, but also worth considering is the economic consequences of the non-availability of resources. A report by Green Alliance, *Resource Resilient UK*, revealed that the copper in the Earth's crust has been overexploited in many places, leading to more expensive future extraction due to the larger amounts of energy and water needed to mine (Hill 2014). Increased raw material costs are now posing damaging effects to the economy due to a lack of security of supply leading to price volatility (Lütkehus 2014).

In the South African context, the constant pursuit of resources is beginning to reach social, environmental and economic limits. For well over a century, South Africa's economy has been heavily reliant on extractive industries such as mining for gold, platinum and coal (Swilling et al.

2016). In South Africa, resource shortages may become problematic in various sectors, as the long history of resource extraction is starting to pose resource depletion challenges (Swilling et al. 2016). The total water supply for South Africa was 16,853.5 for the year 2000, and only 11,5% of this was returned to the system as unused excess (Statistics South Africa 2004a). Statistics South Africa describes South Africa's water situation as stressed and bordering on the status of being a water scarce country, with each individual having access to 1,100 cubic metres of water per year (Statistics South Africa 2010). In 2001, it was estimated that South Africa had 241 years till coal was fully depleted (Statistics South Africa 2004b).

It is evident that this finite, extractive industry that has fuelled the South African economy is beginning to deteriorate. The supply of gold has been in decline since the 1970s (Swilling et al. 2016), which poses significant economic pressures, while the extractive methods used cause significant environmental damage, especially to fresh water resources and soils. What's more, the social dimension of low wages and negative effects on surrounding communities is beginning to unravel as increasing conflict arises between management and workers (Swilling et al. 2016).

Moreover, South Africa depends on its extractive methods to provide economic growth; an ideal that no longer holds the promise for 'catching up' to a developed country status. It is recognised that countries have developed asymmetrically (Sachs 2009); free market fundamentalism has benefitted industrialised countries, while structural adjustment and other policies have kept developing countries behind. It is dangerous to place the focus of national development of developing countries on the same extractive principles afforded by affluent countries because, as Pretty (2013) points out, our planet cannot sustain convergence of the affluent lifestyles in developed countries.

Developing countries may be unable to enjoy the same methods of economic growth as affluent countries have in the past, namely extractive industrial growth. Although affluent countries may benefit from cost savings, economic growth and better resource use if they adopt a circular economy, they do not necessarily *need* such an intervention like developing countries do. Due to the lack of resource availability and increasing prices, developing countries risk capping economic growth if they do not decouple growth from intensive resource use. This is reiterated by Geng, Zhu, Doberstein & Fujita (2009) when they point out the urgency of the need for a circular economy approach in developing countries due to the severe constraints they face on the availability of resources. This is why the circular economy may provide an opportunity for developing countries to leapfrog the out-dated extractive growth model and exploit the opportunity to base economic growth on sustainable practices and decoupled consumption.

The circular economy discourse is being praised as a possible resource scarcity alleviation tool, and a possible developmental tool in third world countries that may allow them to leapfrog the old development models based on extractive consumption. In Seoul, a wastewater reuse system saves the city tons of water, while in Moscow, waste heat from electricity generation is captured and used to heat most of the buildings in the city (Kennedy, Stewart, Facchini, Cersosimo, Mele, Chen, Uda, Kansal, Chiu, Kim, Dubeux, Lebre La Rovere, Cunha, Pincetl, Keirstead, Barles, Pusaka, Gunawan, Adegbile, Nazariha, Hoque, Marcotullio, Gonzalez Otharan, Genena, Ibrahim, Farooqui, Cervantes & Sahin 2015). Although Moscow and Seoul may now be developed countries, these examples still serve to show the benefits of industrial symbiosis and the circular economy in terms of resource and cost savings.

1.3.5 Rising Unemployment

More than 50% of the global population survive on less than $2.50 a day (The World Bank 2013). In South Africa, an estimated total 26,6% of people are unemployed, with a percentage of 22,2% unemployment in the Western Cape (Statistics South Africa 2016). In 2011, 15,5% of households reported having no income (Statistics South Africa 2015), and a recorded 20,2% of the population live in extreme poverty (Statistics South Africa 2014).

Moreover, South Africa faces massive inequality. The Gini coefficient is a metric that measures inequality using a figure between 0 and 1, 0 being complete equality and 1 being absolute inequality. South Africa has a Gini coefficient of 0,65 based on expenditure data in 2011 (Statistics South Africa 2014). This is one of the highest in the world. The circular economy has been recognised for its potential to provide more equal distribution of economic growth and wealth (Geng et al. 2009). For these reasons, a circular economy may be appropriate in the context of South Africa, due to the country's high increase in inequality (Scerri 2015) and need for economic growth (Swilling et al. 2016).

Building on this backdrop, Stellenbosch and Epping are tangible examples of inequality and poverty. In 2014, Stellenbosch recorded a Gini coefficient of 0,55 with about 19% of the population falling below the poverty line (Stellenbosch Municipality 2014). A drive through Epping will reveal the duality between the many multi-national business factories and the roadside communities of the homeless living in the self-made structures beside them. This thesis recognises this duality. The interventions suggested in this thesis could provide low and semi-skilled jobs for South Africans if implemented.

1.3.6 A Lack of Research on the Circular Economy in South Africa

Despite the need for the developing world to move towards sustainable practices, there is still no major, systemic mobilisation towards sustainability. Some ideologies that share the same virtues of the circular economy have been explored in the South African context (Allen, Lampis & Swilling 2016), but these are more focused on city-level infrastructures and large infrastructures, whereas the circular economy deals with businesses and innovation. The importance of infrastructure for the circular economy should not be ignored, but is, however, beyond the scope of this thesis. Although a circular economy may be appropriate in the context of South Africa and other developing countries, there is still no literature that explores this potential specifically. This thesis is well positioned to initiate academic discourse of the circular economy in the contest of South Africa.

1.4 Research Context

This research emerges to assist Distell with their on going pursuit towards sustainable resource stewardship. Research of this nature requires the traditional disciplinary paradigms to be transcended, and requires the integration of both scientific and societal knowledge (Cronin 2008). The nature of the research question meant that preconceived ideas and theories of the circular economy, their applications and business models could not be directly applied to answer the questions. The researcher had to immerse her in the context to gain understanding and eventually arrive at a possible intervention or solution.

Regeer and Bunders (2009) make the rationale behind this approach clear, as they describe the questions and their solutions as answerable only when a process of integration of knowledge and learning from engaging with many of the stakeholders occurs (Regeer & Bunders 2009). The researcher was able to engage with the stakeholders at both the Adam Tas and Green Park facilities, and through, meetings, emails, observations, and learning, the researcher was able to understand the problems considered most pertinent by the staff themselves. From this point, the researcher was better able to understand the context, and to frame the questions that needed to be addressed. The solutions or interventions were more appropriate and viable due to the time spent getting to know the context and which options would be most beneficial. The researcher purposefully tried to help Distell with their continued sustainability efforts, and by making herself useful in this way she was considered valuable and thus gained better access to Distell, which further enriched the research process.

1.5 Research Problem, Questions and Objectives

1.5.1 Research Problems

Consumption has increased since the industrial revolution, and continues to increase rapidly causing resource shortages, price volatility and biodiversity loss due to land use change and habitat loss. As the world population will continue to grow, basic needs will need to be resourced without overstepping more planetary boundaries.

This is especially important for developing countries, as they could face capped economic growth if the goal of decoupling consumption is not reached. This creates a need for a more circular flow of materials through society that favours the economy, the planet and it's people. In the developing country context, a circular economy approach would need to foster income-generating activities for semi and unskilled positions.

This is easier said than done at a large scale. However, there are examples emerging worldwide to show that it can be done and that it does provide economic, environmental and social benefits (Ellen MacArthur Foundation 2013b). Yet, many more examples need to emerge worldwide to help steer the economy towards circular resource use.

Many well written and influential papers within the field of the circular economy have helped define the concept and shown successful case examples and the associated economic, social and environmental benefits (Ellen MacArthur Foundation 2013b; Wilson 2015; Zhou, Fernandez Bonet, Wan, Denis & Juillard 2014). The issue of how to transition towards a circular economy has been outlined by some authors (Horton & Guang 2015; Jackson, Lederwasch & Giurco 2014; Hobson 2016), but non have explored how niche interventions may provide the innovative tool with which to analyse transitions.

This thesis aims to explore whether a circular economy can provide the innovative lens needed to transition towards a circular economic and resource model by using a synthesis of the literatures on transitions and the circular economy, and an immersive case study at Distell. It also presents the possible outcomes and benefits of the research, namely growing mushrooms on filter waste, which could reduce waste to landfill, reduce methane production at landfill, create jobs, regenerate soils and provide an opportunity for these benefits to scale across the Western Cape wine industry.

On a local scale, this thesis addresses the impending closure of the Stellenbosch landfill site that's expected in 2017. This thesis aims to investigate a way of diverting waste from landfill that is

economically, socially and environmental beneficial. This explains in part why Distell was chosen for the immersive case study, because any reductions in their waste disposal to landfill will be of great significance. The associated research questions emerge from the research problems.

1.5.2 Research Questions

a. Main research question:

Can the application of the circular economy approach facilitate broader systemic change in the South African context that provides environmental, social and economic benefits?

b. Article one:

Is there potential for a synthesis of the fields of transition theory and the circular economy that can offer a conceptual tool for the proliferation of the circular economy agenda?

c. Article two:

What circular economy opportunities exist at Distell that can demonstrate the synthesis of fields described in article one to provide a scalable intervention with environmental, social and economic benefits?

1.5.3 Research Objectives

The key objectives of this research are to:

Develop a foundational conceptualisation of the potential synthesis of transition theory and the circular economy discourse, to provide an analytical tool with which to investigate the proliferation of the circular economy, thereby assisting with the Ellen MacArthur Foundation's call to scale up circular economic initiatives.

- Develop a foundational conceptualisation of the potential synthesis of transition theory and the circular economy discourse, to provide an analytical tool with which to investigate a proliferation of the circular economy.

- Bolster both the circular economy and transitions theory through the amalgamation of the two theories.

- Gain a practical understanding of how the circular economy is realised within an existing company.

- Contribute to Distell's sustainability efforts through research and practical findings.

- Respond to Stellenbosch Municipality's target of reducing waste to landfill, with emphasis on eliminating organic waste to facilitate the sorting of waste at landfill.

- Present Distell and/or a third party with practical knowledge and ideas of how they may implement the findings.

- Contribute to the growing research and evidence of the circular economy and its outcomes.

- Motivate continued theory development and empirical research into the potential synthesis of the principles of the circular economy and transitions theory.

- Initiate the academic discourse of the circular economy in the context of South Africa

1.6 Importance of the Research

Three billion additional consumers are expected to emerge in the next twenty years (Ellen MacArthur Foundation 2013a). This rise is mostly due to the growing middle class in emerging markets, particularly in the Asia-Pacific region, but also in South Africa. These consumers will begin to buy more items that they may have previously done without; a trend that is expected to raise consumption in emerging markets by twenty-eight trillion dollars per year by 2025, up from 2010 (Ellen MacArthur Foundation 2013a). There is a need to expand circular economy research into the lexicon of developing countries in order to push the circular economy agenda into the regions where it's needed the most. This research forms part of this drive, and adds to the momentum and academic discussion on circular economy possibilities in developing countries. The research aims to initiate academic discourse of the circular economy in South Africa, which makes this research relevant for those who want to investigate a circular economy in this country.

The research aims to initiate a discussion around the synthesis of the principles of sustainable transitions and circular economy. This may add value to the circular economy discourse and add to the agenda set by the Ellen MacArthur Foundation to accelerate the circular economy. It is the intention of this thesis to highlight the potential of the circular economy as the vehicle for leapfrog development in developing countries and sustainable transitions.

Generally, the research may be beneficial to those living in Cape Town, as better resource stewardship will benefit the collective by means of reduced environmental impact and economic incubation from resource price volatility. The Waste Department of Cape Town has already made some attempts to steer waste management towards a more circular flow of resources. In 2013, the Home-Composting Research Project was introduced to help reduce waste to landfill and facilitate better sorting capability at landfill, with the long term intention of providing more of such infrastructure to residents in years to come (Department: Solid Waste Management 2013).

The Stellenbosch Municipality has set out medium to long-term sector plans including the spatial development framework, which forms part of the integrated development plan (IDP). In these plans, a focus is placed on interconnected nodes, car free living, inclusive economic growth, optimal land use, food and agriculture, heritage and resource custodianship (Stellenbosch Municipality 2015). They state that the municipality's infrastructural load is too large, and more needs to be done to decrease wasted resources such as fresh water, solid waste and energy. The municipality's solid waste system is at maximum capacity (Stellenbosch Municipality 2015). The current landfill site is already over capacity, and the new one that was constructed in August 2012 is projected to reach its capacity in 2017. The municipality is thus urgently looking for ways of reducing waste streams, and innovative ways to divert waste from the landfill are already being investigated. Prototyping a home biogas digester and creating building bricks from discarded building rubble are two examples, and this research could help in this regard.

Thus on a local level, the research is primarily important to Distell and Stellenbosch Municipality. Distell closely engages with the relevant municipal authorities to manage concerns of mutual importance. They are continuously looking for ways to reduce their load on the local authorities and use alternative methods of managing their waste such as using treated waste water for irrigation (Distell 2015). This research may facilitate this engagement and help reduce the pressure that Distell places on municipal infrastructure and resources.

The research may be directly important to Distell Group Limited as it could help them further their sustainability goals, and help them understand their internal processes better. If implemented, the

research may facilitate reduced waste, reduced costs, two extra revenue streams and the creation of 'green' marketing material.

The research primarily focused on the Green Park facility in Epping due to the larger scale of production. However, since the types of production at the Green Park and Adam Tas facilities are in many ways similar, the research can be applied directly to the Adam Tas Park, Stellenbosch. It may also benefit other companies wanting to introduce more circular initiatives, both in South Africa and abroad.

The findings of this research are applicable to the entire South African wine industry. The knowledge produced in this thesis is highly transferable to the industries that make use of the cellulose filter method (which is the majority of the wine industry). This could lead to an industry overhaul whereby tons and tons of waste and methane are reduced, millions in costs saved, with other benefits such as better soil quality, increased jobs, reduced waste at landfill and better carbon sequestration ability in soils.

1.7 Methodology

1.7.1 Overview

This thesis follows a transdisciplinary and case study methodology. Transdisciplinary research is a new mode of doing science *with* society. It is a move away from the narrow Cartesian two-world theory of society, and aims to tackle complex real-world problems through the use of integrated and innovative transformative solutions done using a collaborative process that involves the necessary social actors. These social actors are usually the people right in the centre of the study, or subject of the study itself. They are the ones who provide the insights, skills and access to such a study and can include citizens, professionals and local authorities.

Intended as a methodology that would help unify and synthesise knowledge across a variety of disciplines and specialities, the transdisciplinary method forces the researcher to engage with society to tackle real-world problems. It purports that knowledge must be co-produced, co-generated and co-constructed between varieties of actors from different fields. It is a methodology that has emerged in response to humanity's ever increasing awareness of the complexity of the world and its systems. It responds to the interconnected nature of the polycrisis, and acknowledges the non-linearity and multiple causations that exist.

In this way, the characteristic of transdisciplinary research is an integration of knowledge from a range of social actors relevant to the problem to yield knowledge that is greater than the sum total of knowledge that was synthesised. To facilitate the various elements, integrative methodology and methods are applied, allowing mixed-methods of qualitative, quantitative and transformative research approaches to be used. The selections of methods are based on the context and complexity of the problem, and methods are encouraged to be dynamic to adapt to changes that may occur during the research process.

Transdisciplinary research breaks away from the dualistic, dissecting nature of Newtonian science. The subject-object split does not apply in transdisciplinary research, as researchers embed themselves in the system they are studying. The researcher becomes personally involved in doing the solution-orientated transdisciplinary research. Due to its collaborative approach, transdisciplinary research may require extra time to build the relationships necessary for the research, and to build a consensus between them (Cronin 2008). In addition, transdisciplinary research is challenged by its focus on tackling complex problems and creating a solution that fits the common good (Cronin 2008). However challenging these problems, they can too be considered part of the beauty of the method. These limits were present during the research process in this thesis, and some measures were taken (described later) by the researcher to limit these constraints.

1.7.2 Transdisciplinary Research

History has seen the transformation of the practice of scientific knowledge, from histories and myths which were related between persons, to alphabetic and numeric written communication transferred through a third party – text (Max-Neef 2005). Rational thought became the rule over relational thought, male over female, yin over yang, thinking over feeling, reading over doing.

As a result, science became disconnect from the world, and from the subjects of study. Not only did science become disconnected from the public, but scientists have increasing difficulty communicating ideas to each other across different fields (Max-Neef 2005). Higher and higher specialisation has produced a type of knowledge that is difficult to apply back to reality to affect change. The observer has become separated from the observed.

This Cartesian way of producing knowledge is well suited for many applications and definitely has its place. However, the nature of the polycrisis we now face requires something different. The world in which we live is inherently dynamic and complex, characterised by uncertainty and change. We rely on science to help make meaningful changes to our world, yet are disempowered by the nature of how this knowledge is produced and delivered. Problems we now face such as water shortages,

poverty, ecological collapse and terrorism cannot be solved using binary science or from the knowledge of specific, specialised disciplines (Max-Neef 2005). Changes to problems that have been explicitly proven have been slow, even though all the relevant scientific knowledge is available (Steffen, Richardson, Rockstrom, Cornell, Fetzer, Bennett, Biggs, Carpenter, de Vries, de Wit, Folke, Gerten, Heinke, Mace, Persson, Ramanathan, Reyers & Sorlin 2015). The problems we face are no different in nature to the world in which we live; they are complex and dynamic, and require equally complex and dynamic solutions. This forms the main drive behind the use of transdisciplinary research, as it bridges the division between knowledge development and action. Disciplinary science is about mono-disciplines; transdisciplinary research is about integrating multiple forms of knowledge to generate new forms of knowledge.

A transdisciplinary approach requires researchers and scientists to leave their laboratories and go out into the world in search of the truth. This approach leads to mutual learning between the subject and the object, as solutions are co-created with the individuals for whom the knowledge outcomes are intended (Swilling, Tavener-smith, Keller, Heyde & Wessels 2013). The immersive nature of transdisciplinary research allows the division between knowledge and action to be overcome and meaningful, relevant solutions are mobilised. (Swilling, Tavener-smith, et al. 2013).

Transdisciplinary research is unique in several ways. First, the research takes a problem-focused approach, in the context of the real world challenges. Second, there is no linear, prescribed methodology; each context will call for different methods. This requires reiteration and reflection from the researcher, and an openness to follow an evolving methodology according to what is needed and most appropriate. Third, transdisciplinary research is a synthesis of knowledge that can only be produced between actors in an immersive and collaborative process, unifying the object and subject. This calls for the researcher to remain cognitive of his/her own prejudices, preferences, limitations and disciplines (Cronin 2008).

A transdisciplinary methodological approach was chosen for this study for three reasons:

1. First, the nature of the research required at Distell required an on-going and embedded approach in order to understand the problem and facilitate a desired solution.
2. Second, the thesis presents an argument based on a synthesis of literature from different unmerged fields (sustainable transitions and the circular economy). The combination of different ideas to generate knowledge is one of the defining characteristics of transdisciplinary research.
3. Third, the objectives (discussed earlier) of this research aim to bring about some degree of real world change to Distell's processes, and hopefully to the broader South African context.

Additionally, a transdisciplinary methodology was chosen due to the nature of the topic of research. A circular economy combines and synthesises many approaches in order to present a systems level of solutions to a systems level of problems (the polycrisis). Such approaches include urban metabolism, energy and resource efficiency, product design and alternative business models to achieve a more sustainable flow of resources in society.

1.7.3 Types of Knowledge

The three types of knowledge that transdisciplinary research produces are used in this thesis. The first is systems knowledge, which is the knowledge produced that allows us to understand what the current situation or nature of the problem is. This was the knowledge used at the start of this research, where the processes at Distell were studied to identify what the pertinent waste streams were. The second knowledge type is target knowledge, which is an investigation into what is most desirable in that context. This knowledge type was used during the embedded research at Distell, which uncovered which waste streams were the most problematic to the company. The third knowledge type used is transformational knowledge, where the ideas, processes and social learning necessary to transition towards the desired goal are uncovered. These three types of knowledge outline the steps taken during the research process of this thesis.

The first and second knowledge types were researched and completed as phases one and two. Phase one investigated the nature of the problem, and phase two saw an investigation into what was most desirable in the context. The third phase was researched substantially, but not implemented. As such, this thesis highlighted ideas and practical solutions that Distell, or a third party such as Innovus, could implement to make the transition possible.

1.7.4 Methods

Three types of methods were used for this thesis: direct observation, semi-structured interviews and a literature analysis. Direct observation was conducted at Distell's Green Park and Adam Tas sites. This observation was always under supervision of a Distell employee, allowing the researcher to ask questions and learn about Distell's processes in more depth. Some of these direct observations were merged with semi-structured interviews, as the researcher had the agenda to close the loop on waste and could thus direct the conversation to be more informative.

Meetings were held with the materials and cellar managers after the initial research and findings had been done. These meetings were unstructured interviews that aimed to both provide further

research material and inspire and inform Distell about the possibilities of closing the loop on the filter waste. Some momentum had developed, and there was considerable interest in the research before the researcher had to withdraw from further field research so that the write-up could be done.

The literature analysis helped to inform the research on the ground. The three methods of semi-structured interviews, direct observation and literature analysis were undertaken concurrently and thus the different methods helped inform one another. The literature analysis helped to explore leads discovered at Distell, many of which were not feasible.

1.8 Research Originality

Various databases were searched to determine whether this research had been conducted before. The specific topic in this thesis was not found in any focused literature on databases such as Sabinet (Networked Digital Library of Theses and Dissertation), Academic Search Premier on Ebsco, SUNsearch (University of Stellenbosch) and Google Scholar. This lack of literature indicated a gap in the current literature on the merging of the circular economy and transitions theory in the context of South Africa.

1.9 Ethical Implications of the Research

It is the responsibility of researchers to ensure their research is performed and completed in such a way that doesn't infringe on the rights and wellbeing of others, both personally and commercially. Transparency and methodological rigour was maintained by the researcher to avoid misrepresentation or breach in confidentiality. A low ethical risk classification is appropriate for this thesis due to it being a business-related study. However, to avoid any misconduct, an open, honest and scholarly approach was undertaken to protect Distell's commercial image. Only participants who had given their informed consent participated in the research. It is important that the participants understand the processes and aims of such a study, and these were made explicit to Distell through a written research proposal before commencing. Great care was taking during the write-up of this thesis to ensure that Distell was not misrepresented in any way.

1.10 Thesis Outline

The chosen layout of two journal articles has its limitation in the amount of information that can be represented. The researcher tried to counteract this limit of space by referencing more information

for various topics to show the amount of knowledge and information available on various topics. In this way the research is situated in a wider context of the literature.

This thesis is set out to conform to the layout and style required by the School of Public Leadership, and Stellenbosch University. The first article is aimed to be publishable as a conference paper. This is typically an in-depth analysis of the relevant literature to inform further research. The second article is aimed to be publishable as a journal article for The Journal of Cleaner Production. This article contains the research that builds from the literature analysis in article one. The articles take into account the relevant formatting and content for the targeted audience, but style restrictions of the University of Stellenbosch were complied with where there were clashes. The articles are intended as stand-alone articles, therefore some repetition across the articles are made to give the relevant context.

The first chapter of this thesis provides an overarching introduction to the thesis. This introduction covers the background to the study and the literature topics, giving context to the research findings discussed in later chapters. This chapter also details the importance of the research, the motivation for this study, research questions and objectives and explains the key concepts that will be used. An in-depth description of the chosen research methodology, transdisciplinary and case research, is given, as well as the research strategy and methods. The empirical research used a transdisciplinary research design, direct field observations and semi-structured interviews (article two). The theoretical methods used a literature analysis (article one).

Chapter two forms article one of this thesis and provides a literature review. This chapter explores both transitions theory and the circular economy and makes the argument that a synthesis could prove beneficial for both. The levels of regime, landscape and niche of the MLP are overlaid onto the circular economy to investigate the broader context of the circular economy, while the circular economy is argued to be able to provide the MLP with a clearer methodological tool. Various landscape elements helped reveal what may prohibit the proliferation of the circular economy. The conclusion is presented that an amalgamation of the two theories could reveal the innovative potential of the circular economy and help it advance its agenda, or replicate, and various general conditions (or landscape features) are suggested that could achieve this.

Chapter three forms article two of this thesis, and documents the case study method undertaken at Distell. A brief background of the circular economy and transitions theory is given, ending with the cross-referenced argument for the synthesis in article one. This sets up article two to achieve two aims:

- First, it aims to provide empirical support for the argument made in article one. A two-fold approach helped achieve this.
    - A - The practical application of innovation from the synthesis helped guide the research towards a closed loop waste intervention, which shows how the lens can result in wide transformation.
    - B - The synthesised lens helped uncover the specific conditions under which the case findings may be replicable. These general conditions are congruent with article one.
- Second, it aims to provide practical findings and ideas and knowledge of how the implement the findings via two methods: a start up and an enterprise development opportunity at Distell.

The article then presents the case study undertaken at Distell, and explains the findings as well as the recommendations for implementation.

The final chapter is an overarching conclusion that ties together the previous chapters. The key questions, objectives, arguments and findings are reviewed, and possible outcomes of the research investigated. Recommendations for future research include the continued theory development of the amalgamation of transitions theory and the circular economy, as well as the continuation of the circular economy discourse in South Africa.

Chapter 2 (Article One[1]) - Synthesising the Principles of the Circular Economy and Sustainable Transitions

2.1 Introduction

It is argued in this paper that the work on the circular economy (CE) (Kurilova-Palisaitiene et al. 2015; Genovese, Acquaye, Figueroa & Lenny Koh 2015; Ellen MacArthur Foundation 2013c; Hill 2014; Ellen MacArthur Foundation 2015; Nakajima 2000; Zhou et al. 2014; Blissett 2015; Tukker 2015; Matthews & Tan 2011) and transitions theory (Smith, Stirling & Berkhout 2005; Geels 2010; Geels 2002; Rotmans & Loorbach 2009; Swilling, M. Annecke 2012; Geels 2011; Hodson & Marvin 2010) can be synthesised to strengthen both theories. The circular economy has created empirical and conceptual space for the research and mobilisation towards sustainable resource use at a business level, but needs to be considered at a more systemic level if it is to advance. The circular economy needs to be considered at a more systemic level because it is dependent on wider societal, economic and environmental pressures and influences.

Within transitions theory, the Multi-Level Perspective (MLP) offers a strong heuristic and investigative tool with which to analyse sustainable transitions on a macro and meso scale, and was chosen in this paper due to its potential to bolster the circular economy and be bolstered in return. It is argued in this paper that although a strong investigative tool, the MLP lacks the methodological approach needed to effect change on a micro (niche) level.

This paper argues that when these ideological fields are combined, the strengths in one can be useful in addressing the weaknesses inherent in the other perspective. This article seeks to assimilate divergent "knowledges" from these two fields, not to create a unified "truth", but to search for the coherence across the strengths, differences, similarities and weaknesses. In particular, it will be argued that the MLP helps provide the circular economy with a more systemic lens that accounts for the wider dynamics that are at play to assist in the proliferation of the circular economy agenda. The advantages and inadequacies of both the MLP and CE will be discussed, followed by the amalgamation of the two fields. With this conceptual lens of the amalgamated theories, the circular economy may provide a way of thinking about innovation and from this innovative lens various niches are likely to emerge. This synthesis opens up a new field of research that could result in the promotion of niche innovations that can go to scale if general conditions are met. This paper suggests five general conditions that could help the circular economy replicate. These include policies and governance support, information flows, reputational threats, limited resources and technical limits.

[1] Article targeted as a conference paper

2.2 The Circular Economy: Background and Challenges

Human consumption is having devastating effects on planetary resources on which our survival depends. In addition, the epoch of cheap resources has ended (Hill 2014), affecting businesses and the economy. Humans simply have to rethink the amount and their approach to consumption. The unsustainability of our world is a systems level problem, requiring a systems level solution. Sustainability rests on combining several approaches (Bocken, Short, Rana & Evans 2014b), which is why the circular economy is worth considering, as it combines various approaches including urban metabolism, energy and resource efficiency, product design and alternative business models to achieve a more sustainable flow of resources in society. The environmental crises that have been outlined in this paper require more substantive transitions that have the ability to shift the major systems upon which we depend.

A circular economy promotes a system of circular resource flows where no waste is created. It is born out of concepts such as cradle to cradle, industrial ecology and biomimicry. The circular economy borrows from the way nature uses resources without creating any waste. In this way, two nutrient cycles are imagined: a biotic and an abiotic cycle, where nutrients are either returned safely back to the biosphere (biotic) or kept in a technical cycle (abiotic), where materials are designed for reuse (Hill 2014).

The circular economy approach has been shown to have numerous social, economic and environmental benefits, including reduced carbon emissions, increased profits and job creation (Ellen MacArthur Foundation 2013c; Wilson 2015). The current discourse on the circular economy explains the benefits of a circular economy on businesses and economies, and alludes to the potential that the circular economy has in mobilising wide-scale change through the use of alternative business models, such as Product Service Systems (PSS) that focus on selling services instead of products.

There are numerous successful case examples of the circular economy (Ellen MacArthur Foundation 2013b), one example being Michelin. Michelin is the leading tyre company with circular economy principles, including examples of service provision over ownership. In the 1920s, Michelin pioneered the first pay-per-kilometre program, and in 2011 had 290,000 vehicles successfully employing the rental service in 23 countries (Ellen MacArthur Foundation 2013b). The service allows Michelin to maintain control over their products, and can thus extend their technical life span, effectively keeping the tyres in a closed loop technical cycle.

Renault has also developed their remanufacturing abilities. Their ability to reuse the materials and run their reverse logistics chain has allowed the company to grow its remanufacturing operations to a 200 million euro business (Ellen MacArthur Foundation 2013b).

These examples show how businesses have taken advantage of circular economy principles to their benefit. The circular economy is indeed a useful methodology, and huge impact can be made if this methodology is followed by more businesses. Although the solutions at a business level are to be celebrated, they should not lull us into the false satisfaction that the circular economy is an accomplished method. Such a respite would only serve to halt the momentum of the development of the circular economy.

Just like anything in our complex world, the circular economy is dependent on wider societal, environmental and economic factors. In and of itself the circular economy does not take into account of the wider context that plays such a significant role in its chances of replication. The circular economy seems confined to successful in-house business examples, with some exceptions (Zhou et al. 2014; Yuan, Bi & Moriguichi 2006; Geng et al. 2009), and needs to be considered at a more systemic level if it is to become as effective as it could be. The MLP may provide the framework needed with which to investigate the circular economy, as it deals with the systemic and interdependent nature of socio-technical transitions.

There are commonalities between transition theory and the circular economy. Both theories aim to promote a more sustainable system of production and consumption (Geels 2010; Ellen MacArthur Foundation 2013b). The MLP is a useful tool with which to investigate broad, systemic transitions, but lacks the specific methodological approaches for promoting transitions, especially at a niche level. On the contrary, the circular economy is useful because it provides detailed methodological tools for addressing localised transitions in resource use, but is not located within a wider systems level understanding of sustainability transitions. The development of a synthesis thus makes sense as the advantages of the one approach can address the inadequacies of the other.

2.3 The Multi-Level Perspective: Background and Challenges

The multi-level perspective (MLP) is a multi-dimensional framework that helps us understand the complex changes that take place in socio-technical systems during sustainable transitions (Geels 2010; Geels 2002; Rip & Kemp 1998). The MLP distinguishes niches, socio-technical regimes and socio-technical landscapes as three analytical levels (Geels 2010) that together define and shape a sustainable transition. These transitions (sustainable or otherwise) are defined by the MLP as regime shifts.

Niches, regimes and landscapes interact with one another in numerous ways including spatially, socially, physically and temporally to create the social and technical configurations we see around us. Cell-phone use, vehicle ownership and supermarket dependence could be considered some of the socio-technical configurations upon which we depend. These configurations are unfixed and dynamic, but due to the socially constructed mechanisms that bolster them (landscapes and regimes) they become set in a dynamic equilibrium that creates relatively stable conditions that can appear rigid. For instance, the culture of independence and freedom might support the existence of the car ownership regime. These relatively stable configurations are explained by Geels (2011, p.26) as "dynamic patterns".

The purpose of the MLP is to understand what guides these interacting levels so that we can begin to pay attention to the relevant questions and problems, and perhaps even begin to predict future changes to regimes and niches. The MLP helps identify patterns in transition contexts that can help us understand how to influence these patterns in desired directions. Importantly, the MLP recognises that there is no single cause or driver in transitions (Geels 2011), but that transitions arise from an interplay between the three levels of niches, regimes and landscapes. It is a framework that acknowledges the complexity inherent in systems and distinguishes multiple, or circular causations (Geels 2011) that either reinforce or destabilise one another.

Although each transition context is unique, niches, landscape and regimes help us understand the bigger picture of what is happening in a given configuration. Without forgetting the complexity and unpredictability present in and between these levels, niches, landscapes and regimes can be summarised as follows: niches develop in reaction to regimes, and build up their own internal momentum which has the potential to emerge and take over regimes (Geels 2011). Landscapes help stabilise regimes by providing conditions conducive to their functioning, but can also adversely change and destabilise regimes, which creates a window of opportunity for niches to emerge (Geels 2011).

A brief description of these intersecting levels will be given in preparation for the amalgamation of the two fields of knowledge: the MLP and the circular economy.

2.3.1 Socio-technical Regime

Socio-technical regimes make it difficult for transitions to occur. The analytical use of regimes (and landscapes) helps us understand what keeps societal or technical systems in place (Geels 2002). Regimes create the 'deep structure' (Geels 2011) that helps to stabilise existing socio-technical

systems. This structure comprises of a systems level arrangement of mutually reinforcing sub systems. The way policy and cultural norms reinforce the legislative system is an example of this.

A socio-technical regime can be defined as a system of institutions and practices along with rules and social networks that define what the 'normal' development and use of technologies will be (Rip & Kemp 1998). These systems are robust due to the diversity of functions and activities built around them.

By nature, regimes are slow and difficult to change. This is because they are entrenched in deeper routines including user practices, regulations, industrial networks, infrastructure and symbolic meaning. In order to shift a regime requires a shift in the many aspects that are embedded in the regime. This can be difficult, due to the interdependency each has with the other.

Regimes are also ingrained deeply with our personal lives. They can be described as the outcome of the organisational and cognitive routines that form behavioural patterns (Geels 2002). Various institutional, political and cultural organisations form around regimes, enforcing their trajectory, simultaneously limiting outside innovations. Structural change is thus difficult which results in "lock-in" practices and incremental innovations along a fixed path.

Consequently, few alternatives survive long enough to effect change in a regime. Those that do survive exist alongside the regime, as niche interventions that serve niche markets. Often more radical in their approach, niches can be important for transitions.

2.3.2 Niches

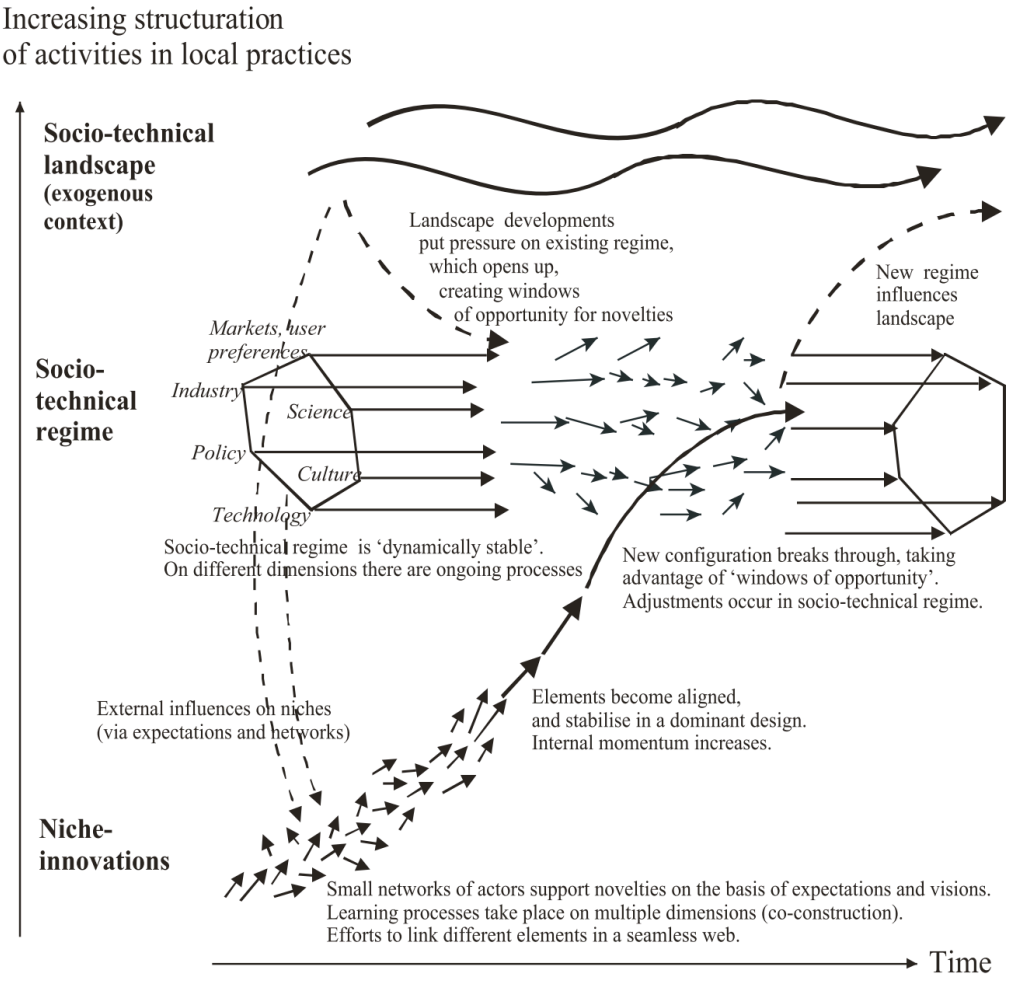
Innovation holds the seed of discovery, as it forgoes the norm in search of the new. Often innovation is sparked by a need, or in response to a problem that must be solved. This is particularly true of niches. Geels (2010) suggests that niches are the very locus for radical innovations. They often arise in response to problems experienced in an existing regime, and develop with the intention of solving them. They may arise to fulfil an exclusive function alongside a regime, incubated by exclusive market conditions. Sometimes, a niche may be recognised for its independent value, and develop specifically for a small, niche market. It is these niches that can emerge and eventually take over current regimes, provided they encounter favourable conditions both internally and externally on a landscape level.

These emerging innovations often address special demands and requirements that can't be found elsewhere in the incumbent regime, and as such users are willing to support them (Geels 2002). An

example of this can be seen in Geels' explanation of how steamships emerged. The steamships were given a window of opportunity because they fulfilled a special need adjacent to the incumbent regime of sailing ships. The actors that drive niches, typically entrepreneurs, are often inspired by the restrictions or shortages in the current regime. Thus niches often develop as start ups or spin offs in protected spaces such as R&D laboratories, subsidised demonstration projects or small market niches (Geels 2011). It is due to this self-marginalisation of niches that makes it difficult for them to replace regimes. Since they rely on innovative and specialised procedures, the supporting components that niches need to scale up often don't exist, which makes it difficult for them to compete with regimes.

Thus it is difficult to instigate or predict the rise of a new regime, as it relies on intersecting and complex phenomena. However, the MLP has identified transition patterns as the outcome of technological substitution or as a destabilisation process by the landscape on a regime (Geels 2011) to create new pathways of possibility.

Figure 3 – Illustration of the MLP



Source: (Geels 2011)

Figure 3 describes this process visually. The parallelogram on the left depicts the structure of an incumbent regime, which follows a fixed trajectory (indicated by the straight horizontal lines), until disturbed by landscape developments. This disturbance loosens the rigidity of the regime and the niche is able to penetrate and change the regime, which then stabilises to form a new parallelogram, or regime. This new structure can in turn influence landscape features. Figure 3 well represents the interdependency and interrelatedness between the three levels.

2.3.3 Landscape

Niche and regime dynamics are influenced by sociotechnical landscapes, as they provide the wider context in which they are embedded (Rip & Kemp 1998). Landscape components can include cultural values, political ideologies, demographic trends, macro-economic configurations and environmental problems.

It is difficult to effect change on a landscape level due to their slow-changing nature. This characteristic is what makes it difficult to effect changes on a regime level (Geels 2011), as regimes are embedded in this relatively rigid and static setting of landscapes. In this way, landscapes help to stabilise regimes (Geels 2011), and help prevent alternative systems from reaching the mainstream platform.

The car-based mobility system is an example of how a regime is stabilised by its surrounding landscape. Globalisation, increasing world trade, individualisation, increasing travel, tourism and growing wealth can all be considered landscape elements that provide the environment conducive for individual car ownership and mobility. Car-based mobility is thus dependent on some or all of these factors for its continued existence.

2.3.4 Advantages and Challenges of the MLP

The advantages of the MLP are in its approach to develop an understanding of a "systems innovation" (Hodson & Marvin 2010). Due to its systemic approach, The MLP has a broad scope of application, making it useful across many contexts in various socio-economic, socio-political and socio-ecological configurations. The MLP achieves this by situating the technological transformations in relation to these varying contexts. The use of the three levels allows room for more specific investigation at different scales: the landscape (macro), regime (meso) and niche (micro) (Hodson & Marvin 2010).

However, the strength of the MLP can also be considered its weaknesses, as it becomes too broad for realistic application. The MLP lacks a methodological approach. Its broad and all-encompassing spatial and temporal scale creates a vague understanding of the specificity of *what* changes are to happen *where*, *when* they are meant to happen and by *whom*. Thus the spaces and the places where transitions could take place are not understood (Hodson & Marvin 2010). This has lead to the criticism that the MLP is limited to a heuristic device (Geels 2010). The methodology of the MLP may be too much based on large, historic patterning to provide insight into current trends (Geels 2010), which doesn't give directly transferable methods. Although this is somewhat the purpose of the MLP – to provide a broad framework for thinking about transitions – it could benefit from the strict methodology of a circular economy approach, where there is a clear set of principles to follow in order to transition sustainably. This is where the circular economy may prove useful, because it has a very specific methodology that is applied to specific processes within specific places or businesses, by obvious actors or actor groups. In fact, the circular economy is a highly contextual approach, as the clear processes (cradle to cradle and sustainable resource use) it aims to achieve result from explicit conditions and circumstances (linear waste flows and the associated problems) it tries to remedy. The circular economy may provide the MLP with the blueprint for sustainable transitions.

Additionally, the way the MLP defines transitions results in the understanding of transitions as complex, long-term processes that depend on many players (Geels 2010). Although this is a correct description, the overwhelming complexity can cause a lack of agency due to the vast scope of possible outcomes or directions one could take. It has been argued that the role of power and multiple actor groups should be considered more in the MLP (Geels 2010), as ultimately it is these actor groups that can affect change. This inertia could be remedied by the approaches and techniques of the circular economy. The circular economy provides a more tangible way of dealing with sustainable transitions that directs specific tasks and/or responsibilities to particular actors or actor groups. For instance, the goal of creating closed loop resource flows calls for various tasks and roles such as customer service, and remanufacturing; each an explicit role that would need to be implemented in a company by design (Garbout & Zouari 2015).

However, this strength of the circular economy is also its weakness, and this is why a synthesis between the two could be so beneficial. The MLP could indeed benefit from the framework for sustainable resource transitions that the circular economy provides, but in the same way, the circular economy could benefit from the more systemic view that the MLP offers. The circular economy on its own does not take into account the wider context in which it is situated, which may limit its

ability to replicate on a more systemic level. The lenses of niche, landscape and regime provided by the MLP may empower the circular economy to progress beyond business borders.

For the circular economy to proliferate in this more systemic way, it is suggested that the circular economy discourse be synthesised with the MLP to uncover a new systemic lens that can inform the chances of replication within the circular economy. In what follows, the analytical challenge of amalgamating the two theories is undertaken with the intention of addressing the challenges in each. If we are to engage both analytically and normatively with the complexities of a circular economic transition, there is a need for more explicit and detailed conceptual tools. This is what the next section aims to explore.

2.4 Synthesising the MLP and the Circular Economy

To engage in the analytical challenge of amalgamating the theory of sustainable transitions with the circular economy, the key notions of the sustainable transitions discourse as defined by the multi-level perspective (MLP) will be used, including the concepts of regime, landscape and niche. It will be argued that the circular economy can be considered a niche level, and therefore could provide a tool for thinking about innovation. To achieve this, the context of the circular economy will be identified through the lens of the MLP. It will be suggested that the way we currently use resources is a regime, and various landscapes exist that may prohibit the proliferation of niche circular economy interventions. These prohibiting landscape features include the social paradigms concerning waste, the culture of individualisation and consumerism and macro-economic conditions. The general conditions under which the circular economy may become replicable are then suggested, including policies and governance support, information flows, reputational threats, limited resources and technical limits.

2.4.1 The Linear Resource Model: A Regime or System?

In this section, it will be suggested that the linear system of resource flows could be regarded as the existing sociotechnical regime whereby society extracts, uses and wastes materials. This section will begin to outline some of the deep structural characteristics of the linear resource model to show why it can be regarded as a socio-technical regime instead of merely a system. The purpose of this initial amalgamation of the MLP and CE is to provide the CE with the more systemic contextual framework of the MLP. This sets up a further analysis into which regimes and landscapes could affect the proliferation of the CE.

The regime concept has been criticized for being used too readily to describe "systems" (Geels 2011). Systems can sometimes seem complex and intricate enough to be called a regime, but are actually not sophisticated enough when considered at a larger scale. The linear regime must be analysed at this level to objectively decide whether it is a regime or not. A critical position has been maintained by using a wide lens with which to analyse the linear waste method. Mitigating this problem is characteristic of dealing with complex phenomena and it becomes important to consider what scale to look at and what the extent of the study remains outside of scope.

This problem has been defined by MLP theorists as boundary setting and defining the extent of analysis (Geels 2011), and is similarly referred to by complexity theorists as frame or boundary setting (Cilliers 2008). Can we really consider the way we use resources as a regime? Or is it merely one of the systems that society uses within some broader regime? This enquiry begins by examining the conceptual difference between a system and a regime.

Geels (2011) puts forward that tangible and measurable elements such as artefacts, infrastructure, consumption patterns and public opinions constitute systems, whereas the intangible elements such as beliefs, routines, paradigms, visions, expectations, norms and heuristics create regimes. Socio-technical regimes are upheld by networks within society, including the state, civil society and market based players and institutions (Smith et al. 2005). Systems are thus more perceptible and concrete, whereas regimes are more subtle and elusive.

Regimes can be defined as a set of rules that coordinate the activities and direction of social groups in the direction of the regime, often using invisible and subconscious methods. These rules help provide the stability that is characteristic of landscapes and regimes. Examples of regime rules are capabilities and competences, lifestyles, user practices, shared beliefs, cognitive routines, institutional and legal regulations (Geels 2011). Actors both enact rules and local practices while simultaneously being influenced by the rules themselves. These rules are thus pervious and symbiotic, and social and technical networks uphold regimes.

Systems are therefore embedded within the regimes they produce and which produce them. The conceptual difference between regimes and systems is thus derived from the scale and degree of fixity of complex phenomena.

The water regime provides a good example of how social and technical networks create a regime, as well as the appropriate defining scale and complexity. The way water is set up in urban areas is such that households have running water available through infrastructures of networked of pipes and taps. There are various social actors that make this possible and contribute to the operation and

maintenance of providing water to households. These members include water companies, capital equipment suppliers, manufacturers of treatments, environmental and economic regulators, consumers and government (Smith et al. 2005). The event of household water being made available in taps is thus due to the combined contributions of each actor group, as non alone would be sufficient.

In addition to the infrastructures and actors that have created this regime, there is also a robust belief system that has given rise to running water becoming a social norm and consequently a physical reality. The belief that water is a basic human right and that it forms part of a basic service has in part caused the manifestation of this amenity. Thus social norms and expectations (the intangible aspect of this regime), together with physical infrastructures and actor networks form the blueprint that create and recreates a regime.

The linear way resources are used could be considered a regime because of the intangible and tangible elements that uphold it. Belief systems, social paradigms, expectations, norms and lifestyles constitute the intangible elements that uphold this regime, while the tangible elements such as landfilling practices, manufacturing, design, and macro-economic further reinforce it. These networks and landscape elements are too robust and complex for the linear waste regime to be considered only a system.

The following section will detail some of the landscape elements of the hypothesised linear waste regime. These include the social paradigms concerning waste, the culture of individualisation and consumerism and the macro economic conditions at play. This helps uncover the macro landscape of the linear waste regime, while also revealing the inhibiting factors of the proliferation of the circular economy.

2.4.2 The Landscape Levels of the Linear Waste Regime

a. Social Paradigms Concerning Waste

Society both shapes and is shaped by regimes. Regimes help maintain stable public attitudes that reinforce its trajectory and stability. Waste has become a socially accepted construct, and in some cases to consume (waste) more is synonymous with social status and affluence.

In nineteenth century Europe the first infrastructure for sewerage systems materialised in response to increased cases of disease from displaced effluent by the poor (Jaglin 2013). Disease had always existed amongst the poor, but as the increased effluent began to affect the affluent population,

change was demanded. The resulting infrastructures moved waste as far from the affluent civilization as possible, with no regard for the potential value in the discarded waste. What followed was the development of a massive, centralized network of infrastructures and actors to handle waste.

Waste was considered offensive, which prompted the organizational (political, economic), technological (waste removal systems and technologies) and infrastructural systems (sewerage works) that we are reliant on today. Interestingly, at the same time as these systems were put in place, circular ideas were being entertained by chemists who were concerned about growing populations and the impact that increased food demand would have on the sustainability of soils (Barles 2010). They recognized the value that the urban excreta of humans and animals, organic household waste, and animal industry by-products could have if used as fertiliser to grow the soils (Barles 2010). However, hygiene concerns and the logistics involved in collecting this waste were major issues and not congruent with the cultural pressures to get rid of the waste and already there had been linear infrastructures set up. Before these ideas could be addressed further, the chemical fertiliser industry had emerged to squash any attempts of fulfilling the closed loop urban metabolic flow in cities (Barles 2010).

Thus the linear flow of materials that we are accustomed to today developed unchallenged, and so began the urban metabolism that burdens us today. The idea of using human excreta as compost or fuel may still seem offensive to many, and reclaiming materials from landfill is still prevented by the take-make-waste ideology that provides us convenience and newness. This deep structure could be considered a landscape feature that inhibits the proliferation of the circular economy.

b. Culture of Individualisation and Consumerism

Culture and social norms typically help to define and reinforce regimes. The culture of consumerism has permeated global borders, creating uniform social norms and expectations that fuel further resource depletion (described earlier in this thesis). Consumerism can be considered a landscape feature that underpins and fuels the linear resource method. Consumerism helps solidify linear resource flows as it provides the deep structure that has influenced and continues to influence the ways we design, manufacture and sell products.

The act of consuming is upheld by the relational culture of individualisation. The concept of ‘the individual’ has been sold to us in order to fuel our consumptive behaviour in the pursuit of self-expression and personal (and even professional) identity. Consequently, consumption has become much more than a habit; it has infiltrated our very psyche. This has been achieved through design or propaganda: an intentional psychological method of persuasion. Edward Bernays, who is referred to

as the "father of consumerism", used these Freudian concepts to incite desire in consumers, and to align products with a sense of identity (Naidoo 2015). These tactics were and still are used to mentally manipulate individuals or groups toward a desired agenda, in this case, to consume. The culture of consumerism and individualism forms the deep and robust structure characteristic of landscapes. This landscape element helps stabilise the way we use resources, as well as other landscape features such as globalisation and continued economic growth.

There are learnt behaviours associated with the consumer culture that arise to further support the linear waste method, such as convenience and disposable products. This social norm helps to uphold the linear waste method by encouraging wasteful user practices, product-orientated businesses and, importantly, the preference of product-ownership over product-services (Tukker 2015).

Businesses have been set up accordingly. The way businesses run can help deliver social and environmental sustainability and influence the flow of materials in society (Bocken et al. 2014a). The current dominant business model aims to provide clients with a product-orientated service, allowing ownership of purchased items, which is the preferred mode of consumption (Tukker 2015). This has resulted in a system where material *products* have to be sold to maximise profits, and increased sales leads to further income resulting in the planned obsolescence of products (Nakajima 2000; Tukker 2015).

Alternative business models, such as Product Service Systems (PSS), or servitisation, can help to decouple resource use from consumption by providing services over products (Tukker 2015). In theory, the incentive for service-oriented business models, such as PSS, differs. Firms aim at providing the service of the product and not the product itself, which shifts the core function from selling products to providing services, thus incentivising an extended product life in order to keep costs low and reap maximum profits (Tukker 2015). Thus resource use becomes a cost factor, which must be minimised. This prompts interest in product re-use and remanufacture in order to use fewer resources. However, it has been recognised that a major risk in the success of the PSS is the nature of consumerism globally (Tukker 2015).

This is because preferences and lifestyles are now adjusted to the convenience and changeability that consumerism provides, making it difficult to change these systems (Geels 2011). This inflexibility is characteristic of regimes, and is why the culture of consumerism could be seen to add to the robust nature of the linear resource method. This landscape feature further embeds this linear method in the intangible nature of cultural and social norms, which adds to the association of the linear waste method as a regime.

c. Macro Economic Conditions

The linear resource regime itself may be seen as nested within the global economic regime. This may inhibit transformation toward a circular economy due to the surrounding lock in practices of the global economy, such as the dependency on economic growth based on consumption. The global economic system is very robust, and was created to help us quantify value and systemise the way we transact with each other globally. It is supported by many subordinate regimes and penetrates every action and interaction of societies globally.

The global economic regime is organised around the extraction, trade and combustion of fossil fuels (Smith et al. 2005). Fossil fuels and oil continue to contribute to the production of most products globally, and sustains economic growth. These products must continue to be consumed and disposed of to make room for the next product, thus incentivising the continued use of fossil fuels. This was evident between 2001 and 2011, when economic growth fluctuated proportionately with resource consumption during that time (European Commission 2014). For this reason, the global economic regime is organised and in some ways also dependent on the continued production of waste, which highlights the difficulty in transforming this landscape.

Geels (2011) suggests that the reason it is difficult to exert change on this macroeconomic landscape level is due to the intricacies of the networks that reinforce this landscape, specifically changes in policies and thus vested interests. For sustained growth, the economic system is reliant on an energy system that is largely based on non-renewable sources (Kemp 1994). Although a move towards renewable energy may be on the rise, the economy is still embedded in unsustainable resource use, while actors with money and power work to maintain the status quo (Marcus et al. 2010).

These landscape elements serve to highlight how pervasive and complex the linear waste regime may be. They also serve to highlight the inhibiting factors on the circular economy. With these inhibiting factors, how would the circular economy be able to replicate? The next section will compare the circular economy to the niche level and suggest that the synthesis of the two can help reveal the innovative potential of the circular economy. By overlaying the two, the circular economy may be seen as a way to promote niche innovations that can be replicable under favourable landscape conditions (described later).

2.4.3 The Circular Economy; Niche

This section will amalgamate the circular economy with the concept of the niche level to better understand how the circular economy can provide a tool with which to approach innovation, and how this tool can encourage various niches to emerge.

Current examples of niche interventions are small in scale and serve as solutions to existing problems. Although each example serves a small market and provides specific results, these ventures could be strong accumulatively. One example of a niche market includes eco-villages. Eco-villages are becoming a trend globally as climate change is now a widespread concern among the public (Lorenzoni & Pidgeon 2006; Semenza, Hall, Wilson, Bontempo, Sailor & George 2008). Although there are exceptions where eco-villages are used in the third world context for socio-political reasons such as reducing poverty (Swilling & Annecke 2006), most examples of eco villages emerge because of the want to "reconnect with nature" (Kirby 2003). Such villages are usually off-grid, expensive dwellings, suited for a small, niche market of wealthy individuals who pay to move away from the incumbent way of urban living to experience more communal living (Kirby 2003). Although currently this trend is isolated to these special requirements of the wealthy, this move may become more mainstream as the associated technologies become cheaper and the size of an increasingly concerned market grow. This can be considered an example of a niche development that exists alongside the predominant, unsustainable, suburban and city mode of living. When one considers this trend with the lens of the MLP, it could be said that this niche could exist and grow stronger until our current ways of living begin to crumble, allowing the eco-village example to proliferate. Constraints of land use and transport may provide negative landscape pressures to the eco-village model, and if this model were to proliferate fully it would need to adjust accordingly.

Agriprotein is another example of a niche innovation. Agriprotein has developed an alternative animal feedstock and agricultural compost by closing the loop on animal agriculture. They have successfully re-circulated nutrients to create their products MagMeal, MagOil and MagSoil (Agriprotein 2016). They call their technology a "waste to protein" process, and create rich nutrient products from harvesting flies and larvae on organic waste, a lot of which is animal offcuts. Although Agriprotein currently serves a relatively small market, this technology could grow to reduce the need for fishmeal trawling, and help slow land use change from the ever-increasing demand for cattle feed. This can be considered another niche innovation that has arisen to mend the problems in the larger incumbent regime of chemical agriculture that supplies the feed-crops. Thus

Agriprotein has arisen in response to this threat, and to alleviate the negative effects from the vast amount of feed-crops needed to support this industry.

The pattern of niches serving problems inherent in incumbent regimes is evident in the approach of the circular economy. The circular economy has clearly emerged to alleviate resource depletion and provide an alternative way of consuming without transgressing further planetary boundaries. This approach is characteristic of niches, and for this reason it is hypothesised that the circular economy could be a niche level intervention in relation to the regime and landscape described earlier. Niches are the very locus for radical innovation (Geels 2010), which helps provide the tool for thinking about the circular economy as a way of innovating. Using the lens of niche to describe the circular economy helps to frame the innovative potential of the circular economy in the broader context that the MLP provides. With this conceptual tool of the circular economy as niche, various niches are likely to emerge that accumulatively could transform the linear waste regime.

If the circular economy is to advance its agenda and proliferate the mainstream, the conditions that can help the circular economy replicate need to be identified. The next section will detail the possible general conditions or pressures on a landscape and regime level that may achieve this replication.

2.5 Conditions for Replication: Landscape and Regime Pressures

Transitions occur when there is a rift in the incumbent regime that allows a window of opportunity for niches to emerge. Changes are seldom radical or quick, and niches that make use of existing cultural trends and infrastructures have a better chance at success (Kemp 1994).

Geels' (2002) example of the emergence of steamships demonstrates how transitions occur. Steamships were first developed to help sailing trade vessels acquire better telecommunications which ensured better predictability, control and co-ordination (Geels 2002). Steamships were thus initially used for mail delivery and urgent passenger travel, and later were recognised for their unique value of providing passenger travel. The circular economy is similar in this regard because it has emerged to alleviate the problems in the current linear resource regime. It is in part influenced by material flows analysis, industrial ecology and urban metabolism, which aims to quantify the flow of resources through systems to create more sustainable resource flows (Hill 2014; Zhou et al. 2014). Life Cycle Assessment is another dimension of the circular economy, with the aim of understanding the resource use during a products life cycle to better understand how to reduce resource use at different points in the value chain. Just like the steamships, the circular economy has increasingly been recognised as having its own value, as a reformed economic system.

Although the steamships were recognised for their unique value, they still relied on external factors to help them emerge. First, mail subsidies were introduced to encourage mail transportation, which stimulated further innovation and development of Steamships. Second, the Suez Canal was opened which gave steamships a comparative advantage because sailing ships were not suited to canal travel. Therefore, steamships did not develop independently, but were given the opportunity and space to develop through external landscape shifts such as mail subsidies and the 'canal-boom'.

If we accept the circular economy as a niche innovation, then for it to replicate there would need to be a landscape shift to help it emerge. Some landscape pressures that could help the circular economy replicate are identified in this thesis, namely policies and governance support, information flows, reputational threats of the linear regime, limited resources and technical limits.

a. Policies and Governance Support

China has seen a rapid transition towards more sustainable resource use in some areas. China has placed the circular economy at the centre of its development goals to address resource scarcity, environmental degradation and to fuel economic development. This is the first national law proclaiming an alternative economic model to the extractive linear model (Matthews & Tan 2011). The city of Dalian, China, was chosen to test circular economy principles, due to it being one of China's largest industrial centres that contributes significantly to the issues described above (Geng et al. 2009). Many businesses in this district have since embarked on new opportunities that turn waste into resources, largely due to policy incentives.

The municipality of Dalian has had a major role to play in this change. They have established a waste reporting system to track and check waste flows, so that they can impose price reforms and manage levies. All polluting industries in Dalian have to undertake compulsory cleaner production audits, which have encouraged manufacturers to reuse their own industrial wastes to score better in audits. The municipality encourages water savings by billing higher levies to those who use old production processes and technologies (Geng et al. 2009). Supportive financial policies and financial services have also been developed to incentivise circular economy strategies (Geng et al. 2009).

The importance of regulatory frameworks and price incentives is maintained by Geels (2011), who argues that because sustainable solutions often don't offer obvious user benefits, is unlikely that existing regimes will be replaced with innovative projects without changes in economic frame conditions.

China gives a good example of how regimes can be changed towards better resource use. China's initiative has been successful because of the regulatory pressures that have been afforded. Matthews & Tan (2011) stress that the 'visible' hand of the government has played a huge role in the establishment of these initiatives, and that such involvement of government is needed for the developing country context. The support of policies and governance could help companies navigate the often risky and expensive terrain of transitioning towards a circular economy. The importance of regulatory pressure is thus very important for providing the favourable landscape conditions for accelerating the circular economy.

b. Information Flows

The organisation of the structures *within* business needs to be considered. These consist of the frequent exchanges of knowledge, learning and information between key players that result in understanding and thus the implementation of decisions that affect material flows. Correct information flows can provide benefits including customer satisfaction and a more efficient circular economy (Kurilova-Palisaitiene et al. 2015).

Also, it can help focus internal management of the business' resources and activities. Often there is a lack of information flows internally in a company due to hierarchy and bureaucracy. This leads to slower or even no implementation of aspects of the company because of this stratification.

The following constraints have been highlighted with regards to creating a circular economy: a lack of awareness of the need for information flows, information uncertainty and information deficit due to fear of competition (Kurilova-Palisaitiene et al. 2015). The corresponding recommendations include the development of standardised data sharing channels, the establishment of accessible knowledge exchange platforms, and an increase in the data exchange speed (Kurilova-Palisaitiene et al. 2015).

China has achieved better information flows with the implementation of various eco-industrial parks. Eco-industrial parks are a grouping of industries that orchestrate the reuse of industrial wastes from one another. These are effective because they are able to take advantage of the localisation and concentration of physical and learning resources. Some of the advantages, which Zhou, Fernandez Bonet, Wan, Denis & Juillard (2014) describe as *integrations*, include material (waste recycling/exchanges), water, energy (for example central heating systems) and information integrations. Perhaps the most pertinent of these is information integration. Clustering circular activities facilitates the flow of information through web capability, management information systems and environmental management and technology services (Zhou et al. 2014). Thus clustering

similar industries together seems to create better opportunities for collaboration, data sharing and learning. This cross sector co-operation is needed to assist the implementation of circular activities, and holds promise for the scale-up opportunities of the circular economy to countrywide implementation.

c. Reputational Threats

Since regimes fulfil socially valued functions (Geels 2002), it could be said that the current regime of unsustainable resource use treads on dangerous ground because it is steadily being equated with climate change and other threats which have entered the consumer lexicon. This reveals an ever-growing fissure in the current regime that could provide the change in landscape needed for the circular economy to move toward the mainstream. There are numerous reputational threats associated with resource depletion (Hill 2014), and consumers are beginning to wake up to the effects of environmental degradation and desire "eco-friendly" products. Usually consumers' desire for such products are on the terms that they don't need to sacrifice convenience (Barbarossa & Pelsmacker 2016). This can be considered a favourable landscape feature that could enable a circular economy because a circular economy via remanufacturing helps provide the customer with both convenience and sustainability (Ellen MacArthur Foundation 2013c). Adopting a circular economy via remanufacturing enables businesses to market themselves in this light, while also capturing the remaining value of expired products; a business activity that can simultaneously generate increased profits (Atasu, Guide & Van Wassenhove 2008).

d. Limited Resources

Some suggest that future economic growth is improbable due to the peak oil crisis (Heinberg 2010; Jackson 2009). The costs of raw materials are already increasing (Lütkehus 2014); a trend that is set to continue which could have negative economic consequences. Aluminium, copper, gold, lead, nickel, palladium, platinum, silver, tantalite, tin and zinc are already seeing price increases that affect the electronics industry (Lütkehus 2014). The global economic system is unsustainable, and will inevitably have to adapt. Climate change and Peak Oil could be considered destabilising landscape features that could lead to a sustainable transition (Geels 2011). This is applicable to the circular economy, as we rely on oil for many products and services.

One could say that this is the metaphorical crack in the economic and energy landscape regime that provides the opportunity for the circular economy to advance its agenda and move into the mainstream. The increased price volatility due to the lack of security of the supply of resources

(Lütkehus 2014) could help convince government and businesses to transition towards circular economic principles.

This could provide the leverage needed to change the vested interests in further raw material extraction, and shift the agenda towards mitigating business risk by transitioning to sustainable resource use.

e. Technical Limits

The linear waste regime may be interrupted by the technical limits of aging infrastructures. Further advances along the same trajectory of networked infrastructures such as huge networked sewer systems, electricity grids and water provision may run into increasing marginal costs (Kemp 1994) while simultaneously becoming too complex to maintain and manage. The idea of the network has been central to the way we have planned and implemented urban infrastructures (Jaglin 2013). The aptness of large, networked infrastructures in developing world contexts is questionable, as these centralised systems become increasingly unmanageable with their indefinite growth. Some infrastructures are simply reaching their capacity, such as landfill sites. These methods of treating waste and material flows are increasingly becoming unmanageable and expensive. This presents a possible landscape pressure to the linear resource regime, if ever these cumbersome technical systems reach their limit, demanding new systems.

The correspondence of the circular economy to a niche is seen strongly here, where the specialised and unique market conditions of the circular economy may provide a solution to these cumbrous infrastructure and more broadly the linear waste regime. Niches provide the seeds for systemic change, and are therefore key for transitions (Geels 2011).

2.6 Conclusion

Transition theory and the circular economy can be regarded as similar approaches in that they each aim to promote a more sustainable system of production and consumption. Both are useful independently, but could benefit from a synthesis due to their individual strengths and weaknesses. The MLP provides a broad, systemic lens for analysing sustainable transitions. This is useful on a macro- and meso-level as it provides a heuristic and investigative lens. However, the MLP lacks the methodological approach needed to affect change on the niche level, and the vast scope of the MLP obscures it from practical application. The weakness of the MLP could be regarded as the strength of the circular economy, and vice versa. This thesis suggests that the circular economy could provide the distinct methodological tools for addressing the change desired in the MLP, while the MLP can

help locate the circular economy within a wider systems understanding of sustainable transitions. This has formed the motivation behind developing a synthesis because the advantages of the one approach can address the inadequacies of the other.

In this article, the synthesis was applied by using the three levels of the MLP, niches, regimes and landscape, to help understand the broader context of the circular economy and the landscape conditions that inhibit its replication. The inhibiting landscape features identified were the social paradigms concerning waste, the culture of individualisation and consumerism and macro economic conditions that help to incentivise the linear consumption of resources.

The synthesis of the two theories has helped open up a way of thinking about the circular economy as a tool for innovation, which through a series of niches, could proliferate the mainstream and support a sustainable transition. The general conditions that may facilitate the replication of the circular economy were identified, including policies and governance support, information flows, reputational threats of the linear regime, limited resources and technical limits. These general conditions are applied in article two to help illuminate under what specific conditions the case findings may be replicable.

It is suggested that further research continue the dialogue of the circular economy in the South African context, while also contributing to the theory development of the amalgamation of transitions theory and the circular economy. Further research is also suggested to apply this synthesised lens is a transdisciplinary case study to generate knowledge about the circular economy that is informed by the wider lens of sustainability transitions. This amalgamated case methodology would have the practical application of innovation.

Chapter 3 (Article Two[2]) – Innovating with Waste: A Case Study at Distell

3.1 Introduction

Chapter two presented an amalgamation of the circular economy discourse and sustainable transitions theory to show how the strengths of the one theory can bolster the weaknesses of the other. It argued that the circular economy could be used as a tool for innovation if bolstered by a more systemic view created by the MLP. This tool for innovation could in turn provide a method for transitions. Chapter two argued that the circular economy provides a way of thinking about innovation, and from this innovative lens various niches are likely to emerge.

This article takes its cue from the suggestions for further research made in chapter two, and documents a transdisciplinary case example at the multinational bottling and brewing company Distell. The aim of the research was to investigate the potential that various waste streams at Distell gave for circularity and innovation, by using the conceptual framework provided in chapter two. In this way, the circular economy was used as an innovative tool and methodology to guide the research, while the systemic lens of the MLP helped analyse the transition context of the research. This article presents this empirical case study undertaken.

This article investigates the waste produced at the multi national brewing and bottling company, Distell, with the intention of prototyping a circular economy intervention. The filter waste presented a good opportunity for further study as it was considered most problematic by Distell, and had the most potential for circularity, innovation and transition. This article will document the progress made on closing the loop on filter waste at Distell, and outline three options for an alternative disposal method that has potential value adding opportunities, while also having the potential for wider change in the industry:

- Growing edible mushrooms onto the filter sheets ;
- Selling the exhausted substrate as compost; and
- Developing a packaging material made from mycelium and filter waste. The waste of this too can be composted

A brief background of the case study will be given, including a brief description of the circular economy and transition theory. The transdisciplinary case example at Distell is then presented.

[2] Article targeted at the Journal of Cleaner Production

3.2 Background

3.2.1 Distell

Distell produces a variety of alcoholic beverages including ciders, wine, brandy, liqueurs and whisky. Distell places great importance on their corporate responsibility, and advocates responsible drinking, sustainability and community development. Distell has already taken some circular economy measures within their processes; some of the grape skins are sent to Brenn-O-Ken and used to produce grape seed oil and tartaric acid (Distell 2015). Dry grape skin is used as boiler fuel, and the rest of the waste is used as compost.

3.2.2 Resource Scarcity

Exploitive resource consumption is increasing worldwide as populations grow and people aspire to live more affluent lifestyles (Pretty 2013). Increasingly more people are joining the middle class and are enrolling in the globalised consumer culture (Pieterse 2015; Tukker 2015), which is having devastating consequences such as widespread pollution, resource and habitat depletion and price volatility (Lütkehus 2014; Rockstrom et al. 2009). Developing countries are pursuing economic growth so they may 'catch up' to more affluent countries, which fuels even further the infinite consumption of resources on a finite planet. Between 2000 and 2010, private vehicle sales rose from 8% to 37% in emerging market cities (Swilling, Robinson, Marvin & Hodson 2013). This trend could be similar for other household and luxury goods, as it is estimated that India could increase its average consumption by six times in the ten years leading up to 2025 (Swilling, Robinson, et al. 2013). In 2010, 65 billion tonnes of raw materials entered the economic system (Ellen MacArthur Foundation 2013b). Simply put, humanity will need to find other ways of sustaining the economy, preferably before we exceed more planetary boundaries. Rectifying these trends is of utmost importance and calls for investigation into decoupled methods of living in an urbanised world.

The circular economy and transitions theory both aim to create more sustainable production and consumption (Geels 2010; Ellen MacArthur Foundation 2013b). However, both theories have weaknesses in their approach that the other can resolve, as argued in chapter two. In remedy, this thesis intends to synthesize transitions theory and the circular economy to achieve a particular conception of innovation that can be used at Distell for more widespread change.

3.3 Circular Economy

The circular economy envisions a restorative economic system that relies on renewable energy and eradicates waste through careful design. A formative concept to the circular economy is the idea of cradle to cradle. Cradle-to-cradle production attempts to design materials to flow in a circular fashion, thus moving away from cradle to grave production. The idea was popularised by a book written by McDonough & Braungart (2002) titled "Cradle to Cradle – Remaking the Way We Make Things". In cradle-to-cradle thinking, two waste streams are imagined: abiotic and biotic, which can be designed to recirculate into a virtuous flow of materials. The influences of cradle-to-cradle thinking are central to the circular economy approach, and highlight the potential the circular economy has in becoming regenerative by design (Ellen MacArthur Foundation 2015).

The circular economy has shown some impressive results in the early stages of its existence. The Ellen McArthur Foundation (2013b) describes the circular economy an opportunity to save between USD 380 billion and USD 630 billion, considering only some of the EU manufacturing sectors. Some of the benefits countries can receive are reduced price volatility related to supply and distribution risks, cost savings and employment benefits. Businesses can benefit from strategic opportunities such as better client relationships and feedback, more strategic placement to capture value, reduced warranty costs, new revenue streams and product-service systems that are cheaper for the user (Tukker 2015).

Various problems within the circular economy have been identified, such as a lack of the new skills and learning required, cash flow restrictions upon transitioning to a circular resource model and a lack of information flows which can restrict business operations (Kurilova-Palisaitiene et al. 2015; Atasu et al. 2008). Even with these problems the circular economy still provides many benefits, as described above.

However, the circular economy may not provide the transformative changes that the polycrisis requires, as it lacks the systemic approach needed. If the circular economy is to advance its agenda, it should consider the broader context in which it exists. The MLP is well positioned to resolve this inadequacy of the circular economy, as it provides a strong investigative tool with which to analyse sustainable transitions on a macro and meso scale.

3.4 The Multi Level Perspective

The MLP is a multi-dimensional framework that assists in the understanding of complex socio-technical systems during sustainable transitions (Geels 2010). It offers the use of three analytical levels, landscape, niche and regime, to help define a sustainable transition.

The three analytical levels of landscape, niche and regime interact with one another spatially, socially, physically and temporally to create the socio-technical structures, or regimes, we see around us. When these configurations are disturbed, a transition, or regime shift, may occur. The analytical framework of the MLP provides a heuristic with which to investigate such regimes shifts, and identify possible patterns for the future.

Socio technical regimes help stabilise existing socio-technical systems by creating the deep structure of organisational and cognitive routines and behavioural patterns (Geels 2011; Geels 2002). User practices, regulations and infrastructure are some examples of the many aspects that constitute regimes. Regimes exist within a broader context of landscapes. Landscape elements are the slow changing backdrops to regimes and can include cultural values and environmental problems. They mostly help to stabilise existing regimes, but can sometimes destabilise them too. Destabilisation does not occur regularly, but when it does, a window of opportunity emerges for niches to develop. Niches are the innovative projects that develop alongside a regime for a small, specific market. Niches often try to solve problems in incumbent regimes, but often remain marginalised due to their exclusive role.

Although the MLP provides a good tool for understanding transitions, it lacks the methodological approach needed to help implement desired goals or transitions. This weakness can be resolved by adopting the clear methodology inherent in the circular economy, which includes the distinct design of cradle-to-cradle production and consumption.

3.5 Synthesising the MLP and the circular economy

Although both the circular economy and the MLP are similar in that they each promote sustainable production and consumption, they both have their own inadequacies that the other can resolve. The MLP is too general and does not provide a specific or detailed roadmap of how to create a sustainable transition. Its focus is too broad and vague and does not consider the detailed methodology of what changes are to happen by which actors, leading to the limitation of the MLP as a vague heuristic device (Geels 2010; Hodson & Marvin 2010). The circular economy may offer the clear methodological approach needed by the MLP, as it makes use of specific processes within

specific places and by unambiguous actors or actor groups. In this way, the circular economy may provide the blueprint needed for the MLP to become more powerful.

The circular economy on its own, however, does not provide this complete tool either. The circular economy is too narrowly focused and does not address wider systemic dynamics that the MLP deals with. The circular economy needs to be considered in its wider context if it is to proliferate. A synthesis between to two would bolster each theory with the individual strengths in each. A synthesis helps to enhance the innovative potential of the circular economy, as it can be considered a niche intervention and analysed within a more systemic context that allows it to amplify or replicate. With this premise, the case study at Distell produced innovative and original results. This chapter will document the process and the results of the case study.

3.6 The Study

3.6.1 Aim

This study aims to investigate the consolidation in chapter two of transition theory and the circular economy discourse through a transdisciplinary case study at Distell. The investigation aimed to transform a current waste stream produced at Distell using the innovative lens of the synthesis into something that would offer reduce costs and resource use and less environmental impacts, while also providing an opportunity for more widespread change. This case study was informed by the synthesis to help provide the innovative approach adopted.

3.6.2 Design

Data was collected during 2016. For the theoretical findings, data analysis was used between the literature and immersive case study at Distell to generate findings that were grounded both in theory and reality. Three sources of information were used: direct observation of Distell's production activities, semi-structured interviews and relevant literature and theory analyses to create a triangulation of analysis. The same method was used for the three empirical findings, namely the solution of growing mushrooms onto filter waste, selling the filter waste as compost, and/or developing a packaging product. These empirical findings can be viewed more as the innovative result or outcome of the theoretical findings rather than a study on its own.

3.6.3 Context

Businesses worldwide can no longer assume that resources will be infinitely available and cheap for use (Lütkehus 2014). Although some of the consequences felt by worldwide overconsumption is externalised and thus not of obvious consequence to big businesses, the resource shortages worldwide are increasingly moving 'closer to home', and the effects of overshooting planetary boundaries will inevitably be felt by big businesses in the near future. Businesses that have steered their processes towards resource stewardship and circularity will be the least vulnerable during imminent price volatility and resource shortages.

Sustainability is increasingly seen as an important factor to consider when pursuing on-going profits and growth for firms (Hahn et al. 2010). The pursuit of profits is considered a major contributor to the environmental degradation we see today (Marcus et al. 2010), which is why firms could be considered well positioned to steer the economic trajectory towards more sustainable production and consumption since they have the skills and systems needed to implement change (Boons et al. 2013; Hawken 2009). Business have been recognised as key players in changing our world towards better resources stewardship (Hawken 2009).

Firms could lead the way towards a more sustainable world, while simultaneously benefiting from their efforts as sustainable practices have been shown to have multiple benefits such as cost savings, reduced risk and reputational benefits (Anderson 2009; Schulschenk 2015). From a circular economy perspective, waste can be considered a resource that with research and design could be used to the benefit of a company. Examples worldwide show that such research can help a company in various ways, which include reduced costs, exploring new innovations, generating new business opportunities, generating internal investment and learning and reducing their carbon footprint (Anderson 2009).

Stellenbosch is a good example of how these consequences are beginning to be felt. Stellenbosch municipality's solid waste system has reached maximum capacity, and the new landfill site that was constructed in August 2012 is projected to reach capacity in 2017 (Stellenbosch Municipality 2015).

This forms the motivation behind choosing Distell as a case study due to their size and scale of operations. Distell is a JSE listed, multi national company that produces tonnes of waste that goes to the Visserhoek, Belville and Stellenbosch landfill sites, among others.

Distell's head office is situated in Stellenbosch, where they produce wine, ciders and spirits. Distell is often in contact with the local municipality to monitor their waste, and are constantly striving to

increase their sustainability efforts. Currently they endeavour to reuse glass bottles, recycle packaging waste, and have their organic waste used as compost or animal feed (Distell 2015).

Figure 4 shows some of the initiatives Distell has taken on closing the loop on waste. Organic waste is Distell's primary waste output, a lot of which has already been entered into closed loop cycles. This waste consists of grape skins, seeds and stalks. Most of the grape skins and seeds are sent to Bren-O-Kem where they produce grape seed oil, tartaric acid and dry grape skin as boiler fuel. The other organic waste is composted either by Distell and used to enrich their soils, or removed by a contractor for their composting purposes.

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Figure 4 – Distell's Organic Waste Treatment

Organic waste treatment methods	
Site	**Treatment method and site treated**
Adam Tas	Since 2012, grape skins and seeds have been removed by contractor to Seed Oils South Africa for the manufacturing of grape seed oil, while stems are taken to the Weltevrede nursery for composting
Bergkelder	Since 2011, the waste gets removed by a contractor and taken to Brenn-O-Kem
Nederburg	Waste gets removed by a contractor and taken to Brenn-O-Kem
Durbanville Hills	Since 2011, the waste gets removed by a contractor and taken to Brenn-O-Kem
Plaisir de Merle	Composted on site for use in the farm's own organic vineyards
LUSAN – Le Bonheur	Composted on site for own use
LUSAN – Uitkyk	Waste gets removed by a contractor for composting
LUSAN – Stellenzicht	Composted on site for own use
LUSAN – Alto	Composted at Stellenzicht
LUSAN – Neethlingshof	Waste gets removed by a contractor for composting

Source (Distell 2015)

Although Distell is doing well with regards to limiting their waste and emissions, there remain some opportunities in their daily processes for closed loop interventions that may increase their sustainability, profitability and corporate social responsibility. This is what this article aimed to investigate.

Research was conducted at the Green Park site in Epping due to good the accessibility given to the researcher, both in terms of contacts, location. Green Park also has the most diverse production and activities on site, and thus more waste opportunities to study. The facility comprises of dry goods storage, bottling, packaging, final product storage and distributions and a bottle washing facility.

3.7 Transdisciplinary Case Study - Distell Group Limited

This section details the results of the investigation undertaken at Distell to find a waste stream that presented opportunity for a closed loop innovation. The conceptual lens developed in chapter two of this thesis informed this process, the application of which is innovation.

Through an immersive study of Distell's internal processes, several waste streams were identified for their potential for circularity and innovation. It is hoped that this investigation stimulates further research into the feasibility and implementation of the findings, either internally within Distell or via a third party such as Innovus (discussed later in more detail).

Table 1 explains the various waste streams that were identified as having potential for circularity:

1. The process of labelling Distell's beverages causes reels and reels of unrecyclable plastic backing paper that gets sent to landfill. Some investigation was undertaken for this waste stream with the idea of turning the backing paper into a fabric to make promotional material for Distell. However, the unrecyclable label backing paper will be phased out in the future and replaced with a recyclable PET alternative, making this a redundant waste stream.

2. Distell produces other organic waste which cannot easily be sold as compost or animal feed due to the dairy and alcohol content present in the waste. This waste has high priority for Distell, and research is currently being done to anaerobically compost this waste and potentially use it as a source of methane energy.

3. The process of product filtration at Distell's many branches produces tonnes of filter sheet and filter powder waste that gets taken to landfill. The filter waste stream waste was selected due to its high priority given by Distell and the lack of research that had been done.

Table 1 – Waste Streams

Waste Stream	Priority Level from Distell (1 - low priority)
Label Backing Paper	3 To be phased out
Organic Production Waste	10 Research in progress
Filter waste	9 No research had been done.

Source: Author

3.7.1 Filter Waste

The filter waste was given high priority by Distell for various reasons. First, they currently pay two bills to dispose of this waste: a removal fee and a landfill levy. Second, and more importantly, it is anticipated that within the next couple of years the relevant municipality may no longer accept the disposal of this waste at landfill. It is thus important to Distell that an alternative method of treating or disposing this waste be interrogated. This waste stream thus presented an opportunity to benefit Distell, the municipality, and the surrounding environment and society.

The filter waste consists of both filter sheets and filter powder. The filter sheets and powder are essentially the same material in different consistencies, and are both comprised mainly of cellulose. Cellulose is the most abundant organic polymer on Earth, and is found in many different types of plant matter. The type of cellulose contained in the filter sheets and powder is silicon dioxide (SiO_2), also referred to as quartz or silica: a very common natural chemical compound. The specific type found in the filter sheets is from cristobalite and quartz. These minerals are both identical in composition, but vary in their molecule structure.

Silicon dioxide makes up 89,6% of the filter material. The rest consists of various minerals present during mining, including aluminium oxide (4%), iron oxide (1,3%) and calcium oxide (0.5%) (Celite 2012). The filter sheets also contain other types of cellulose, such as the filter aids Kieselguhr and Perlite. Kieselguhr, otherwise known as Diatomaceous earth, is a naturally occurring, soft, siliceous rock that can be easily made into fine powder. The powder's total cellulose content is thus 99,0%. This powder mostly consists of fossilized algae, and happens to be a suitable feedstock for the growth of mycelium (the vegetative part of a fungus) and mushrooms.

Fungi are the predominant decomposers of cellulose (Fontaine, Henault, Aamor, Bdioui, Bloor, Maire, Mary, Revaillot & Maron 2011), making the filter waste an appropriate substrate for the growth of edible mushrooms. This article outlines three options for circularity that make use of this potential:

1. Growing edible mushrooms to provide an additional revenue stream, among other benefits described later.
2. Selling the exhausted substrate as a fungi-rich compost
3. Developing a packaging material made from mycelium and filter waste.

In what follows, the current waste disposal method of the filter waste is analysed, which highlight the consequences of the linear method of treating this waste, after which the three alternatives will

then be interrogated. Chapter three will present recommendations for the implementation of the projects.

3.7.2 The Cost of the Linear Disposal Method

The filter sheets are currently removed from Distell as general waste, and dropped at Bellville and Visserhok landfill sites. This is a costly method, both environmentally and economically.

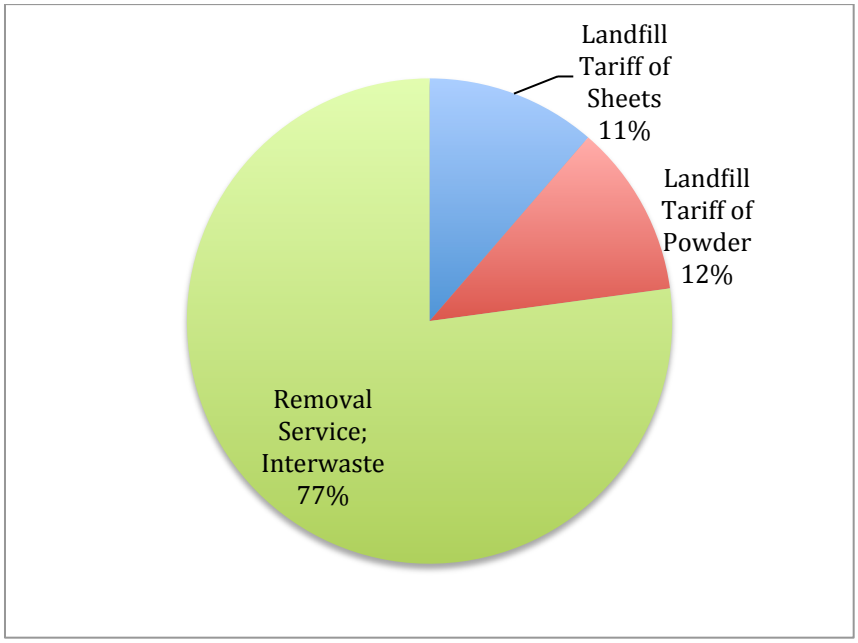
The disposal tariff for general waste at Cape Town's landfills is R443.20 per tonne for general waste, including VAT (City of Cape Town 2016). If we compare this cost with the projected filter sheet usage we can estimate the costs of landfilling this waste. According to Distell's 2017 budget, it is expected that approximately 5045 filter sheets will be used in 2017. Each sheet is heavier after being used because it will be laden with the filter waste and soaked with the beverage it was filtering. Each sheet weighs approximately 1,5kg when damp, which means that 7567,5 kg of filter sheets are deposited at landfill per year. The landfilling cost is thus approximately R3353, 70 per year for the filter sheets.

The projected use of the filter powder for 2017 is 3839kg, according to Distell's 2017 budget. Once used, the filter powder contains sediments from the filtering process and forms a wet sludge, which is much heavier than it's dry weight. During experiments, the filter powder weighed in at double its dry weight. This leads to a total of 7678kg of disposed filter powder, and a landfill charge of R3402.9 per year.

The second type of cost incurred because of the linear disposal method of the filter waste is the removal costs. Currently, Distell uses the services of Interwaste. According to a quote from Interwaste on 30 August 2016, the removal cost per collection is R1 750 with a monthly rental fee of R200 (total R1950). The filter waste is collected with other general waste, making it difficult to estimate exactly how much it costs for the filter waste alone on each skip. One of the cellar managers at Distell gave an approximation, and described that the filter waste takes up between 5-10% of a skip three times a week, or about 15-30% of one skip per week. Using this estimate, the weekly transportation costs would be between R292, 5 and R585; or between R15 210 and R30 420 per year. Using the average, the estimated transportation cost of the filter sheets is R22 815 per year.

This leads to the sum total annual cost of R29 572 for the filter waste at Green Park, Epping, if the annual landfill charges of the filter waste and the annual transportation costs are combined. Table 2 shows these as percentages.

Table 2 – Cost breakdown shown as percentages



Source: Author

3.7.3 Closing the Loop on Filter Waste

Three circular economy methods for the alternative use of filter waste are suggested in this article:

1. Growing edible mushrooms to provide an additional revenue stream, among other benefits.
2. Selling the exhausted substrate as a fungi-rich compost
3. Developing a packaging material made from mycelium and filter waste.

This section will document the progress made on the three alternatives, and highlight areas for further research and possible implementation.

a. Mushroom Cultivation

Fungi have a wide range of food sources, and specific enzymes have been created for each type of mushroom to suit the available food sources in the region they occupy. One common food source for mushrooms across all regions of the world is cellulose, since this is the main component of plant matter. Fungi uses the complex, large molecules found in cellulose and decompose them into smaller nutrients such as water, nitrates and carbon dioxide.

Fungi have a strong advantage in the utilisation of a cellulose substrate as the cellulose promotes rapid mycelium growth (Fontaine et al. 2011). This opportunity was realised for having circular

economy potential, and various experiments were undertaken to test the theory. A total of seven trials were completed that investigated the viability of growing mushrooms onto the filter waste. In each experiment, the following process was followed:

- The filter sheets are broken into smaller pieces, each about 2cm by 2cm, and rinsed with water. The pieces are placed on a cotton bag and spun in a washing machine to achieve the desired moisture content. When squeezed, the pieces of filter sheets must not drip water, but must still be damp.

- Supplements are added to the filter sheets, and the mixture is heat-sterilised in a bag. The mixture is then allowed to cool, creating a vacuum in the bag. Once cooled, the mixture is hung and maintained at a stable, optimum temperature of between 21 to 23 degrees Celsius. The air now enters through a micro-porous filter that maintains a sterile environment.

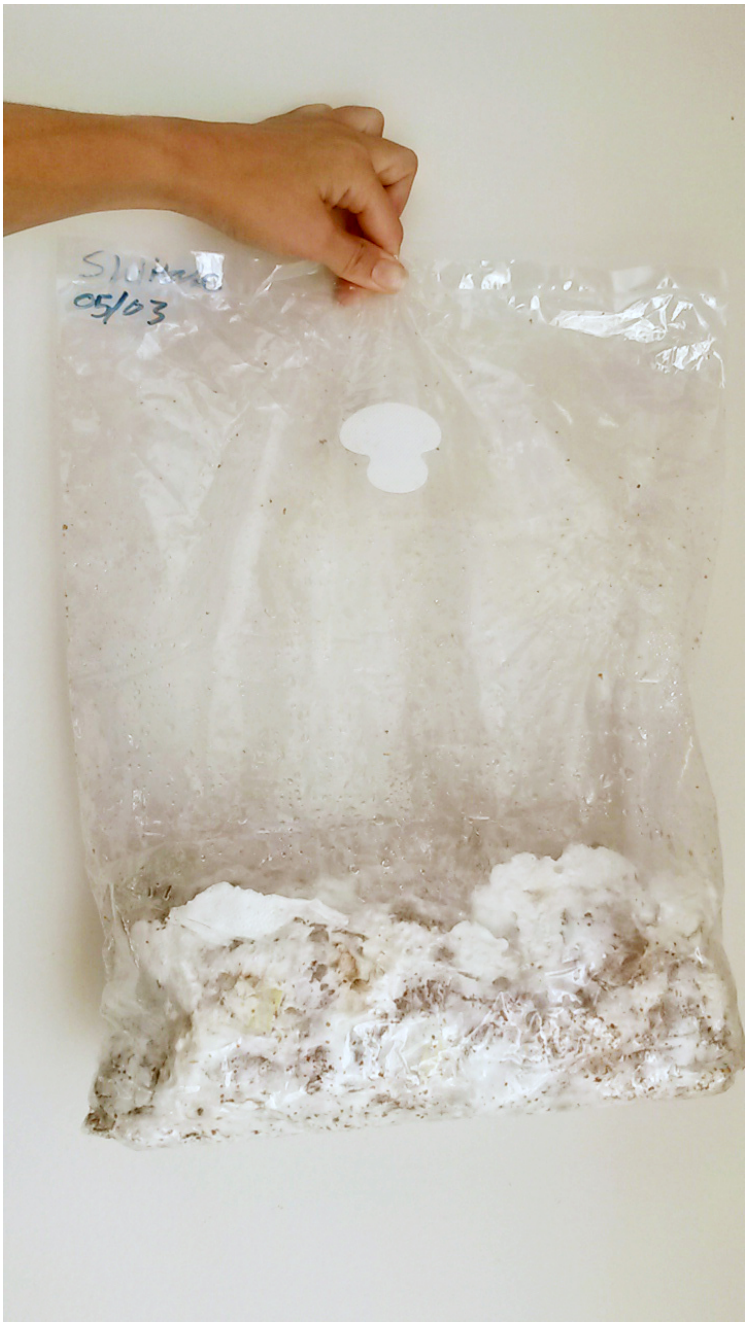
- The mixture is then colonised with the desired strand of mushroom. Full colonisation of the mycelium is reached after about ten days. The fruiting body (edible mushroom) may be ready to harvest after another 10 days. Once harvested, the mushrooms will re-fruit numerous times before the substrate is exhausted.

Every trial was successful in delivering the growth of mycelium on the substrate. In these trials, the mycelium was prevented from fruiting to determine the density of the mycelium growth of the substrate. Figures 5 and 6 show the results of mycelium growth onto filter sheets that had been used for white wine filtration. Experiments were also done on filter sheets with residual amounts of brandy, whisky and red wine.

Figure 5 - King Oyster Trial

Source: Author

Figure 6 – Shiitake Trial



Source: Author

The Shiitake mushroom yielded the best results of mycelium growth (evident in Figure 6), giving a thick, dense and white growth throughout the substrate.

If mycelium has succeeded to grow onto a substrate, fruiting is almost always easy. One trial was completed to demonstrate this potential using the pink oyster mushroom. Figure 7 shows the results of this experiment and indicates that growing mushrooms is easy on this substrate.

Figure 7 - Pink Oyster Fruiting

Source: Alex Verlaque-Napper

Once the substrate has been completely exhausted, what is left over of the fungi-enriched substrate is a perfect fertiliser for soils. Mushrooms have been referred to as a soil magician; they are the molecular decomposers and recyclers of nature, and essentially are the generators of soil (Stamets 2006). The experiments done for this case study are briefly documented below.

b. Composting Exhausted Substrate

Once mushrooms have been grown onto the filter waste, the exhausted substrate may be sold as compost. Distell, or any other company that uses this filter method would not only benefit from reduced costs and additional revenue streams, but also contribute towards the environmental benefits associated with increased fungi in the soil and reduced methane from landfilling (discussed in chapter 4).

Various tests were conducted to determine how easily the fungi-enriched filter substrate decomposes. Four methods of composting were used for this test, where the exhausted substrate was placed:

- In a probiotic Bokashi composter with other food scraps, thereafter being placed in –
    a. Untreated soil

b. A compost heap
c. A worm farm

- Directly into the worm farm without prior treatment
- Directly into untreated soil
- Directly into a compost heap

The exhausted substrate decomposed completely in every scenario, but some methods facilitated faster decomposition. The quickest and easiest decomposition method explored in this case study was placing the substrate directly into the worm farm.

c. Developing a Packaging Product

Options A and B discussed above both require little or no research and development, and can be done using the same substrates and are ready to commercially exploit. Option C, developing a packaging product, requires further research and development that was beyond the scope of this thesis.

The experimentation in this thesis shows that it is possible to use the filter waste as a substrate for the growth of mycelium, which alludes to the potential this has for development as a packaging product. After growing the mycelium, the mixture needs to be dried for a number of hours to terminate the mycelium growth, rendering the growth process complete. Two drying methods were tried in this experiment:

1. Low heat oven dry
2. Repeated sun exposure

The low heat oven drying worked better than the sun exposure. The substrate was completely dry after being placed in the oven for 3 hours at 70 degrees Celsius.

3.8 Recommendations

Option A and B are easily attainable and ready to commercialise with little risks and costs. Although option C will require initial investment for developing the product, option C may be the most profitable long term. It is recommended that option A and B be commercialised, and a portion of the revenue be used to conduct the necessary research and development for option C.

Next, this thesis theorises two implementation pathways for the findings of the case study. First, the closed loop filter waste intervention is theorised as an independent enterprise start up. Second, the project is explored as an enterprise development opportunity within Distell as part of their CSR.

3.9 Conceptualising a Circular Economy Enterprise for Filter Waste

3.9.1 Characteristics of a Successful Enterprise

It has been suggested that companies thrive when they create value *differently* from the norm through different competencies, capabilities and positional advantages (Shafer, Smith & Linder 2005). If we assess the mushroom business in this regard, we see there are some specific positional advantages, including reduced cost, third party advertising and a positive reputational association with the circular economy, or sustainability.

a. Positional Advantages

The first positional advantage is the use of a free substrate. This will give the company a cost-competitive advantage, or allow the company to remain competitive while reaping more profit.

Second, having an association with various wineries may provide third-party advertising. Removing the unwanted waste from various wineries in the Western Cape not only helps them reduce costs, but also allows them to be part of a circular economy story. Essentially, this provides a good green-marketing opportunity for wineries that may result in free advertising for the mushroom company.

Third, the business creates its value by fulfilling a circular economy initiative by closing the loop on filter waste. This gives the business a positional advantage with regards to its focus on sustainability. There is growing consumer concern for global warming and the associated environmental problems. Businesses that don't align themselves with sustainability may suffer negative reputational threats associated with resource depletion. Consumers are beginning to demand "eco-friendly" products (Hill 2014), and companies that can deliver on these demands will be at a positional advantage to companies that resist this change. It has also been found that goodwill in the marketplace far supersedes any amount of clever advertising or marketing, and that people's benevolence and desire for sustainability is a far more effective strategy (Anderson 2009).

3.9.2 Innovus

Innovus is the innovation company of Stellenbosch University who manage the commercialisation of the University's innovation and intellectual property. They are responsible for entrepreneurial

support and development, technology transfer and innovation at the university, and perform the patenting, licensing and the formation of spin-out companies. Their business incubator, LaunchLab, offers services and opportunities for entrepreneurs all under one roof that encourages collaboration and idea sharing.

Innovus has shown interest in the commercial viability of this thesis, even though the case research is not patentable. Innovus has agreed to assist in the start-up of this venture and after the thesis the researcher intends to embark on the project.

Although the idea of growing mushrooms onto filter waste has not yet been fully realised and implemented, the support from Innovus gives legitimacy to the proposal as those with commercial and entrepreneurial experience have showed interest and support for the potential this idea has for success

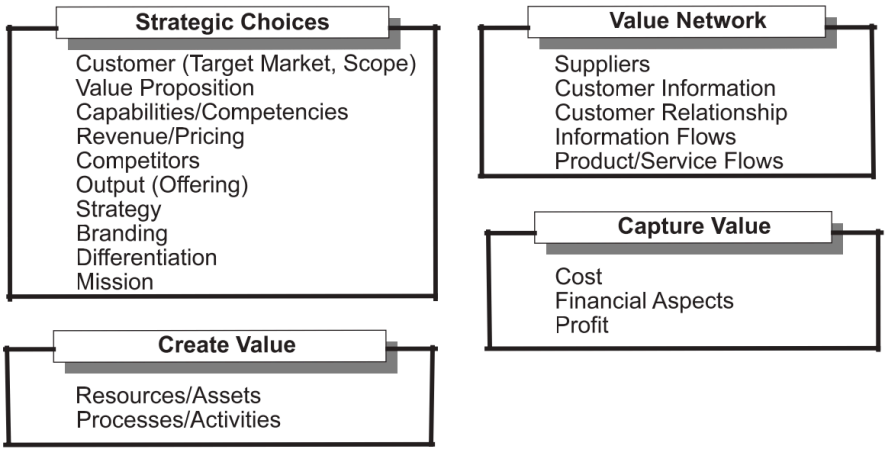
In this section, the business case of growing mushrooms on filter waste will be investigated, informed by the conceptual framework of the synthesis of the MLP and the circular economy.

3.9.3 Business Model

A business model is important for a number of reasons. First, it guides the company with a vision and goal. It focuses and orientates the company in an agreed and strategic direction, and allows internal coherence within the company's members (Shafer et al. 2005). A business model may be flexible to accommodate changing customer needs and discover new potential, but needs to remain within a common framework that still enables a unified direction in the company. A business model essentially embodies a set of choices (Shafer et al. 2005)

Business models can play a positive role in corporate management, while also providing a framework for other aspects of the business. Figure 8 categorises four components of a business model that contribute to the functioning of the business.

Figure 8 – Components of a Business Model

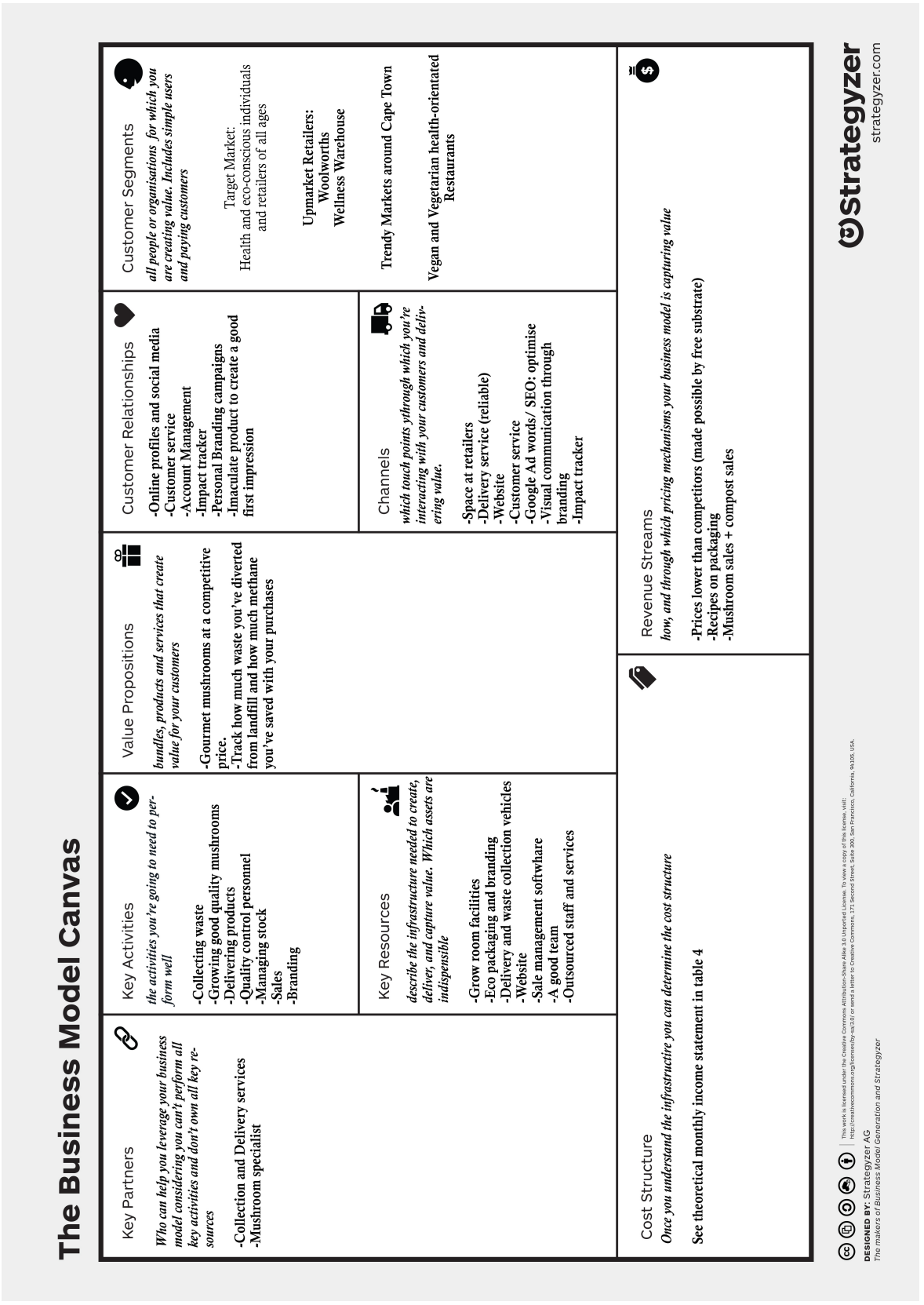


Source: (Shafer et al. 2005)

These components will be used to define the business model for the mushroom business. Businesses' are mainly concerned with how to create and capture value. For this reason, the definition by Shafer et al. (2005) has been chosen to help outline a business model: "We define a business model as a representation of a firm's underlying core logic and strategic choices for creating and capturing value within a value network".

These components are relevant for the mushroom business, and a brief business model will be outlined using the above components. Figure 9 outlines the most relevant components, including customer target, customer relationship, channels, key resources, key partners, key activities, revenue streams, cost structure and value propositions.

Figure 9 – Business Model Canvas



Source: www.strategyzer.com & Author

The business model would need to be tested to develop a more realistic model, and during this process it is important to remain flexible and adaptable to allow co-learning between the shareholders and key partnerships.

3.9.4 Profitability

Financial sustainability would be the main goal of the enterprise to allow for the social and circular economic benefits to ensue. It is difficult to determine the exact social and environmental benefits that may arise from this enterprise.

The product is aimed to compete with the Woolworths mushroom range, as they are the ideal target customers for the product. The competing mushrooms on the shelves at Woolworths range from R27.00 to R59.99 (See table 3). The intention is to grow and sell exotic mushrooms at a competitive price.

Table 3 – Woolworths Mushroom Range

Type	Weight	Price
Mixed	400g	R27.00
Button	250g	R22.99
Brown	250g	R26.99
Baby Button	150g	R29.99
Portabellini	250g	R27.99
Sliced Button	250g	R26.99
Exotic	150g	R42.99
Brown Steak	4-pack	R39.99
Shiitake	120g	R38.99
Porcini dried	25g	R59.99

a. Sales Revenue

Table 4 shows the estimates of a theoretical monthly income statement. For this estimate, it is hypothesised that the company has over the years acquired 200 stockists who each sell 5 products per day; or a total of 30, 000 products sold each month. If each product is aimed to compete with the Woolworths range, the aimed retail price could be between R35 and R40 for 150g of exotic mushrooms. Acknowledging that the retailers may mark up by 45%, a conservative estimate of the

selling price of R25 has been chosen. This would lead to sales revenue of roughly R750 000 per month.

b. Costs

The costs of the enterprise are imagined to involve the following tasks: collection and delivery services, staff, grow room rental, packaging, computer expenses, fuel, assets and their depreciation and management.

Table 4 shows the breakdown of the estimated monthly costs, and the resultant operating profit of R492 970. It has been assumed that the company has acquired Woolworths as a stockist, and the processes have been calculated accordingly. This assumption has been made according to the meetings had with Innovus, where they have said it is likely that they may be able to help secure Woolworths as a stockist as it would allow them a competitively priced mushroom product as well as contribute to their farming for the future label.

Table 4 – Theoretical Monthly Income Statement

Monthly Income Statement			**Average Month**
Gross Turnover			**885 000**
	Units	Unit Price	
Product Sales	30000	25	750 000
By Product - Sold as Fertiliser	900m^3	150/m^3	135 000
(30,000 Sheets to be disposed of)			
Customer Allowances	10%		**75 000**
(Assuming WW private label business model)			
Settlement	2,50%		
Rebate	5%		
Advertising Allowance	2,50%		
Net Turnover			**810 000**
Cost of Sales			**60000**
Packaging		1,5	45000
(R2.50 per unit when bought in small scale)			
Private Label		0,5	15000

Gross Profit			750 000
Selling & Distribution			**5 000**
Transport to WW DC			5 000
(Assuming proximity to WW DC is close)			
Distribution Fees			
(None as delivering to DC)			
Commission			
Contribution			**745 000**
General & Admin			**252 030**
Computer Expenses (Licensing & ADSL)			1 000
Fuel			2 000
Depreciation			27 000
Electricity			10 000
(Temperature & Humidity Control, Refrigeration)			
Salaries			**140 000**
Production & Cultivation			
Mushroom Specialists	X2	30 000	
Quality Control & Food Technologists		15 000	
Harvesting & Processing Staff	X10	45 000	
Admin Staff			
Facility/ Branch Manager		30 000	
Bookkeeper (Invoicing, Payments & Payroll)		20 000	
Facility Rental	m^2	Rate	
Total	1460m^2	43	**62 780**
Grow Room	1010m^2		
Chilled Packaging & Staging Area	300m^2		
Office 150m2	150m^2		
Insurance			3000
Printing and Stationery			500
Repairs & Maintenance			2000
Telephone & ADSL			750
Utilities (Water & Sanitation)			3 000
Operating Profit			**492 970**

Tax			138 000
Profit after Tax			354 970
EBITDA			**465 970**
(Earnings before Interest, Tax , Depreciation and Amortisation)			

Source: Author & Meghan Honing, CA

Table 5 depicts the estimated balance sheet for this theoretical business. It estimates the initial asset investments that would need to be made, including the property, plant and process equipment.

Table 5 - Balance Sheet

Balance Sheet		
Non-current Assets		**2 500 000**
Property , Plant & Equipment		**980 000**
Shelving	200 000	
Insulation Panels for fridge	100 000	
Climate Control Units	300 000	
Refridgerated Truck	380 000	
Computer Hardware & Software		**20 000**
Start-up Costs Capitalised		**1 500 000**
Current Assets		**1 150 000**
Inventory		
Packaging @ R1.50 a unit	300000	450 000
Accounts Receivable		200 000
(Assume a 7 day invoice term with WW)		
Cash & Cash Equivalents		500 000
Total Assets		**3 650 000**

Capital		3 310 000
Share Capital		2 955 030
Retained Earnings		354 970
Non-current Liabilities		-
Current Liabilities		340 000
Accounts Payable		240 000
VAT		100 000
Total Liabilities		**3 650 000**

Source: Author & Meghan Honing, CA

Table 4 and 5 show a seemingly profitable and simple business model, but it must be acknowledged that the time scale in which this happens is important. It may take some time to perfect the business process so that Woolworths may be acquired as a stockist. The start up capital needed to run the full operation in six months is estimated to be R1 500 000. A loan or an investor would need to be secured for this to be possible. This is more a reference figure, as it is unlikely that all would be set up in six months, and the entrepreneur may not wish to take on such risk. The less risky way of starting up this business would include a slow start up process, which acquires stockists gradually before approaching Woolworths.

3.10 Conceptualising an in-House Circular Economy Intervention at Distell

Distell could use this as an enterprise development opportunity to form part of their CSR, and depending on the nature of their engagement, could also use this opportunity to advance their B-BBEE goals. During 2015, 69 CSR projects of R16, 67 million were supported by Distell under the company's corporate and regulatory affairs division, the key focus of which is to address unemployment (Distell 2015). Distell could add this project to their enterprise development portfolio, and help to support the start-up while benefiting from reduced cost and waste, while also gaining a 'green' marketing story. If they supported a third party in this way, they would be able to remain better associated with the project than if an independent entrepreneur were to implement it, and thus benefit from the sustainable association.

If Distell were to decide to implement this as an in-house project, there would need to be various institutional arrangements configured.

3.10.1 Institutional Arrangements

An institution is a specific organisation formed for the purpose of facilitating specific tasks. Various partnerships could be made to facilitate the start up of the mushroom cultivation business. These partnerships could include:

- University research and development
- Associated institutions
- Mycologists and technical experts
- Scientists and technical advise
- Export institutions

First, these partnerships should allow the enterprise access to research and development assistance. Distell could partner up with universities to gain access to lab work and researchers to further the project. They could also approach the newly established Circular Economy Institute of South Africa for assistance in research and support. These institutions may help provide the technical support needed to increase the productivity of the mushroom cultivation. In addition, the Circular Economy Institute of South Africa may be able to market the product in sustainability and circular economy circles worldwide, and perhaps further the reach for support.

This enterprise would provide semi and low skilled job creation that could be beneficial in helping South Africa's high unemployment rate (Statistics South Africa 2014). This may require skills and training of newly appointed staff, and Distell could partner with an institution that can provide specific life and business skills training and support to new staff.

At some point the business may require links to export markets. Distell could reach out to other institutions and organisations that help link growers to export markets; a common tactic (Hall, Bockett, Taylor, Sivamohan & Clark 2001). In some cases, growers are given subsidies for the cost of samples and trial shipments as well as promotional costs (Hall et al. 2001). Organisations that help market products at a premium price may also be a viable approach for Distell, since the mushrooms will have a niche, sustainability-orientated target market.

In general, the institutional arrangements should remain flexible enough to bridge the gap between theory and implementation (Hall et al. 2001). Some put forward that there needs to be a strong link between institutions, market and technology (Dorward, Poole, Morrison, Kydd & Urey 2003). This could entail a more productive interaction between growers, marketers and scientists so that problems can be articulated and the necessary knowledge exchanged.

A growers association could be joined, as well as the formation of a cooperative to assist with marketing the product. Buyers are increasingly showing concern for environmental and international concern that can affect markets (Krijnen 2006), and if Distell finds the appropriate grower connections they could be at an advantage. This cooperative could increase the power and reach of the product by pooling funds and skills for marketing and other activities. A cooperative may help to lessen export or distribution costs if organised correctly.

Government often has limited resources and reach, which is why businesses can often play a major role in assisting government objectives (Pless & Maak 2011). Market forces often don't yield the most sustainable or pro-social outcomes, which is why the development of institutional arrangements other than competitive markets needs to be promoted by policies (Dorward et al. 2003). This too is why innovators must be firmly embedded in the social context (Boxenbaum 2006), as they often have the power to provide important country objectives. Distell could develop this venture as part of their CSR, and aim to fill gaps in the public sector provision, including job creation and soil regeneration of the very valuable wine industry of the Western Cape. This could attract the government (and thus universities) and encourage them to allocate various measures of support. The more companies align themselves to these objectives, the more resources they may be able to mobilise (Boxenbaum 2006).

This thesis has theorised two pathways for the implementation of the case study. First, a third-party could pursue the project as an independent start-up, while Distell benefits from the reduced costs. Second, Distell could implement the findings as part of their CSR. In both methods, the circular economy cannot advance without the broader context being taken into consideration (as argued in article one). Next, the conditions for these findings to be replicated will be investigated.

3.11 Applying the MLP lens onto the Case Study to Determine the Conditions for Replication

The combined lens of the MLP and the circular economy have helped guide the research toward an innovative solution that uses the inherent qualities present in the filter waste, and connects this to a solution that may give various ecological, economic and social benefits (some of which is described later). The methodology undertaken was mainly the methodological approach of the circular economy that looks to create cradle-to-cradle solutions from linear waste problems. Although this has been a good direction up till now, this approach does not offer further advances for this case study.

The question now is to understand under what conditions could this innovation most likely be replicable, in both business scenarios of a start up or in-house intervention. As argued in article one, this question is not a question that the circular economy can adequately address on its own. Closing the loop on the filter waste needs to be considered in its broader, systemic context to discover its potential for replication and broader positive effects. To progress in this way, the MLP will be overlaid onto the case study to discern the broader context of this intervention in order to understand how this case study may be replicable.

As described earlier, the MLP helps analyse transition contexts through the use of landscapes, regimes and niches. Pressures on a landscape and regime level can provide windows of opportunity for niches to emerge into the mainstream. If we consider the closing the loop on filter waste as a possible niche intervention, then what conditions on the landscape and/or regime level would help to create a window of opportunity for it to replicate? This thesis theorises the following conditions under which the case study can most likely be replicable: landfill restrictions, environmental pressures, the introduction of a third-party entrepreneur, economic pressures, cultural change, isolation and bureaucracy and vested interests. Most of these conditions are congruent with article one, but describe more specific conditions relating to the case study.

3.11.1 Regime Change: Landfill Restrictions

Some members of Distell consider finding an alternative disposal method for the filter waste a high priority, as it is expected that the waste may no longer be disposed at landfill in years soon to come. This has been discerned from the on-going relationship between Distell and landfill management at the Visserhok and Bellville landfill sites. This could be described as a crack in the linear waste regime whereby waste is disposed in a linear fashion. Landfill sites are finite spaces, and some sites are beginning to reach capacity around Cape Town (Stellenbosch Municipality 2015). This has already provided enough pressure to urge actors at Distell to look for alternative disposal methods of the filter waste, and is why they urged this research to focus on the filter waste. It is unclear whether they will begin diverting the waste from landfill before the formal decision has been made at landfill not to accept this waste.

This is a regime shift that could affect the entire wine industry, as many wine producers use this filter method. Therefore this presents a possible disruption in the incumbent regime that may provide the window of opportunity for closing the loop on the filter waste to proliferate the Western Cape.

3.11.2 Landscape Change: Environmental Pressures

Increasing awareness of climate change and greenhouse gasses may see the review of disposal methods not because of limited landfill space, but because of pressure to reduce the associated emissions. The negative environmental effects of landfills are well documented (Barlaz 2006; Banar, Cokaygil & Ozkan 2009; Bogner, Pipatti, Hashimoto, Diaz, Mareckova, Diaz, Kjeldsen, Monni, Faaij, Gao, Zhang, Ahmed, Sutamihardja, Gregory, Qingxian Gao, Tianzhu Zhang, Mohammed Abdelrafie Ahmed, Sutamihardja & Gregory 2008; Kirkeby, Birgisdottir, Bhander, Hauschild & Christensen 2007), and could in future influence policy regarding landfill usage. Higher levies for those using old infrastructures such as landfills is one example of how the political landscape may help the circular economy agenda. This could provide another metaphorical crack in the landscape surrounding the linear method of disposing the filter waste.

3.11.3 Landscape Change: Third Party Entrepreneur

The economic benefits of the two revenue streams imagined in this thesis could receive interest from a third party entrepreneur (such as myself or Innovus). This would cause a demand for the filter waste, thus sparking a change in the landscape of the current disposal method. Distell would be incentivised to allow the entrepreneur to remove the waste free of charge, thus saving them money, and the filter waste would be diverted from landfill to the satisfaction of the municipality. Initially, the entrepreneur would not be able to use all the filter waste, and competition may arise and offer payment for the filter waste thus monopolising the supply and jeopardising the success of the first start-up. Some way of ensuring the stability of the price of the supply would need to be found. The entrepreneur could offer the free removal of the waste with the legal agreement, so that no third party can offer a superior service.

3.11.4 Landscape Change: Economic Pressures

The circular economy has been recognised for the economic opportunity it presents, as well as being able to reduce costs (Ellen MacArthur Foundation 2013b). Additionally, price volatility related to resource shortages could pose risks to companies (Lütkehus 2014). Money may become the landscape pressure that causes the replication of this niche intervention. Either through external taxes or hiked landfill charges for organic waste, the solution of closing the loop on filter waste may be replicated.

3.11.5 Landscape Pressure: Cultural Change

Awareness of climate change has become virtually universal, with the highest number of those aware being educated individuals (Semenza et al. 2008). Consumers are beginning to search for "eco-friendly" alternatives (Hill 2014), allowing a strategic positional advantage for companies that deliver on this cultural shift. It has been found that this goodwill and desire for sustainability is good for the marketplace and supersedes many marketing campaigns (Anderson 2009). This evolving cultural shift could provide the necessary landscape pressure to incentivise Distell to adopt more sustainable strategies.

Distell already tries to align their branding with responsible alcohol consumption (Distell 2015) to mitigate against the negative association with alcohol abuse. Closing the loop on filter waste provides a "green" marketing story, and the company can track its methane savings and be involved with soil regeneration (described later). These stories can help the company gain better ethical and environmental publicity.

The above can be described as a changing landscape pressure. They are deep, cultural values. Socio-technical regimes are either bolstered or destabilised by such cultural values (Geels 2002), which indicates the effect this could have on the linear disposal method of the filter waste.

3.11.6 Landscape Pressure: Internal Motivations

This desire for sustainability is not limited to those outside the company. At times, members within a company are limited in their role to perform the changes they'd like to make. One member within Distell has a deep personal pursuit of sustainability within the company. He was the most motivated to find an alternative filter waste disposal method, as he wanted to eliminate the negative environmental effects associated with their disposal. If realised, this could create the internal motivation with the company that could act as a landscape pressure effecting change internally. If he acted independently, he would do some things differently to create a more sustainable company. Another member was keen on the execution of this case study, and had he the authority he may have began its implementation. Often information is not effectively transferred between the stratospheric layers of bureaucracy at Distell, which creates this inertia. Better co-ordination between these actors could result in the agency needed to facilitate the advance of the circular economy.

3.11.7 Landscape Pressure: Vested Interests

Two members at Distell were personally concerned about the on-going method of disposing the filter waste. Each of them was concerned about the impending refusal by landfill authorities to accept the filter waste and what it would entail for their office. Although neither actor had received instructors from their authorities to look into alternative disposal methods, both actors were motivated to find alternative ways because a failure to do so would reflect negatively on them. In particular, if they were suddenly unable to landfill the filter waste, Distell would be stuck with this waste and be forced to store it until an alternative way was found. This would not reflect well on the actors responsible, which is why over and above the environmental concerns, these actors have vested interests in diverting this waste from landfill as soon as possible, or at least having a plan to do so.

If we apply the MLP to this scenario, we could describe these vested interests as a shift in the regime level of this linear disposal method, as the actors involved were personally motivated to change it from within.

3.12 Configurations That May Prevent Replication

There is one threat to the replication of closing the loop on the filter waste: the proliferation of an alternative filter method. Cross flow filtration methods are increasingly being used to filter wine. These methods use filter powder, but in much lesser amounts that conventional methods. For this reason, one of Distell's employees is advocating the use of the new method because it produces less waste, but it remains too expensive to be considered, especially since it has a low return on investment. It may be possible that in years to come Distell might choose to switch their distilling methods, and in such a case much less filter waste would be produced which might phase out the need of the niche intervention presented in this thesis. However, according to the same Distell employee, Distell may take a long time before switching methods due to cash flow requirements and the lack of new skills required for the new technology.

To sum, it is unlikely that the niche of the alternative filter method would completely eliminate the need for filter sheets and powder. The landscape and regime pressures described above may present the opportunity for the niche innovation described in this case study to be replicated or taken to scale. The factors that remain unclear are which parties would implement the niche intervention and benefit from the profitable operation. This thesis has provided some insight into two methods of implementation, namely a third party start-up or an in-house intervention.

3.13 Conclusion

Humanity must consider alternative ways of consuming if no more planetary boundaries are to be transgressed. The rise of the middle class and consumer culture urges a move towards more sustainable production and consumption. The circular economy and transitions theory both aim to do this, however each cannot effect widespread change because of their unique weaknesses. The circular economy lacks the systemic view to advance its agenda, while the MLP lacks a clear methodology for implementation. Both these weaknesses can serve to bolster the strengths of the other.

The lens from the synthesised theories was applied to the case study at Distell, which informed the innovative approach taken. Direct observation, semi-structured interviews and the literature analysis helped direct the transdisciplinary case study.

The filter waste was identified for having potential for circularity, and due to its high cellulose content, various opportunities were possible. These included growing edible mushrooms to provide an additional revenue stream, selling the exhausted substrate as a fungi-enriched compost and developing a packaging material.

The research completed for each option was documented. It was found that each option could be successful, and it is recommended that option A and B are ready to exploit.

Two pathways of implementation were explored in this article. The first was a third party enterprise that could simply remove the waste from Distell, thus saving Distell costs. The feasibility of this enterprise was explored in a simplified business model, theoretical monthly income statement and balance sheet. The exercise showed the commercial feasibility of the project. The second implementation pathway shown was an in-house project at Distell, and various policy and institutional arrangements were discussed to facilitate this pathway.

The synthesised theories allowed for an innovative approach to be taken, the methodology of which was mainly from the circular economy. However, to advance the case study and understand how it may be best replicable, the MLP had to play a bigger role. The MLP was used to understand the broader context in which the case study exists, and seven landscape or regime conditions were identified that may facilitate replication: landfill restrictions, environmental pressures, the influence of a third-party entrepreneur, economic pressures, cultural change, isolation and bureaucracy and vested interests. Most of these conditions are congruent with article one, but reveal more specific conditions.

Chapter 4 – Conclusion

4.1 Introduction

This thesis has reviewed the circular economy and transition theory to explore a synthesis between them, both in theory and practice. To frame this chapter, the original aims, questions and objectives of this study need to be revisited. This will assist with the reflective process of reviewing the thesis as a whole so that results, difficulties and further research can be identified.

Main research question:

Can the application of the circular economy approach facilitate broader systemic change in the South African context that provides environmental, social and economic benefits?

Article one:

Is there potential for a synthesis of the fields of transition theory and the circular economy that can offer an analytical lens for the proliferation of the circular economy agenda?

Article two:

What circular economy opportunities exist at Distell that can demonstrate the synthesis of fields described in article one to provide a scalable intervention with environmental, social and economic benefits?

Key research objectives:

- Develop a foundational conceptualisation of the potential synthesis of transition theory and the circular economy discourse, to provide an analytical tool with which to investigate a proliferation of the circular economy.

- Bolster both the circular economy and transitions theory through the amalgamation of the two theories.

- Gain a practical understanding of how the circular economy is realised within an existing company.

- Contribute to Distell's sustainability efforts through research and practical findings.

- Respond to Stellenbosch Municipality's target of reducing waste to landfill, with emphasis on eliminating organic waste to facilitate the sorting of waste at landfill.

- Present Distell and/or a third party with practical knowledge and ideas of how they may implement the findings.

- Contribute to the growing research and evidence of the circular economy and its outcomes.

- Motivate continued theory development and empirical research into the potential synthesis of the principles of the circular economy and transitions theory.

- Initiate the academic discourse of the circular economy in the context of South Africa

4.2 Answering the Main Research Questions

The overarching purpose of this study was to explore the environmental, social an economic implications of a circular economy initiative at Distell. The synthesis of transition theory and the circular economy helped provide a conceptual framework with which to approach this case study. The practical application of the amalgamated theories in the case study resulted in innovation. The coherence across the theoretical and practical aspects of this study indicates that the findings of the research may support a wider transformation in the wine industry of the Western Cape, with positive implications such as reduced waste to landfill, soil regeneration, job creation, economic savings and revenue. These broader, more systemic actualisations were a result of bolstering the circular economy with the MLP, and vice versa.

Article one

Combining the closed-loop design method of the circular economy with the diagnostic approach of transitions theory helped to strengthen each theory. The weaknesses of the one theory were bolstered by the strengths in the other: the lack of a systemic view of the circular economy was augmented by the MLP, while the MLP benefited from the clear methodology within the circular economy. The result was a conceptual tool that helps to amplify the agenda of the circular economy through innovation. The general conditions under which the circular economy may be replicable is suggested, and the framework was used in the case study at Distell (article two).

Article two

This article took the proposed synthesis further by exploring it as a heuristic in the immersive case study at Distell. The objective of the case study was to transform a linear waste stream into a circular one and test the theory of whether it would provide economic, social and environmental benefits.

This article had the aim of furthering Distell's sustainability goals by turning a linear waste stream into a circular one. Experimentation and research with the filter waste provided evidence that this waste could be entered into a closed loop system whereby edible mushrooms are grown using the filter waste as a substrate, thereafter selling the mushrooms and selling the exhausted substrate as a fungi-enriched compost. An addition intervention could be the development of a packaging product using the filter waste and mycelium, but this would require more research and development. The more accessible interventions of mushroom cultivation and composting may have many benefits such as two new revenue streams, reduced costs, waste diverted from landfill, reduced greenhouse gas emissions associated with landfilling, soil regeneration, increased carbon sequestration ability of soils, strategic positional advantages and semi and low-skilled job creation. Since the majority of the Western Cape wineries use the same filter method, these findings could potentially transform the Western Cape wine industry, and thus our soils. Suggestions of how this intervention may become replicable are given.

4.3 Outline of Core Logic and Argument

This thesis undertook to integrate different fields of knowledge from two unrelated and distinct fields by overlaying the lens of the one on the other. The purpose of this was to bolster the weaknesses in each theory with the strengths in the other. Specifically, the author intended to provide the circular economy with the more systemic lens it needed to provide an innovative tool for sustainable transitions. It was suggested that the circular economy could be considered a niche, with the potential of providing systemic sustainable change in resource use if these niches accumulated. Based on the in-depth examination of the existing literature and transdisciplinary research, it was argued that there is potential for a synthesis between the concepts of the circular economy and the MLP.

The author began the search to explore this claim by investigating the notion of global resource depletion. Resource depletion could be understood as the main driver behind climate change, species extinction, and other transgressed planetary boundaries. This is because the industrial activities that fuel these crises are all to satisfy the consumption of a direct or indirect product; electricity, food, transport and communications. Uncapped economic growth based on GDP will lead to increased consumption and the ensuing environmental, social and economic issues. The author presents rising

global consumer culture, population growth and growing affluent societies as the main drivers of resource depletion. This main problem is at the core of what the circular economy aims to address. The author suggests the circular economy is a useful tool to help alleviate resource depletion.

The Ellen MacArthur Foundation states their goal is to accelerate the circular economy agenda. The literature documents the benefits of the circular economy in different contexts, yet none have inquired into how the circular economy may proliferate the mainstream. The theory fails to extend its methodology beyond business applications because it lacks a wider systems understanding of sustainable transitions. This is the problem statement of the circular economy that this thesis hypothesises, and it is suggested that the MLP can provide the necessary systemic approach that's lacking.

The MLP provides a useful heuristic for investigating sustainable transitions, but lacks the clear methodological approach to that can actualise these transitions. This is where the circular economy can strengthen the MLP, as the circular economy provides a clear framework and methods for achieving sustainable resource use.

To amalgamate the theories, the three levels of regime, landscape and niche were used to further understand the broader context surrounding the circular economy. The landscape and regime features that inhibit the circular economy are identified, and the conceptualisation of the circular economy as a niche was proposed. The MLP characterises the level of the niche as innovative. This synthesis shows the innovative potential of the circular economy; a niche intervention that has the potential to take over the incumbent regime of linear resource use. Thus the amalgamation results in a conceptual tool whose practical application is innovation.

By using the language of the MLP, it was possible to visualise what regime the circular economy is embedded within, and what landscape features constrain the circular economy from evolving into a regime itself. These landscape features include the social paradigms concerning waste, the culture of consumerism and individualism and macro-economic conditions. Moreover, the superimposed language of the MLP helps to identify under what conditions on a landscape or regime level the circular economy may become replicable and proliferate the incumbent linear resource regime. Chapter two identified these conditions as policies and governance support, information flows, reputational threats, limited resources and technical limits. In this way, the circular economy may be understood as an accumulation of innovations, or niches, that have the potential to accumulate and proliferate the linear resource regime.

The conceptual tool developed in chapter two was used to guide the transdisciplinary case study at Distell. The case study investigates the various waste stream opportunities at Distell that can demonstrate the synthesis in article one to provide a scalable intervention with environmental, social and economic benefits. The filter waste stream was chosen due its high priority given by Distell, and with the conceptual tool it was possible to design a closed loop intervention that has the potential for widespread positive environmental, economic and social effects.

The closed loop intervention of growing and selling edible mushrooms, thereafter selling or using the exhausted substrate as compost, could provide many environmental, social and economic benefits; some of which will be described in the next section. It is recommended that options A and B are ready to exploit, whereas option C requires more research and development.

The end of article two suggests the specific conditions under which this case study could be replicable, including landfill restrictions, environmental pressures, the influence of a third party entrepreneur, economic pressure, cultural change, isolation and bureaucracy and vested interests. This reflects the landscape conditions described in article one, but are case specific. Table 6 shows the congruence between the conditions in article one and two and details their similarities.

Table 6 – Conditions for Replication

Article One	Article Two	Similarities
Policies and Governance Support	Environmental Pressures	Environmental pressures could influence policy making, both of which could support a transition to a circular economy
Information Flows	Isolation and Bureaucracy	Increased knowledge and idea exchange could facilitate implementation
Reputational Threats	Cultural Change	Increased demand for "eco-friendly" products, that allow businesses to gain positional advantages that can deliver on these demands
Limited Resources	Economic Pressures & Vested Interests	The limit to resources and the associated price volatility may provide the motivation to shift vested interests and transition
Technical Limits	Landfill Restrictions	The physical and managerial restrictions on infrastructures may call for alternative disposal methods to be used

4.4 Projected Outcomes

By using the amalgamated theory, it was possible to consider the case study more systemically, which helped to realise the opportunities at a micro and meso scale. Thus the implications of the case study could yield positive outcomes for number of beneficiaries. These projected outcomes could include two new revenue streams, reduced costs, waste diverted from landfill, reduced greenhouse gas emissions associated with landfilling, soil regeneration, increased carbon sequestration ability of soils, strategic positional advantages and semi and low-skilled job creation. Since the majority of the Western Cape wineries use the same filter method, these findings could potentially transform the Western Cape wine industry, and thus our soils. The next section will analyse the case and the various outcomes. This excludes the projected cost savings of R29 572 that Distell could receive, and the potential earning if an enterprise was developed to implement the project discussed in article two.

4.4.1 Landfill vs. Composting

The filter waste can be classified as organic waste due to its high cellulose (plant and algae) content. Inorganic waste is often considered toxic at landfills, while organic waste is regarded as safe and natural to dispose in this way. Organic waste (food and other) is often assumed harmless because it is seen as biodegradable, and the real effects that this waste has at landfill sites is overlooked. Although inorganic waste is a major concern, the negative effects of organic waste at landfill should not be ignored.

The amount of oxygen available differs between landfills and composting scenarios. These differences are called aerobic and anaerobic conditions. Aerobic conditions have more oxygen present, and microorganisms that require oxygen carry out the decomposition process. Anaerobic conditions have little or no oxygen present during decomposition, and the active microorganisms don't require oxygen. In landfills, organic waste gets trapped underneath masses of other waste, creating an anaerobic condition. Composting is aerobic due to the looser stacking of waste, and the presence of worms and other organisms that help the decomposition process. In addition, the compost eventually feeds the soil with the broken down nutrients.

Organic waste at landfill contributes significantly to the production of the greenhouse gas methane (Barlaz 2006; Banar et al. 2009; Bogner et al. 2008; Kirkeby et al. 2007). The methane produced in landfills is due to the man-made anaerobic conditions present, which is why it is counted as a green house gas and not part of a natural carbon cycle (United States Environmental Protection Agency EPA 2010). Organic waste is comprised mainly of cellulose and hemicellulose, and their decomposition in landfills produces methane. Equation (1) and (2) show this process chemically (Barlaz 2006):

$(C_6H_{10}O_5)n + nH_2O \rightarrow 3nCO_2 + 3nCH_4$ (1)
$(C_5H_8O_4)n + nH_2O \rightarrow 2.5nCO_2 + 2.5nCH_4$ (2)

The decomposition of biodegradable cellulose and hemicellulose depends on the microbial process of various bacteria (Barlaz 2006). This is the natural process when compounds break down in nature. When waste such as wood, paper, cardboard, food scraps and garden refuse are disposed of at landfill, the landfill essentially acts as an anthropogenic storage, as these materials are unable to break down under the unnatural, anaerobic conditions (United States Environmental Protection Agency EPA 2010). Moreover, the high lignin (complex organic polymers) content in landfills acts as a microbial barrier, preventing the breakdown of such materials (Barlaz 2006).

Furthermore, as the oxygen is depleted in landfills during initial decomposition, carboxylic acids accumulate and the pH decreases, transforming a portion of the biodegradable materials into leachate (United States Environmental Protection Agency EPA 2010). When it rains, the landfill is percolated and the leachate can contaminate nearby groundwater and soils. Even the most advanced management systems can't fully cope with this ensiling problem (Wang, Shen & Xu 2006). Table 7 provides a summary of the varied conditions and outcomes between composting and landfilling, which include reduced greenhouse gas emissions, increased carbon sequestration ability of soils and the reduced need for high-consumption-fossil-fuel machinery, and the fact that composting may help to reduce chemical fertilisers and their production emissions.

Table 7 – Compost vs. Landfill

Compost	Landfill
Aerobic decomposition	Anaerobic decomposition
Reduced CO_2	Higher CO^2 produced
Soil regeneration	Leachate, acidification, eutrophication
Little or no methane	Methane production
Improves soil workabilit	
Increases plant growth & carbon sequestration	
Reduced need for fertilise and machinery	

Global methane emissions from landfills are estimated to be between 30 and 70 million tonnes each year and may account for up to 20% of global anthropogenic methane emissions (Ximenes, Gardner & Cowie 2008). This is concerning when methane is one of the worst greenhouse gases and is expected to contribute 72 times more to global warming than carbon dioxide in the next 20 years (Hutton 2009). Composting organic waste is a much less harmful solution. It is estimated that greenhouse gasses could be reduced by between 12.8% and 65% in 17 years by composting (Seng, Hirayama, Katayama-Hirayama, Ochiai & Kaneko 2013). Tan Khoo & Khoo (2006) suggest that only 1.5-2% of biologically available carbon from waste material is emitted as methane during composting. It is recognised that green house gas emissions are higher in landfill scenarios when compared to composting (Lou & Nair 2009), and that composting produces less carbon dioxide, acidification and eutrophication, contributes less to human toxicity, and has contributes less to photochemical ozone depletion from methane (Banar et al. 2009).

Furthermore, using the composted waste as fertiliser could give extra benefits such as a reduced need for chemical fertilisers leading to less emissions from their production and application (Lou & Nair 2009). Large-scale use of compost as fertiliser could improve the workability and tillage of soils thus reducing the need for fossil fuel driven tilling machines, which could reduce agricultural costs. Plant growth is stimulated by the use of compost-fertiliser, which would increase carbon sequestration of plants thus removing carbon dioxide from the atmosphere. For every ton of wet compost, it is estimated that 50kg of carbon gets sequestered (Lou & Nair 2009).

There have been various estimates of how much methane is generated anaerobically from municipal solid waste at landfill. Themelis & Ulloa (2007) estimate that per dry tonne of municipal solid waste about 200Nm^3 is produced, or 50Nm^3 per ton of municipal solid waste. This estimate accounts for organic and inorganic waste, and for this study an organic estimate is needed. Mou et al. (2014) predict an average of between 61-106kg methane is produced per ton of organic waste, and between 114-189kg methane per ton of cardboard and paper waste.

The estimate for cardboard and paper waste was used to predict how much methane Distell's filter waste produces annually. The figure of 151,5kg CH_4 per ton waste was chosen for this article, as it is the mean of the estimate given by Mou et al. (2014). This number is higher than the food waste, which seems appropriate due to the filter's high cellulose content. If we apply this estimate to 15,245.5kg of filter waste disposed at landfill by Distell, we see that an amount of 2310kg, or 2,3 tons of methane is produced by the filter waste annually at landfill under anaerobic conditions. Closing the loop on filter waste can thus help to save tonnes of methane produced at landfill each year.

4.4.2 Soil Regeneration

Fungi help regenerate soils by facilitating the distribution and bioavailability of nutrients already present in soils. Mushrooms are the so-called 'gate-way' species because they decompose and recycle waste to create nutrient-rich soils that in turn sustain plants and other living organisms. Plants depend on fungi to break down nutrients and distribute the nutrients where they are needed to feed plants. In return for this plant husbandry, the fungi benefits from a continued supply of food for its survival. In this way fungi and plants and fungi have become mutually dependent for their survival (Stamets 2006).

Fungi plays as important part in regulating the carbon content in soils and the biosphere (Zhu & Miller 2003; Fontaine et al. 2011; Clemmensen, Bahr, Ovaskainen, Dahlberg, Ekblad, Wallander,

Stenlid, Finlay & Lindahl 2013). They are able to decompose old plant matter by using carbon as a source of energy; a process called the priming effect (Fontaine et al. 2011) that helps to sequester carbon and regenerate soil. Fungi has been referred to as natures internet (Stamets 2006); it provides communication between plants which helps to stabilise soil aggregates, thereby increasing carbon storage and facilitating carbon sequestration (Zhu & Miller 2003). The fungi achieves this by creating a demand for carbohydrates and drains 4-20% of carbon from plants, thereby increasing the sink strength of soils (Zhu & Miller 2003).

Microbial growth, respiration and immobilisation of nitrogen were all stimulated with the supply of cellulose in soils, which helped amend soils and allow for the rapid growth of mycelium (Fontaine et al. 2011). Worldwide, soils suffer from overexploitation and contamination (Meterlerkamp 2013). It is envisioned that closing the loop on cellulose filter waste could have positive effects on mycelium growth in soils thereby boosting soil quality and plant growth. The added benefit of having first grown mushrooms onto the filter substrate may boost these benefits, as the mycelium is already present on the substrate.

Until recently, scientists thought that carbon sequestration in soils was due to the stored carbon in fallen tree leaves and branches that is released back in to the soil. However, 50-70% of stored carbon in soil comes from the tree roots and the associated fungi that grow on them (Clemmensen et al. 2013). This is possible because mycelium produces oxalic acids, which helps breakdown matter into soil (Stamets 2008). Stamets (2006, p.154) explains it well, “The bottom line is that mushrooms generate soil. They are the grand molecular decomposers in nature and the grand recyclers of the dead, whether they are plants, animals, bacteria, or protozoa”.

When soils are depleted by farming or other activities, the nutrient availability is low, and fungi helps to provide the carbon and nutrients needed to increase plant production once again (Fontaine et al. 2011), and the associated life that depends on the soil. Thus fungi provides the foundation and support for increased biodiversity (Stamets 2006). In addition to the improved carbon sequestration in plants, the mediating effects fungi has on plant growth also helps to increase the net primary production of plants thus sequestering even more carbon through increased plant growth (Zhu & Miller 2003).

In conclusion, various studies have confirmed that composting is the most effective solution when compared to alternatives like landfilling, incineration or recycling (Banar et al. 2009; Bogner et al. 2008). Composting produces less carbon dioxide, acidification and eutrophication and also causes less human toxicity. Composting is in fact regenerative, as it enriches the soil. Moreover, companies that use this filter method can benefit significantly from reduce costs and extra revenue by selling

this as compost. This is already being done successfully in one instance (Stamets 2006) where red worms are used to speedily break down mushroom substrates before being used as compost. The difference in this research is that the filter sheets contain alcohol; but most of this alcohol is rinsed before it is used as a substrate making this negligible. The increased soil quality above could benefit the wine industry if they become the beneficiaries of the fungi-enrich compost.

4.4.3 Effects on the Wine Industry

By definition, the wine industry in South Africa includes other spirits such as brandy and whisky, because these spirits must be added to make the fortified wines such as port and sherry (SAWIS 2016). The South African wine industry thus includes both fortified and sparking wine, wine for brandy, distilling wine, brandy and other spirits distilled from distilling wine, grape juice and grape juice concentrate (SAWIS 2016).

Figure 10 shows the extent of the South African wine industry and how many litres of wine are produced in the country.

Figure 10 – Litres of wine produced in South Africa

	2013	2014	2015	
PRODUCTION	**MILLION ℓ**	**MILLION ℓ**	**MILLION ℓ**	**2015/2014 TREND**
Wine	915.5	958.8	968.4	101.0
Wine for brandy	42.0	53.6	41.8	78.0
Distilling wine	140.7	133.6	112.9	84.5
Grape juice concentrate and grape juice	58.7	35.1	30.9	88.0
Total	1 156.9	1 181.1	1 154.0	97.7

Source: (SAWIS 2016)

Using the 2015 data in figure 10, and the litres per sheet in Distell's processes in table 8, we can estimate the amount of filter sheets used across the Western Cape. According to Distell's 2017 budget for filter materials, the amount of litres filtered per filter sheet is as follows:

Table 8 - Litres per sheet

Product	Litres per filter sheet
Fortified wine	5,500
Unfortified wine	5, 000
Whiskey	2, 000

Source: Distell

According to this data, approximately 184,460 filter sheets are used per year in the South Africa. This is using the aggregate between the fortified and unfortified wines, 5,520 litres per sheet. In the Western Cape alone, about 746 million litres of wine are produced per year (Vink & Tregurtha 2004), leading to a number of 142,095 filter sheets used annually. The filter sheets alone in the Western Cape could contribute towards 213 tonnes of waste deposited at landfill yearly, using the 1,5kg per used filter sheet introduced in 3.6.2 in article two. This means that the Western Cape wine industry contributes 32,3 tonnes of methane from landfilling this waste. It should be noted that this is only for the filter sheets, and the effects from the filter powder has not been estimated. While it is true that some wineries take the filter waste straight out into the fields as compost, this is not widely done according to Distell.

4.4.4 Local Economy Benefits

Closing the loop on filter waste may have benefits such as job creation and local economic growth. In particular, the circular economy has been recognised to have positive implications for countries struggling with unemployment. In many cases, a circular economy approach has provided employment for many (Ellen MacArthur Foundation 2013a; Beuren, Ferreira & Miguel 2013; Baines, Lightfoot, Evans, Neely, Greenough, Peppard, Roy, Shehab, Braganza, Tiwari, Alcock, Angus, Bastl, Cousens, Irving, Johnson, Kingston, Lockett, Martinez, Michele, Tranfield, Walton & Wilson 2007; Lütkehus 2014; Swilling, Robinson, et al. 2013; Wilson 2015).

The business plan in article two of this thesis reveals that a number of jobs could be created with the mushroom enterprise, as well as employment for the shareholders and third party employment of delivery and collection services, among others.

Developing countries could benefit most from implementing a circular economy. Jobs are increasingly created for skilled positions such as product design and engineering, while the vast majority of unemployed people are unqualified and relatively less skills (Ellen MacArthur

Foundation 2013a). These trends are especially true for developing countries such as South Africa, where a large portion of unemployed people are uneducated and/or unskilled. Although the jobs created by the circular economy are both skilled and unskilled positions, the larger portion of opportunities lies in unskilled or semi skills work such as collection and sorting activities.

The employment created by the mushroom enterprise is beneficial in the context of South Africa where there are high amounts of unskilled and semi skilled people in need of jobs. The required activities such as collection, substrate preparation, inoculation, maintenance, harvesting, packaging and delivery require unskilled or semi-skilled labour, with the exception of two or three more skilled persons to oversee and manage the mycological process.

The projected outcomes in this thesis have all been guided by the synthesis between transitions theory and the circular economy. The processes leading to increased soil quality, reduced greenhouse gasses, increased carbon sequestration of soils, have been researched via the conception of innovation. Although the knowledge of how fungi can help soils sequester carbon is existing knowledge, the process that was discovered in this thesis is innovative due to the unique closed loop process undertaken. This innovation is the product of the synthesised theories.

4.5 Limitations and Recommendations for Future Research

As with all studies and research, this thesis has its limitations. This study was the author's first experience at academic research and as such will result in some weaknesses. To minimise the weaknesses, the author exercised a reflective approach and tried to remain aware to minimise this weakness. Another decisive limitation was the time constraint. Many relationships, intricacies and complexities had to be developed to obtain the level of embedded research that the researcher aimed for with Distell. Moreover, a key relationship with the mushroom specialist needed to be nurtured to gain the help and expertise needed for the experiments completed in this research. The time and effort it took to follow up and pursue these relationships was a constraint, but also necessary to gain inside access to Distell and the mushroom specialist.

The mushroom specialist had constraints of his own such as time and space restrictions, which constrained the depth of prototyping that was completed. The researcher is pleased to have been able to test the mycelium growth capacity on all the spirits and wines that Distell produces. Nevertheless, the researcher would have preferred to have more time to test the fruiting capacity of each. Even so, the specialist has given assurance that the degree of mycelium growth shows that fruiting would be easy. Both the specialist and researcher aim to continue developing the experimentation and pursue an enterprise from this research together, with help from Innovus.

The estimates of methane emissions, carbon sequestering ability of soils, costs and waste to landfill were rough estimates based on the information that the researcher could access through the case study and literature at the time the research was conducted. The researcher did no quantitative, scientific measuring. The estimates are thus time-specific and are subject to change as the research grows.

Moreover, the time available did not allow for the implementation of the closed loop intervention of growing and selling mushrooms onto filter waste at Distell or via third party enterprise. The researchers involvement with Distell had to be withdrawn at a certain point so that there was sufficient time for the write up. However it is the author's intention to pursue the implementation of this research as a business venture after the thesis is complete.

Another limitation was the chosen format for this thesis. The two journal articles have a more limited word count than a traditional thesis. Also, both articles must stand independently, which requires repeated sections to explain context.

Despite the limitations listed, the researcher believes that this work provides useful insights and adds to body of research on the circular economy. However, the limitation experienced in this study presents issues that future research could address. The researcher will pursue some of this research after completion of this thesis, but other recommendations are put forward for others.

This thesis hypothesises that both the circular economy and the MLP may benefit from a synthesis of the two. In particular, this thesis has argued that this synthesis provides a useful conceptual tool for thinking about innovation. Future research should seek to develop the amalgamation of the circular economy literature and transitions theory, so that the circular economy can be conceptualised as an innovative niche to help it proliferate the mainstream. The core ideas in article two could be extrapolated into implementation research and a business model. This is something the researcher hopes to pursue. If a third party were to execute the findings, the research would have to address the following issues in greater detail: the development of a fully-fledged business model, securing the supply of filter sheets, financing procedures, training and implementation of the enterprise. If Distell were to implement the findings as an in-house activity or enterprise development opportunity, there would need to be more research of the appropriate institutions, policies, financing and skills development.

In the introduction to this thesis it was stated that this thesis responds to the agenda set out by the Ellen MacArthur Foundation to accelerate the circular economy. This thesis has responded by

investigating an innovative conceptual tool that uses the language of the MLP to guide the circular economy toward more systemic change. The researcher used these tools to guide the transdisciplinary research at Distell, which led to the discovery of a circular intervention with potential for implementation across the Western Cape wine industry, which may boost the positive environmental, economic and social benefits province-wide if implemented.

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