Introducing the circular economy with the help of systems thinking in regional areas

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INTRODUCING THE CIRCULAR ECONOMY WITH THE HELP OF SYSTEMS THINKING IN REGIONAL AREAS

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Submitted in partial fulfilment of the degree of Master of Sustainability:
Sustainable Regional Development

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"We cannot solve problems by using the same kind of thinking we used when we created them."

- Albert Einstein

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Glossary of Terms

ABV – Alcohol by volume.

AD – Anaerobic digestion.

BOD – Biochemical oxygen demand.

CATWOE – Customers, actors, transformation, worldview, owners, environment.

CE – Circular economy.

Charge – Total volume of ingredients (raw and liquid) put into the still for distillation.

CHP – Combined heat and power.

COD – Chemical oxygen demand.

DE – Doughnut economics.

DELWP – Department of Environment, Land, Water and Planning.

DWW – Distillery wastewater.

EE - Eco-economics.

EPA – Environmental Protection Agency.

Gypsy distiller – a person who hires still time to distil their own products.

LALs – Litres of pure alcohol.

LCA – Life cycle analysis.

Heads – First liquid captured from distillation process. Contains volatile chemicals such as phenols compounds and esters (flavour compounds).

Hearts – The middle cut of the distillation process that is kept.

HRE – Holistic rural ecosystem.

NGO – Non-governmental organisation.

North Central CMA – North Central Catchment Management Authority.

PQR – soft systems method – P: what, Q: how, R: why.

R&D – Research and development.

SDGs – Sustainable Development Goals.

Spent Botanicals – assortment of organic products such as flowers, herbs, roots, bark, and fruit peel.

Spent Lees – Liquid residue remaining in still after distillation has been completed.

SSM – Soft systems methodology.

SVA – Spirits Victoria Association.

Tails – Last portion of liquid captured from distillation. Low alcohol, unwanted flavours, and aromas.

TSS – Total suspended solids.

Abstract

The navigation towards a circular and ecologically resilient future requires a fundamental shift in thinking at all levels of society. However, one of the greatest obstacles, slowing this transition, stems from the persisting neoliberal narrative which has influenced policy development, how communities live their lives and how business is undertaken. With pressures mounting in the face of climate change, the concepts of the circular economy, doughnut economics and eco-economics have begun to challenge the mainstream, neoliberal view as a viable way to operate. In particular, the circular economy has emerged within the Australian policy landscape as a means to reshape decision making, production and consumption systems, and modes of doing business.

This thesis discusses and explores the layers of difficulty experienced when introducing the circular economic concepts to an industry, such as craft spirit manufacturing, where the adoption of these principles is not commonplace. Much of the literature to date, regarding circularising the distilling industry, has used a scientific or hard systems lens to solve a technical issue. Through the employment of a multimethodological systems thinking approach that focuses on soft systems methods, the distilling and olive industries in regional Victoria were analysed. This approach has allowed for a deeper appreciation of the surrounding influences and issues experienced. By mapping out the systems of both industries, key learnings have surfaced on how challenges can be overcome if holistic socioecological objectives drive the decision-making process.

1. Introduction

The transformation of attitudes and actions that lead towards an ecologically resilient future is a challenging undertaking, but one that urgently needs confronting at all levels of society and industry. Population expansion, urbanisation, increased production, consumption, and waste generation have amplified the impacts of global warming worldwide, with Australia being “highly vulnerable to the impacts of climate change” due to the economy’s reliance upon resource and carbon intensive sectors (Christoff 2014, p. 235; OECD. 2019). The ecological, social, and economic consequences already experienced highlight an assortment of conflicting attitudes expressed by policymakers, industry and the community which undermine appropriate green strategies, that mitigate the effects of climate change, from taking place (Measham et al. 2012; Wiedmann et al. 2020). The pursuit of endless growth and malconsumption have ensured that waste streams continue to rise. Australia produces approximately 76 million tonnes of waste annually, and still maintains “a strong dependence on landfill as its primary means of waste management” (ABS 2020; Australian Government 2020; Vella 2019, p. 266). Although political priorities have begun to be reframed - with discourse leaning towards a shift to a circular economy – to date, no definitive plan has been developed that will curb our reliance on landfills. In Victoria, the waste management sector is undergoing a major overhaul, primarily in response to the Chinese National Sword Policy, but much of these circular policy initiatives will not be realised for some time, raising concerns about the remaining landfill capacities across the state – forecast to be exhausted by 2026 (Jones 2020a; VAGO 2021). Historically, the Federal Government has opted for a “hands-off non-regulatory stance” leaving state and local governments to manage it themselves. This has created a fragmented assortment of approaches to waste management across the country and a “reinforced preference to landfill” (Jones 2020a, p. 220; 2020b, p. 17). The management of waste has become the responsibility of a local government to oversee. Innovative regional development that advocates for local, decentralised solutions often fails to gain traction due to a lack of funding and constitutional power (Jones 2020a). Many opt to outsource the obligation to a limited number of private providers, often outside of the regions themselves, resulting in higher costs, public distrust, ad hoc responses, with reduced transparency and oversight across the state (Tobin & Zaman 2022; VAGO 2019, 2021).

Peripheral regions also face additional challenges of inadequate infrastructure, services and amenities being unable to keep pace with their communities. "How and where we live, work and recreate has changed" - capital city residents moving to regional areas, aging populations and youth migration - due to limited employment and educational opportunities - has placed additional pressures upon local governments to ensure they can create an environment that can sustain regional communities into the future (Centre for Population 2020; Foster et al. 2013, p. 51; Houghton 2019). The imperative to identify and attract innovative new industries, knowledge and skills to a region is a priority to ensure migratory pressures can be alleviated and regional prosperity achieved.

Australia's prosperity is underpinned by its exploitation of natural resources, with the industrialised "treadmill of [agricultural] production" playing a key role within rural communities. This, in turn, generates a significant amount of organic waste through production and processing, which places a strain upon fragile ecosystems (Horlings & Marsden 2011, p. 444; Mateo & Maicas 2015; Sarkodie et al. 2019). With the world's population set to hit 9.7 billion by 2050, pressures such as climate change, resource depletion, biodiversity loss and water scarcity - already felt by peripheral communities - will only continue to increase (Park, Howden & Crimp 2012; Sarkodie et al. 2019). For regional industries and the community, waste streams can represent sizable, ongoing costs, with many enterprises, being reluctant to deviate from the neoliberal "take, make, use, waste" mindset which mistakenly dismisses environmentally responsible practices as economically unviable (Ormazabal et al. 2018, p. 157; Sartal, Ozcelik & Rodríguez 2020). Historically, policy discourse and decision-making for regional areas in Australia has been undertaken outside of the regions themselves, often with little understanding of the impacts created within peripheral communities, with proposed benefits unevenly dispersed (Stimson 2011). Today, policy discourse has begun to be framed around circularity and reducing emissions with Prime Minister Albanese upping the ante on his conservative predecessors by passing legislation to combat climate change (Martin 2022). This represents new opportunities to restructure and move towards a circular economic model that supports the ideals of sustainable development, but it also requires a "fundamental shift in economic values and procedures by policymakers, businesses and consumers" (Arauzo-Carod, Kostakis & Tsagarakis 2022, p. 256; Ghisellini & Ulgiati 2020). Viewing waste streams as an opportunity, rather than a hinderance, facilitates new ways to shape regional prosperity through the enhancement of adaptive capacity, resilience and partnerships (Marsden 2016). However, due to the top-down policy actions of the past, decisions will need to be considered and tailored specifically to regional circumstances – as a one size fits all approach cannot always be applied. Regional networks are complex, and consideration needs to be given to the people and industries that reside within them. Understanding a region's strengths, constraints and spatial connections is a key factor in the transition towards becoming a resilient, sustainable regional city (Arauzo-Carod, Kostakis & Tsagarakis 2022).

Multifunctional agri-business and manufacturing pathways have begun to emerge across Australia, with the craft spirit industry beginning to flourish. This has garnered the attention of both state and federal governments which have pledged grant funding for facility upgrades, export opportunities and improved cellar door experiences to boost the tourist economy (Haydar 2022). Presently, over 60% of spirit producers are located within rural and regional areas across Australia and all are playing their part in revitalising local economies through purchasing produce from local agri-businesses, job creation and attracting visitors to the area (Spirits & Cocktails Australia & Australian Distillers Association 2022). However, an undesirable side effect of a new industry emerging is the resultant waste streams from production. This presents a complex challenge for distillery businesses and the regions they reside within – what happens to the waste? And how can we make better use of it? We all, generate waste streams, often with little regard for where it ends up after we are finished with it. Headlines pertaining to sustainable development, environmental destruction, climate change, projected warming of 4°C are constant reminders that society's actions have set us on a destructive path (Christoff 2014). For individuals, businesses, and the wider community the shift towards a circular mindset can be quite daunting. The sense of overwhelm produced can be paralysing with resultant inaction on unfamiliar processes. Determining the correct path forward is not a straightforward process – with conflicting governmental policies and regulations, many businesses struggle with the "strategic choice of structurally implementing sustainable and inclusive business practices" (Roobeek, De Swart & Van Der Plas 2018, p. xiii).

The project seeks to ascertain what is the best way to introduce the concepts of the circular economy to an industry, such as spirits manufacturing, where the adoption of these principles is not commonplace. A potential sticking point in the facilitation of a transition to a circular model is the notion of zero waste. As such, this research seeks to better understand the types of organic waste streams that are generated within the operation of an agri-business, determine what is current practice in the management of these waste streams and assess whether circular waste practices can be adopted. Undertaking a case study approach, the study will analyse the insights gained from a craft distilling operation and olive producer in the Greater Bendigo region, to determine if any potential synergies exist in the management of organic waste streams that can assist in the transition towards sustainability and the zero waste ideals of the circular economy. Drawing upon the insights gained from the case studies, a purposeful activity model will be devised to assist in the navigation towards a circular business model.

The structure of this thesis is organised as follows. The first section examines the shift in thinking towards a sustainable and circular economic model within the Australian context. The second section shows the juxtaposition between three theoretical paradigms – the circular economy, doughnut economics and eco-economics. Each paradigm's strengths, weaknesses and application in practice will be discussed culminating in the conceptualisation of a holistic rural ecosystem to help shape the decision-making process. The third section presents the Australian distilling industry, the waste streams it produces and analysis of its components and management using international experience as a guide. Section four introduces the multimethodological analytical framework that the author has utilised to gain new perspectives on the problematic situation. Utilising system thinking approaches, the fifth and final section examines the case studies of the distilling and olive industries to develop a purposeful activity model that will facilitate discussion and provide possible pathways in the transition towards a more circular future for the distilling industry.

2. Paradigms of Change

During the post-war era, Australia's economy, like much of the world, has operated within a capitalist, neoliberal framework which has shaped government policies, how we live our lives and how we treat the planet (Barreiro-Gen & Lozano 2020; Raworth 2017). This linear model is framed around the pursuit of never-ending financial growth, short-term gains, inequality and malconsumption. All of this has created a milieu in which society considers itself separate from nature and able to operate beyond the boundaries of the living planet (Steffen et al. 2015; Waddock 2020). Attempts have been made to curb waste and protect the environment, however, these efforts have "often failed to impact on the strain [placed upon] natural resources" due to the mainstream assumption of infinite resources and the encouragement of endless consumption (Philp & Winickoff 2018, p. 6). With mounting concerns relating to climate change, native flora and fauna facing extinction and pending ecological collapse, the concepts of the circular economy, doughnut economics and eco-economics have begun to challenge the mainstream, neoliberal view as a viable way to operate.

The following concepts represent a potential paradigm shift in how businesses, society and government view their consumption and waste practices. Having a sound understanding of these concepts is essential to ensure that a cohesive conceptual framework can be established. This will enable entities to transition to a circular approach that encourages transformational change in problematic situations.

2.1. The Circular Economy

The origins of the circular economy (CE) stem from two core sources. Industrial ecology (the examination of production processes and energy flows through an industrial system via an ecosystem lens) and from a paper written by Boulding (1966), which formulated much of the insights upon which the CE paradigm is now derived (systems thinking, the tragedy of the commons, issues associated with production and consumption, and the emphasis that humankind now lives within a closed system with finite resources) (Ekins et al. 2019; Korhonen et al. 2018). Since 1966, these themes have continued to evolve, however it was not until the presentation of the Brundtland Report in 1987, and the subsequent emergence of the Millennium and Sustainable Development Goals, that the idea of CE gained traction. CE has drawn upon a diverse set of ideas - "…cleaner production, product-service systems, eco-efficiency, cradle-to-cradle design, biomimicry…natural capitalism, zero waste and others" (Brundtland 1987; Korhonen, Honkasalo & Seppälä 2018, p. 39; United Nations nd). Due to the heterogeneous collection of ideas that have mounted over the years, CE represents a "definitional quagmire" with little consensus on what a universal definition or theoretical framework should be (Table 1) (Corvellec, Stowell & Johansson 2022, p. 422). This has come about, principally from policy and business strategists promoting their narrow version of the concept without due consideration of a holistic approach and adequate investigations into potential limitations (Korhonen et al. 2018; Suárez-Eiroa et al. 2019).

Definitions	Source
"A regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, and recycling."	(Geissdoerfer et al. 2017, p. 759)
"The circular economy is an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output to maximise ecosystem functioning and human well-being."	(Murray, Skene & Haynes 2017)
"An industrial economy that is restorative or regenerative by intention and design."	(Ellen MacArthur Foundation 2013, p. 14)
"Operating the economy in closed circles or loops that ideally require only the input of energy derived from renewable sources. It optimises utilisation of resources by cascading (e.g. reuse, refurbishing and recycling) materials through consecutive stages of value extraction."	(Kristensen, Kjeldsen & Thorsøe 2016, p. 757)
"CE is a sustainable development initiative with the objective of reducing the societal production-consumption systems linear material and energy throughput flows by applying materials cycles, renewable and cascade-type energy flows to the linear system. CE promotes high value material cycles alongside more traditional recycling and develops systems approaches to the cooperation of producers, consumers, and other societal actors in a sustainable development work."	(Korhonen et al. 2018, p. 547)
"Circular economy is a regenerative production consumption system that aims to maintain extraction rates of resources and generation rates of wastes and emissions under suitable values for planetary boundaries, through closing the system, reducing its size and maintaining the resource's value as long as possible within the system, mainly leaning on design and education, and with capacity to be implemented at any scale."	(Suárez-Eiroa et al. 2019, p. 958)
"The circular economy is an economic system that represents a change of paradigm in the way that human society is interrelated with nature and aims to prevent the depletion of resources, close energy and materials loops, and facilitate sustainable development through its implementation at the micro (enterprises and consumers), meso (economic agents integrated in symbiosis) and macro (city, regions and government) levels. Attaining this circular model requires cyclical and regenerative environmental innovations in the way society legislates, produces, and consumes."	(Prieto-Sandoval, Jaca & Ormazabal 2018, p. 610)

Table 1: Varying definitions of CE

The most commonly used definition comes from NGO - the Ellen MacArthur Foundation (2013, p. 7), which states that the aim of CE is to regenerate and restore the industrial system by rethinking how products are made and used, by "designing out waste" and extending a product's lifecycle, through the use of renewable energy, product reuse and remanufacture. The CE contains two circular loops – which relate to biological and technological cycles - with the linear economic framework contained within the centre of the diagram (Figure 1). Rather than continuing a linear path from design through to disposal, each loop aims to keep a product's nutrients or components within the economic system for as long as possible. This is achieved through the restoration or sharing of technical nutrients or the thoughtful design of biological nutrients, designed to return to the environment and recapture value at "each stage of decomposition" (Ellen MacArthur Foundation 2013; Kristensen, Kjeldsen & Thorsøe 2016; Raworth 2017, p. 220).

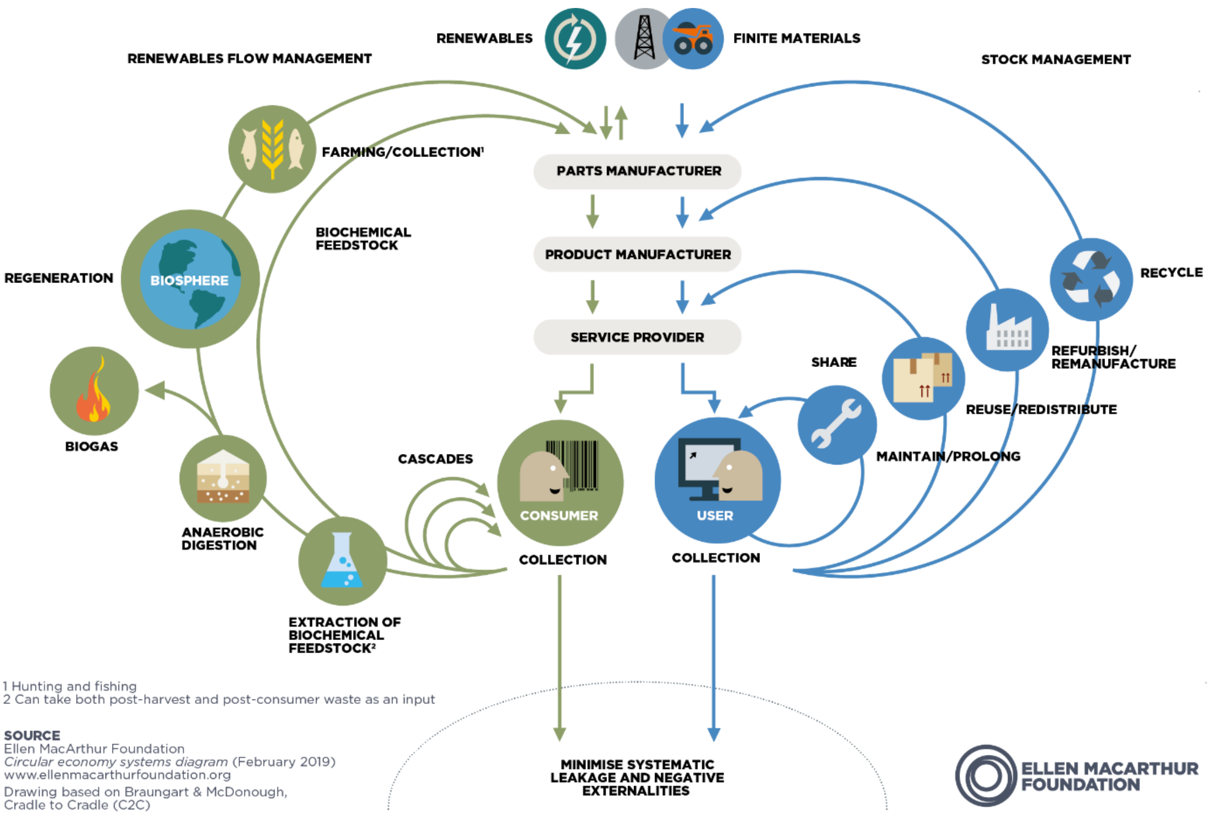

Figure 1: Circular economy systems diagram Source: (Ellen MacArthur Foundation 2019)

Within the Australian context, CE principles have begun to emerge in South Australia, Victoria and Tasmania (Global Australia nd). Unlike the direction taken in many European countries, in Australia, the transition to CE principles has been slow due to the country's reliance on fossil fuels and landfill (Taylor 2022; Vella 2019). With the appearance of a new waste management policy directive – *Recycling Victoria: a new economy policy* – there has been a shift to CE thinking, resulting in a dramatic overhaul of attitudes to waste management practices in Victoria. However, this has been a reactive rather than proactive stance as up until 2020, there had been a six-year hiatus of any policy direction on waste management - due to an overreliance of shipping the state's recycling waste overseas (Jones 2020a; VAGO 2019). According to Parry-Husbands et al. (2020, p. 9), Australian business is willing to transition towards the CE, however knowledge gaps exist for many due to an incomplete understanding of the CE and equating it to "improved recycling," and nothing more. This highlights the need for educational programs to be implemented at all levels of the community. Additionally, prior to the State Government's CE directive being unveiled, it was region specific waste and resource management groups who were tasked with the coordination and management of these services. However, with the new policy, these groups have been absorbed back into the state led department, Recycling Victoria (Recycling Victoria 2022). Whilst representation for peripheral communities remains, actions and proposed infrastructure directly pertaining to the regions themselves is unclear.

Whilst the CE offers inspiration and a win-win scenario for policy makers, businesses, the environment, and the community to aspire to, its promotion of a simplistic, completely circular, no waste economy is not attainable. "A circular economy future where waste no longer exists, where material loops are closed, and the place products are recycled indefinitely is therefore, in any practical sense, impossible" (Corvellec, Stowell & Johansson 2022, p. 423). Nothing lasts forever - entropy causes energy and materials to dissipate over time and this inevitably limits the number of times something can truly be circulated through the system (Korhonen, Honkasalo & Seppälä 2018; Raworth 2017). Additionally, many of the sustainable opportunities promoted may have unintended repercussions for the environment – deforestation of large areas and biodiversity loss to make way for biofuel production; the mining of rare earth metals for green technologies; biopolymers and bioplastics unable to biodegrade; rebound effects occurring from production efficiencies and subsequent savings - resulting in increased consumption, rather than a decrease (Atiwesh et al. 2021; Korhonen, Honkasalo & Seppälä 2018; Murray, Skene & Haynes 2017).

Much of CE's adoption has been in response to the Sustainable Development Goals (SDGs) and the necessity to address the pillars of sustainability (people, planet and profit) to "meet the needs of the present without compromising the needs of future generations" (Brundtland 1987, p. 43) but there has been minimal focus placed upon the social domain, with employment being the only objective (Murray, Skene & Haynes 2017). The implication is that, if the economic and environmental aspects are the key focal point, social benefits such as wellbeing will then trickle down as a result. However, the "main beneficiaries of the CE appear to be the economic actors that implement the system", not the people who live within it (Geissdoerfer et al. 2017, p. 764; Murray, Skene & Haynes 2017). Development continues to be uneven which undermines the holistic view of the SDGs. CE has shown promise as it provides a new way of thinking which has encouraged many governments and businesses to advocate and adopt sustainable practices, with Europe (especially France) and Japan leading the way (García-Sánchez et al. 2021). However, without consensus on its overarching definition, it is not a panacea. Utilisation of this framework alone is insufficient to enact long-term, meaningful change, as "governments have often used CE as a narrative device for greenwashing" and have been still heavily focused upon economic growth and consumption by utilising technocratic solutions, with little priority placed upon waste avoidance (Friant, Vermeulen & Salomone 2020, p. 1). "If the current consumption culture will not change, CE will remain as a technical tool that does not change the course of the current unsustainable economic paradigm" (Korhonen, Honkasalo & Seppälä 2018, p. 43).

2.2. Doughnut Economics

Like CE, the Doughnut Economics model (DE) illustrates that our current economic system is outdated and needs dramatic transformation to contend with the dire problems facing society and the environment in the 21st century. Conceived by Kate Raworth, DE is a multi-dimensional approach that looks at how humanity can thrive and prosper in balance with the planet – it considers the social and ecological wellbeing as fundamental elements which are deeply embedded within an economy (Raworth 2017; Wahlund & Hansen 2022). Drawing upon the SDG's and Rockström et al. (2009) Planetary Boundaries, the doughnut provides a holistic, visual representation of the two fundamental concepts in the shape of a compass designed to guide humanity in the 21st century (Figure 2) (Raworth 2017).

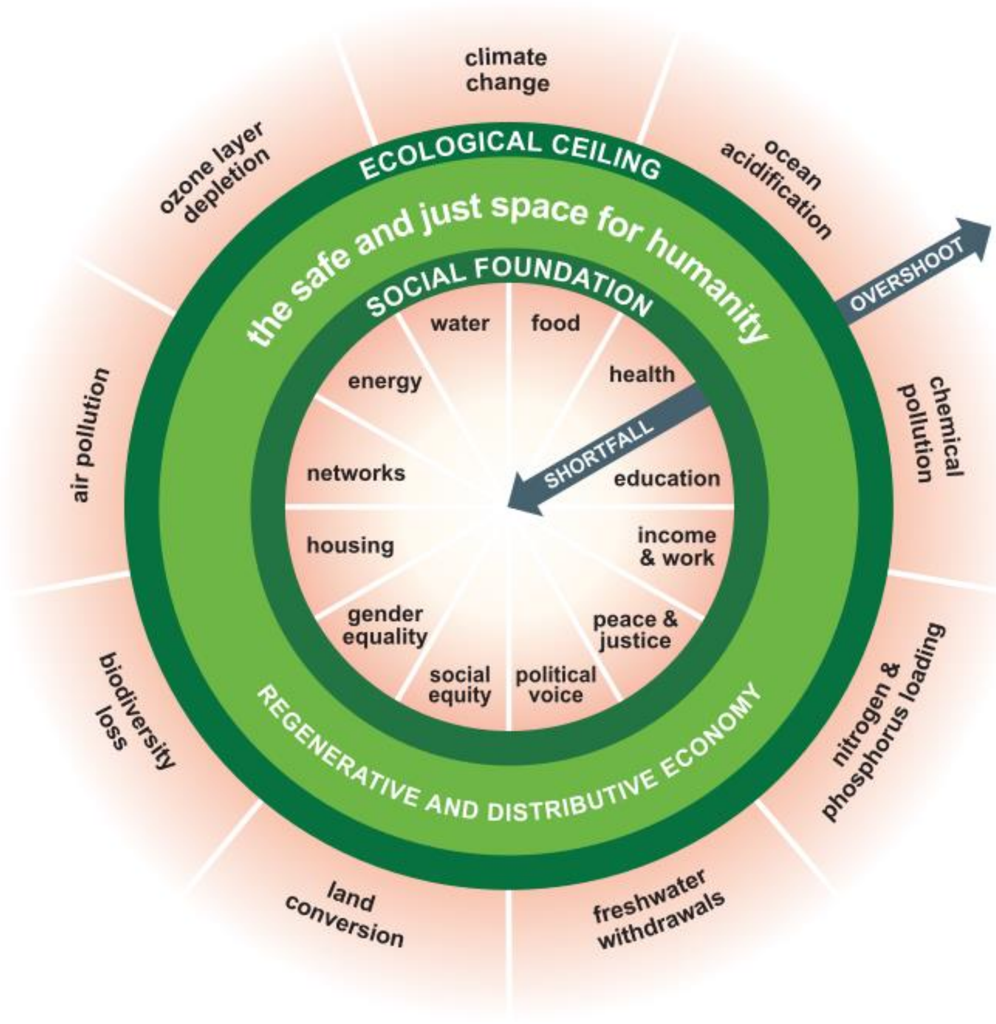

Figure 2: The doughnut of social and planetary boundaries Source: (DEAL 2022c) © [CC BY-SA 4.0]

The doughnut stands as an “orientating metaphor” that shows a potential future that humanity can strive for (Raworth 2017; Wahlund & Hansen 2022, p. 171). Outside of the doughnut’s social foundation is a representation of the shortfall in meeting humanity’s essential needs – food and water security, a place to live, access to education, health care and human rights. The space beyond the ecological ceiling represents the degradation of the living world and interconnected tipping points. Between the two boundaries resides “the ecologically safe and socially just space for humanity” (Raworth 2017, p. 45). The objective is to be a regenerative and distributive economy, where no one falls short, and the planet is protected for future generations. Globally, many thresholds of the doughnut have already been breached (Figure 3).

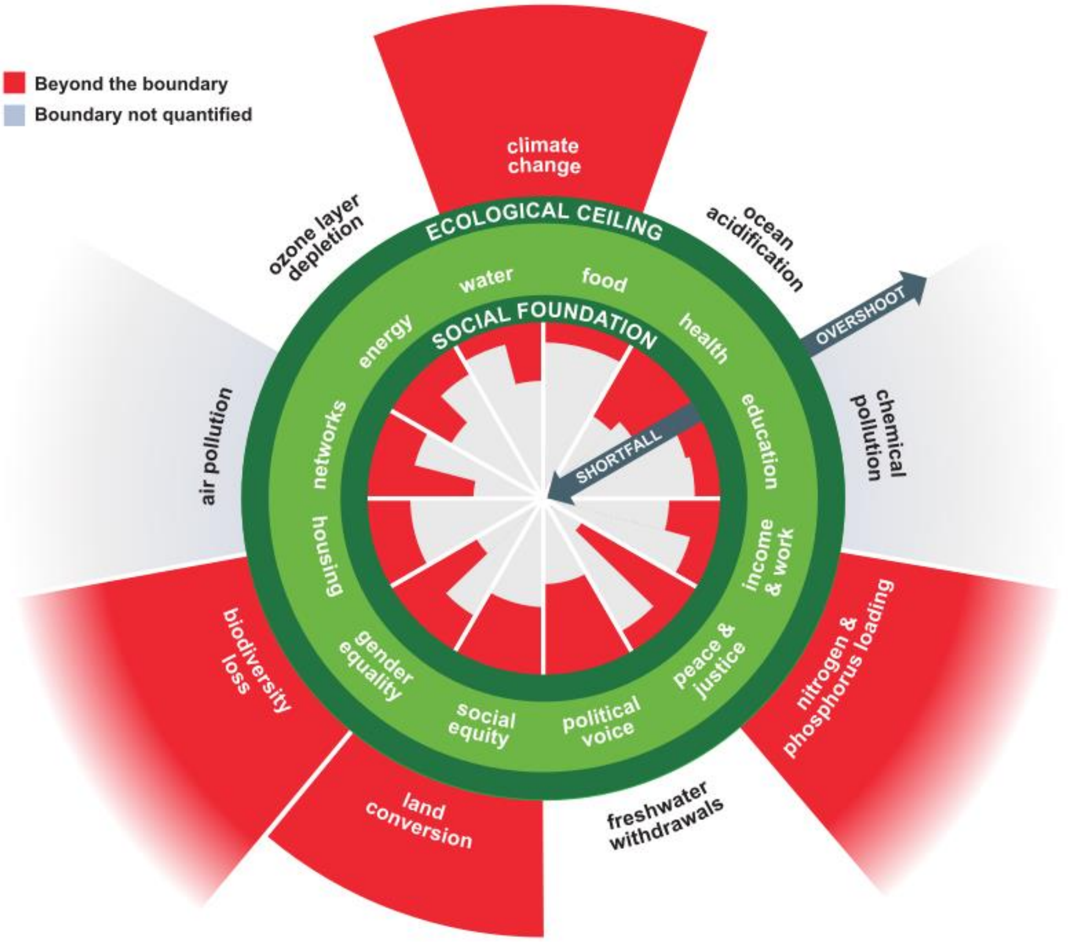

Figure 3: Transgression of the ecological ceiling and social boundaries of the doughnut

Source: (DEAL 2022b) © [CC BY-SA 4.0]

Raworth offers seven notions to help reframe our thinking for the 21st Century in order to secure a more sustainable future: "changing the goal, seeing the big picture, nurturing human nature, adopting systems thinking, distributing wealth and knowledge equally, encouraging regenerative design and being agnostic about growth" (Raworth 2017, pp. 26-30). In essence, society's success cannot be simply measured by financial outcomes but more broadly in its efficacy at meeting the needs of all within the boundaries of the living earth. This can be achieved when a region is studied holistically through interconnected partnerships of collective knowledge and collaboration that aim to regenerate and protect the environment. Amsterdam, Philadelphia, and Portland have been the first cities to pilot the DE framework, via the Thriving Cities Initiative in 2019. Amsterdam has since announced its adoption of the DE framework into future policy development, with many regions across the globe following suit, including Melbourne (DEAL 2022a; Regen Melbourne 2021). Through the creation of a "City Portrait" the doughnut can be tailored for a region by developing a "holistic snapshot of the city and its impact through four lenses – social, ecological, local and global" (DEAL et al. 2020, p. para 3). This helps to prompt discussion and shape policy development and a vision for the future.

Opponents of DE argue that many of the concepts presented within the model are very idealistic and naïve. There is a lack of critical analysis within Raworth's ideas about how they can be executed in practice – "it suffers the same deep problem that has plagued economics from the beginning: an unfortunate and confusing mixture of positive and normative considerations. Most of her policy prescriptions are based on beliefs, hopes and convictions, rather than serious empirical analysis" (Schokkaert 2019, p. 130). Whilst DE suggests that humans are altruistic in their intention, doubts remain about whether the masses are in fact, willing to change but are instead self-centred, addicted to financial growth and quite comfortable in remaining with the status quo (Milanovic 2018). Critics contend that the ambitious goals set forth in DE for social and environmental balance cannot be realised without continued GDP growth (Buckley 2021; Milanovic 2018; Schokkaert 2019). Some assert that DE can never be realised with the capitalist model still being the dominant ideology. However, others contradict this sentiment by stating "rather than constructing a 'mainstream' strawman and kill it", lessons can still be learnt with mainstream economics and can be utilised as a coherent framework to tackle problems (Schokkaert 2019, p. 131). Others raise concerns of socialist undertones and in relation to the doughnut being implemented in Amsterdam, the expectation of immediate results and subsequent criticism when initiatives take time to be fully realised (Teicher 2021). Whilst a firm methodological framework for the creation of the City Portrait has only recently been developed, it is not prescriptive and requires the adoption of an iterative approach. Each location is unique in its experience and challenges, therefore solutions to problematic situations need to be specifically tailored. DE encourages a new way of thinking which aids a community to begin dialogue on how humanity can strive to live in balance (DEAL et al. 2020; Ross 2019).

"Rethinking economics is not about finding the correct one (because it doesn't exist), it's about choosing or creating one that best serves our purpose – reflecting on the context we face, the values we hold, and the aims we have" (Raworth 2017, pp. 22-3).

2.3. The Eco-Economy

In contrast to the CE and DE approaches, the eco-economy focuses upon a rural context, utilising a sociological lens which pays close attention to agro-food networks, their activities, and interconnections in order to help shape sustainable, ethical and resilient spaces (Kristensen, Kjeldsen & Thorsøe 2016). This is of particular importance as peripheral, regional communities are fundamental to Australia's prosperity with their abundance of natural resources and production spaces. However, often little regard is given to the fragile ecosystems they inhabit (Kitchen & Marsden 2009). The eco-economy paradigm (EE) emerged from the amalgamation of three ideologies - ecological economics, eco-system services and ecological modernisation - to better understand the complexities of regional development and to challenge the treadmill of intensive agricultural production. A benefit of the EE is that it seeks out multifunctional pathways to enhance and restore the environment. This is in contrast to the place-less, technological remedies presented by the circular and bioeconomy frameworks, which "treat space and nature as a vehicle to be manipulated 'from above', without accounting for its ecological and socio-cultural diversity" (Marsden 2016; Marsden & Farioli 2015, p. 335; Sposito, Romeijn & Faggian 2016). The basis of the rural eco-economy consists of three interconnected domains in the shape of an equilateral triangle (Figure 4) – the production of commodities, a region's socio-cultural relationship with the land and resources, and a region's ability to generate value from the use and mobilisation of resources – all equally playing a part in contributing to the economy (Kitchen & Marsden 2009). Through these domains, new development pathways form where collective knowledge and rural activities can be enhanced – ecologically minded conservation and development emerge that strengthens a "regional ecosystem rather than disrupting and destroying it" (Marsden 2010, p. 226). Many regions across Europe and the UK have adopted the paradigm with success (Kitchen & Marsden 2011).

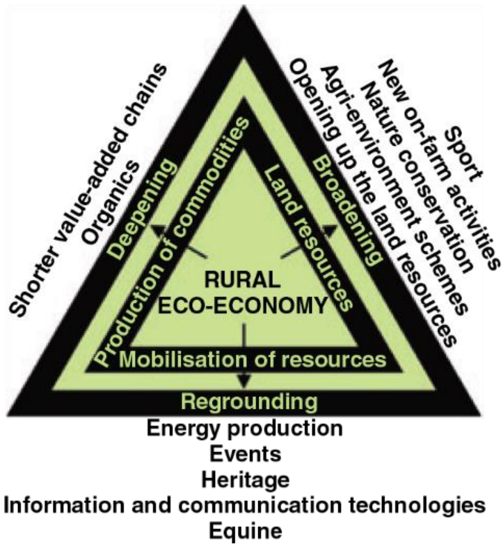

Figure 4: Basis of the eco-economy Source: (Kitchen & Marsden 2009, p. 281)

Building upon the interconnected domains, the EE provides the structure to identify collaborative, place-based solutions with ecological and socio-cultural heterogeneity embedded in its core (Marsden 2010). By identifying a region's rural web, a region can build a sustainable and resilient community that fosters new partnerships, identifies multifunctional pathways, develops social capital and the circulation of knowledge (Figure 5).

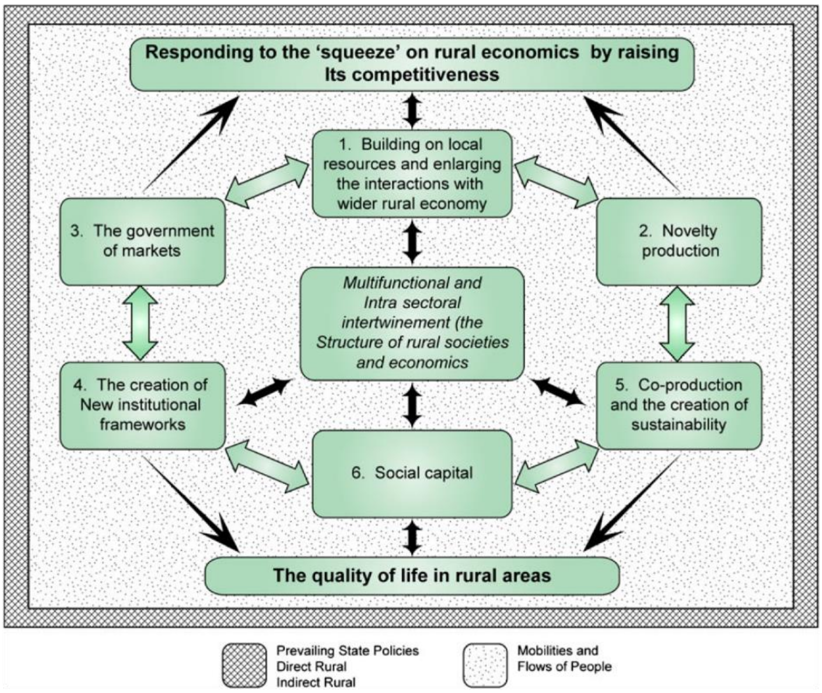

Figure 5: Marsden's conceptual model of the rural web Source: (Marsden 2010, p. 227)

As regional spaces are continually evolving, the six overarching dimensions of the rural web serve as drivers that influence how decisions are made within the regional system – **endogeneity**: the extent to which natural resources underpin and distribute wealth through a regional economy; **novelty production:** the encouragement to develop and experiment with novel ideas which help to shape policy development and partnerships; **market governance:** the skill to manage, maintain and establish new markets unique to the region; **new institutional frameworks:** that draw upon the collective knowledge of a region in partnership with local government to solve problems and devise strategic goals and relationships for the future; **sustainability:** embedding sustainability into the decision making process to ensure the long-term stability and resilience of a community and intertwined industries are maintained; **social capital:** creating a milieu where all actors within a region's community actively engage and encourage one another to improve the region as a whole (Marsden 2010). Through the facilitation of the rural web, a regional community can act as a regenerative, multifunctional and inclusive system that equitably distributes wealth without compromising the fragile landscape for future generations (Knickel et al. 2021).

Barriers to the widespread adoption of the EE stem from path dependency. Policy makers and communities are constrained by the past and are reluctant to change - irrespective of the positive social and environmental outcomes that could be achieved - due to the cost-price squeeze of agricultural production. “Sustainable alternatives are ‘locked out’, because societies are ‘locked in’ to established ways of thinking” (Maye 2020, p. 37). To seek solutions to the complex problems felt by regional communities, policy becomes framed around generalised bioeconomic solutions which are often unfit for purpose. As such, attempts to expand the EE become marginalised in favour of weaker notions of ecological modernisation (Kitchen & Marsden 2011; Knickel et al. 2021; Marsden 2012; Marsden & Farioli 2015). Critics of the EE contend that the economic lens of the EE paradigm undervalues the “entanglement of facts and values” (Christensen 2015, p. 540). Whilst Kitchen and Marsden (2009) assert that collaboration and knowledge sharing does occur throughout the domains of a rural economy, as it is implied in the conceptual triangle (Figure 4). However, some may interpret the sides of the triangle as being domains that act in isolation rather than as a holistic, interconnected community. If interpreted as such, the value of a region’s ecosystem and natural resources becomes reduced to market driven opportunities for the ecologically minded entrepreneur and, rather than considering the possible unintended flow on effects that may occur within a community, the EE undermines the sustainable intentions that it sets out to achieve (Christensen 2015). It is necessary that the rural web framework be used in conjunction with the conceptual triangle to ensure that all elements of a rural community are considered holistically and that decisions are attuned to local conditions.

2.4. Conceptual Framework – The Holistic Rural Ecosystem

The holistic rural ecosystem (HRE) is a conceptual systems approach that amalgamates ideals of the CE, DE and EE approaches with communication, collaboration and knowledge sharing at its core (Figure 6). Whilst each methodology individually has merits, their fusion helps to provide a more robust analytical framework that can be tailored specifically to the regional experience.

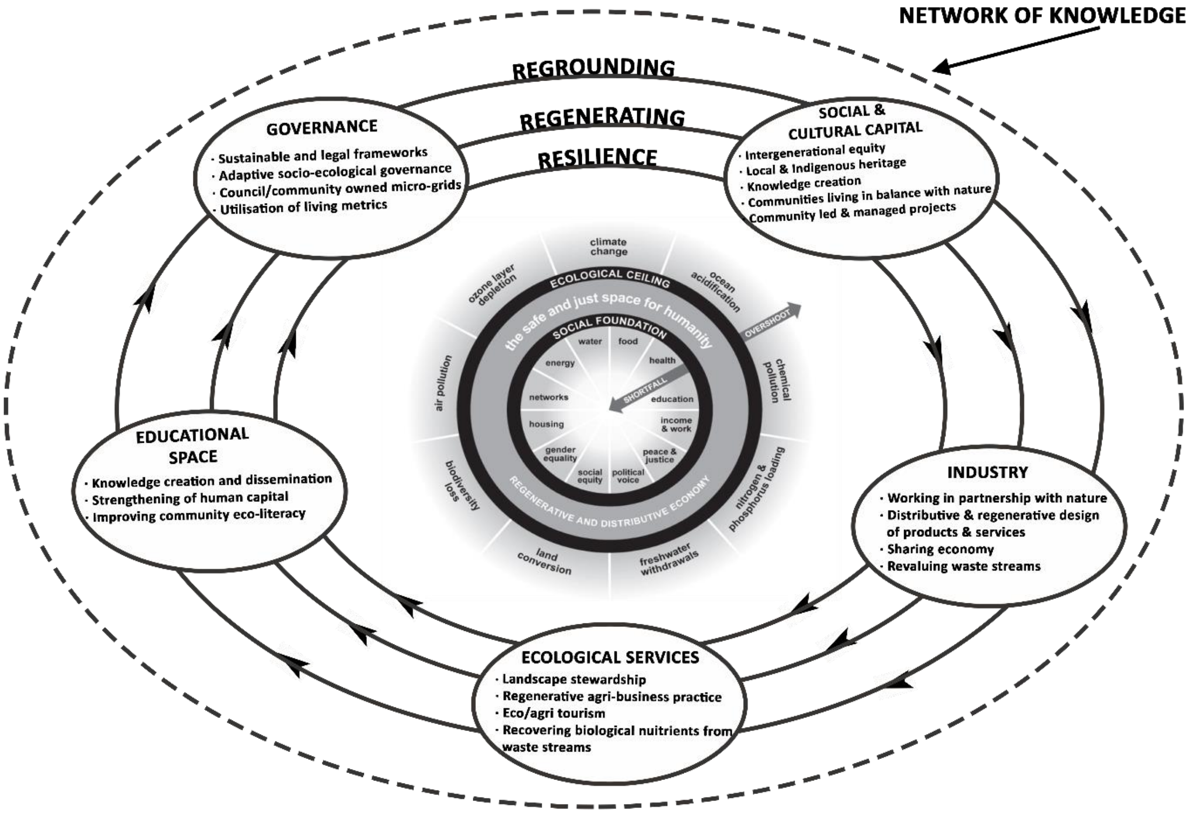

Figure 6: Conceptual framework – the holistic rural ecosystem Adapted from: (Carayannis, Barth & Campbell 2012; Ellen MacArthur Foundation 2019; Marsden 2010; Raworth 2017)

Central to the HRE is the network of knowledge which contains five spheres which all serve as key drivers in the creation of a cohesive, resilient, and regenerative community. By working together, these five interconnected spheres, deeply embedded within societies, facilitate transdisciplinary problem solving. This collective influence shapes the decision-making process to support the emergence of a diverse, innovative, sustainable, and robust rural economy:

- *Social and cultural capital*: the people who reside within the regions matter and have been the direct recipients of top-down policy measures, which historically have not been fit for purpose. A community's lived experience, histories, Indigenous and cultural heritage provide a rich tapestry of knowledge which circulates through the rural ecosystem where innovative place-based solutions can be devised, thus enabling potential place-based solutions.

- *Industry:* working in partnership with nature and the community, distributive and regenerative design of products and services can occur. One industry's waste can be another's treasure - via the network of knowledge, a re-evaluation of waste streams can highlight new synergies where co-products can be generated that divert waste and potentially enrich the surrounding environment of the region.
- *Governance*: adaptive socio-ecological governance assists in the design and administration of sustainable frameworks and green infrastructure which supports community-based initiatives focused upon sustainability, community wellbeing and resilience.
- *Educational space*: lived experience "can be a powerful teacher" (van der Linden, Maibach & Leiserowitz 2015, p. 759). The production, sharing and dissemination of knowledge helps to strengthen a rural community to create a milieu where ecological innovation is encouraged and supported.
- *Ecological services:* "don't bite the hand that feeds you." Historically, rural economies have been built upon the wealth and exploitation of a region's natural resources, moulding landscapes for purpose rather than protecting them. Progress has always been at the expense of the environment. By regrounding communities and reminding them what's important, all actors within the system can become ecological stewards that focus upon the long-term, sustainable ecological development of a region.

At the heart of the framework is the doughnut of social and ecological boundaries, which helps to shape decision making and regions to strive to become regenerative, distributive, and resilient economies. Change is "endogenous, [iterative, and] driven from within" (Eversole 2017, p. 306). Value is circulated throughout the entire system through the establishment of critical connections and partnerships which creates a resilient community, capable of realising its own future.

All three paradigms CE, DE and EE show great promise in becoming an enabler for a sustainable future. Whilst the policy narrative within Australia talks specifically about the ideals of the CE, it has not been issues surrounding climate change that have prompted this shift - the current waste crisis has been the overriding factor (Iyer-Raniga, Gajanayake & Ho 2022; Lee 2021). Rather than viewing it as an opportunity to enable systemic change, policymakers perceive it to be a sporadic, technological solution to be embedded within the existing linear economic system (Kristensen, Kjeldsen & Thorsøe 2016). In terms of the adoption of DE and EE, they have been limited in their practical application as opposed to CE, however both DE and EE advocate for a more holistic, systems based approach to be adopted which places socioecological priorities at the core of the decision-making process (Marsden 2010; Raworth 2017). Through the fusion of the three paradigms, the HRE provides a cohesive network of knowledge where socioecological ideals are embedded at its core. Irrespective of the paradigm chosen, the complexities that society faces need to be addressed holistically and this can only be achieved through place-based, collaborative, cross-sectoral partnerships.

3. Distilling Industry

3.1. Background

The production of distilled beverages possesses a rich history with origins dating back approximately 3,000 years. Initially for medicinal use, spirits quickly transformed into a popular drink for the masses (Cockx, Meloni & Swinnen 2021; Kellershohn & Russell 2015). Today, spirit production equates to 50.7% of alcohol consumption globally, with whisky, vodka and gin being the most prominent within Australia (Anderson, Nelgen & Pinilla 2017; Reeves 2020). Whilst spirit production creates tremendous economic opportunities for producers and distributors, it relies heavily upon the use of agricultural raw materials and energy. Ultimately, the waste by-products produced can be harmful to the environment (Montes & Rico 2021). Developing and manufacturing premium beverages in an environmentally responsible way is a challenge for producers. Market driven, neoliberalist thinking, and the pursuit of endless growth has dominated society's lexicon with the landscape and finite resources being considered secondary to economic outcomes (Frank & Marsden 2016; Marsden 2016). This mindset creates risks for the integrity and resilience of the environment. There is no shared understanding of distilling industry processes by local governments which complicates the regulations imposed on distillers. As such, current waste management measures employed in the distilling industry are a mixed bag due to the great variability in the size, nature, and locations of operation.

As the products and processes vary, determining the best method to handle waste streams can be problematic to implement and monitor. As with any other industry, there are ecological impacts that need to be addressed if society is to become more circular in its approach to achieving sustainability. For spirit manufacturing the following by-products are produced: biomass disposal (spent grains and botanicals'); intensive energy and water use; and the removal of effluent containing a diverse organic load (Golub & Potapova 2018; Hidalgo & Martín-Marroquín 2019). Disposal of wastewater can be onerous and costly due to its heterogeneous composition containing toxic compounds accentuating a need for producers to establish efficient and cost effective solutions (Mosse et al. 2011). With global concern and discourse regarding the anthropogenic effects of climate change dominating the public domain, the quality of the liquid produced can no longer be a producer's prime concern. Their impact on the environment cannot be downplayed. Furthermore, sustainability issues are now influencing the purchasing decisions of the public with consumers expecting transparency about a distillery's ethos, their supply chain, and eco-integrity (Australian Government 2021; Carruthers 2018; Cooper 2019; Hoskin 2018). Therefore, it becomes paramount that spirit producers undertake the responsibility to be proactive in their efforts to identify, design and administer processes that conserve and protect the surrounding environment.

As a means of contending with the environmental impacts spirit manufacturing can create, life cycle thinking offers a hard systems framework for analysis in determining a producer's ecological footprint and how best it can be understood and addressed (Kellershohn & Russell 2015; Saxe 2010). A life cycle assessment (LCA) is a holistic tool that assists decision makers in making the transition towards sustainable production systems. Initially, a review of the production system is undertaken. Then data of the product's evolution from raw material to final state is compiled and quantified, taking stock of a product's inputs, outputs, interconnections and environmental impacts (ISO 2006). Areas of consideration for the beverage producer range from: the acquisition of raw ingredients; distilling practices; energy consumption and sourcing; managing waste streams; water use; packaging and end of life processes (Hoskin 2018; Saxe 2010). The systematic mapping and comparison of scenarios assists producers in making strategic, long-term decisions that create sustainable pathways with reduced environmental trade-offs and risks to the community (Kral, Huisenga & Lockwood 2009). Although valuable, an LCA still has limitations and cannot be used in isolation as the period required to undertake the process thoroughly presents challenges in obtaining consistent data. Beverage production processes and inputs constantly evolve. As soon as an LCA is complete, the data obtained may already be outdated, therefore posing risks to those who perceive it to be a panacea (Singh et al. 2021). "Data and modelling cannot be viewed as the end goal… but rather as a conduit to providing actionable information to stakeholders" (Singh et al. 2021, p. 927).

3.2. Distilling Industry – Australian Context

The distilling industry in Australia dates from the early 1800s, however key legislation such as the *Distillation Act of 1862* in Victoria and the *Commonwealth Distillation Act of 1901* enforcing minimum production requirements to a still capacity of 2,700 litres, favoured large-scale distilleries. This effectively put the brakes on small scale production in Australia (AustLII nd; Australian Distillers Association 2022a; Butcher & Butcher 2021). Due to the lobbying efforts in 1989 of Bill Lark, of Lark Distillery - considered to be the Godfather of the Australian craft spirit industry - elements relating to the still capacity within the act were overturned meaning small-scale distilleries could operate once more (Australian Distillers Association 2022a; Dunn 2019; Lark Distillery 2022). Since 1989, a burgeoning craft industry has emerged, with over 350 craft distilleries in operation today (Australian Craft Spirit & Cellar Door Directory 2021; Spirits & Cocktails Australia & Australian Distillers Association 2022). "Australia is at the forefront of the craft movement… growth is coming from every state and territory in the country – in regional and rural areas and increasingly in cities and nearby suburbs" (IWSR nd, pp. para. 4, 5). The industry generates approximately

2.3 billion in revenue per annum with forecasts indicating an annual growth of 2.0% annually until 2027 (Kartik Jeswanth 2022). For many producers, their entrance into the industry was intended to vary their farming activities, provide another avenue of income and to champion produce unique to their regions and climate. Their efforts have been reaping rewards. Craft beer, gin and whisky have been gaining prestige within the industry since 2010, with many producers such as Starward, Stone and Wood, Never Never Distilling Co and Sullivans Cove winning international accolades for their efforts. This demonstrates that there are potential fiscal opportunities to be attained which could improve the lives and livelihoods for those in many peripheral regions in Australia (Allen 2020; Ho 2019; IWSR nd; Ward 2021; Waters 2019).

In Australia, the following alcoholic beverage production occurs whisky, gin, rum, ethanol, agave, wine, beer; all with varying characteristics contained within their liquid waste streams (Table 2). Across the assortment of products produced, the wastewater characteristics and chemical ranges vary, the only consistent factor throughout being low pH. All are rich in phenolic compounds, which can be beneficial to the environment, however in the quantities presented, without pre-treatment, these concentrated forms can be dangerous to a region's ecosystem and waterways if managed incorrectly (Makadia et al. 2016; Strong & Burgess 2008). Much of the research undertaken on the characterisation of DWW has come from an international perspective, focused upon large scale beverage manufacturing operations.

	Whisky (Lin, Liu & Wang 2020, p. 3)	**Gin** (Montes et al. 2019, p. 44)	**Rum** (Gebreeyessus, Mekonnen & Alemayehu 2019, p. 299)	**Ethanol** (Gayathri & Srinikethan 2019, p. 951)	**Agave** (España-Gamboa et al. 2011)	**Winery** (España-Gamboa et al. 2011, p. 1237)	**Brewery** (Akunna 2015, p. 418)
COD (mg/L)	37,750	168,000	110,000 – 190,000	87,433	55,200 – 66,300	26,000 – 50,200	1,800 – 50,000
BOD (mg/L)	1950	n/a	50,000 – 60,000	20,700	20,600	14,540 – 16,300	2,700 – 38,000
TSS (mg/L)	n/a	n/a	n/a	31,420	n/a	n/a	50 – 6,000
pH (mg/L)	4.0	4.2	n/a	4.3	3.4	3 – 4.2	5 - 11
TKN (mg/L)	n/a	n/a	n/a	n/a	n/a	n/a	20 - 600
(N) Nitrogen (mg/L)	330	1,200	5,000 – 7,000	2,333	n/a	104.9 - 650	n/a
(P) Phosphorous (mg/L)	n/a	300	2,500 – 2,700	90	41	65 – 118.4	4 - 103
(K) (acidity) Potassium (mg/L)	888	42,000	n/a	190	240 – 345	118 – 800	n/a
(SO_4^{2-}) Sulfate (mg/L)	253	n/a	7,500 – 9,000	n/a	780 - 880	120	20 - 50
(Cu) Copper (mg/L)	n/a	n/a	n/a	n/a	0.36 - 4	0.2 – 3.26	n/a
(Cd) Cadmium (mg/L)	n/a	n/a	n/a	n/a	0.01 – 0.2	0.05 – 0.08	n/a
(Pb) Lead (mg/L)	n/a	n/a	n/a	n/a	0.065 – 0.5	0.55 – 1.34	n/a
(Fe) Iron (mg/L)	n/a	n/a	n/a	n/a	35.2 - 45	0.001 – 0.077	n/a
(C6H6O) Phenols (mg/L)	n/a	n/a	8,000 – 10,000	477	44 - 81	29 - 474	n/a
(CI-) Chlorides (mg/L)	n/a	n/a	8,000 – 8,500	n/a	n/a	n/a	n/a

Table 2: Varying compositions of wastewater from beverage production

*n/a – No data available

With the impacts of climate change becoming more intense across Australia and the resultant long-term hardships burdening many people, the need for sustainable operations that address the social, environmental, and economic perspectives in a holistic way has become increasingly evident – producers need to strive for a positive impact and be responsive to challenges that arise within their locality (ABA 2022; Roös 2021; Sacks 2020). This sentiment has been mirrored by the Commonwealth in their *Food and Beverage National Manufacturing Priority Roadmap*, emphasising the urgency of improving "sustainability across the food chain, minimising food waste and adopting circular economy principles" (Australian Government 2021, p. 12). For every bottle of spirit produced, approximately 2.94kgs of CO_2 emissions are generated (BIER 2012). Furthermore, the substantial volume of water required by the spirit producer for production and cleaning purposes, results in a burden being placed upon finite water resources, and also for waste stream disposal (Hidalgo & Martín-Marroquín 2019). To date, approaches to this issue employed by operators have varied "[Ranging] from no treatment at all through to tertiary treatment and the use of processes such as bioreactors" (Kumar et al. 2009, p. ii). From a regulatory point of view, there is no consistent standard relating to distillery wastewater (DWW) that can be applied nationally. This is because regulations can be "adapted by jurisdictions to take account of their own legislative and environmental requirements - they are not intended to provide detailed prescriptive standards" (Australian Water and Wastewater Association 1998, p. 13). Each state operates within a silo, with only South Australia and Western Australia explicitly tailoring policy documentation around winery and distillery waste streams. The resulting situation is a haphazard approach to a serious environmental issue that threatens environmental sustainability if not managed appropriately.

To date, in Australia, research into the effects of beverage production effluent management has only come from a winery perspective, primarily due to the boom in the wine industry in the late 1990s (Goode 2017). This is also evident with effluent management guidelines across the country being mainly focused on wineries with only a tokenistic mention of distilleries. So, there is little guidance offered to distilleries about responsibly managed sustainable practices. There is a gap that needs to be filled by policymakers to be proactive and ensure that the distilling industry has appropriate guidance to be able to responsibly manage waste streams and circularise their businesses. To do that, policymakers need to have a sound understanding of the industry's processes and potential environmental impacts and to tailor policy that considers not just waste disposal but also the organic value still remaining within the industry's by-products (Turunen 2020).

According to Alcohol Beverages Australia (2022, p. 21), over the next 10 year period, market share for the Australian craft spirits category is expected to "create a similar trajectory to wine export growth." However, there are issues associated with this growth that need to be grappled with. Whilst increases to regional jobs and the local economy are welcome news in Australia's current political context, there are hidden costs associated with this growth. There are environmental implications when fragmented state policy frameworks are inconsistently applied to beverage industry waste. The emergence of distilleries across Australia has increased dramatically, therefore it is imperative that regulations and frameworks are clarified to address their needs. How this information is communicated to distillers also needs consideration. For new entrants into the distilling field, with varying knowledge bases, navigating disposal regulations successfully presents challenges for them due to a "complex patchwork of approaches" being applied at varying levels of government and location (Jones 2020b, p. 7). As such, distillery effluent is categorised as a priority industrial waste that requires disposal rather than being viewed as a nutrient rich resource that has the potential to benefit the environment (EPA Victoria 2021b).

Globally - with the bulk of research coming from India, China and the United Kingdom – it has become evident that spirit producers need to minimise their carbon footprint and principal concern at the forefront is the necessity of repurposing of distillery waste (Leinonen, MacLeod & Bell 2018). It has been widely reported within the literature that approximately 10 – 15 litres of effluent are created for every litre of sprit produced (Gebreeyessus, Mekonnen & Alemayehu 2019; Lin, Liu & Wang 2020; Santal, Singh & Saharan 2016; Sridevi, Sivaraman & Mullai 2014). Distillery wastewater (DWW) contains elevated quantities of volatile fatty acids, organic and phenolic compounds in its composition, which contributes to "high chemical oxygen demand (COD) values – up to 60 – 120g O_2/dm^3 and low pH values of up to 3.7" (Anwar Saeed et al. 2018; Gayathri & Srinikethan 2019; Golub

& Potapova 2018, p. 175; Lin, Liu & Wang 2020; Pant & Adholeya 2007; Santal, Singh & Saharan 2016; Sridevi, Sivaraman & Mullai 2014). Without suitable treatments in place, DWW can expedite water eutrophication, compromise soil quality, land use and biodiverse ecosystems, precipitating adverse outcomes for the environment and surrounding population (Makadia et al. 2016; Pant & Adholeya 2007; Sartal, Ozcelik & Rodríguez 2020). Furthermore, as production processes for distilled spirits differ, the effluent created is not common to all distilleries - due to the type of product produced, still configuration and cleaning methods utilised – therefore, the challenges associated with its removal are complex. Solutions need to be tailored specifically for the location and circumstances.

3.3. Anaerobic Digestion and Distillery Wastewater Management

The strategies adopted in the management of DWW have been disparate. These have included: "solvent extraction; adsorption on activated carbon or chitosan; chemical oxidation; filtration; aerobic digestion; activated sludge; the use of wetlands; ponding and land application" (Gebreeyessus, Mekonnen & Alemayehu 2019; Strong & Burgess 2008, pp. 72-4). Each method has merits and drawbacks and the majority have high establishment capital and operational costs. Additionally, traditional practices can be ineffectual, and, in some cases, further toxic compounds are inexorably produced (Hidalgo & Martín-Marroquín 2019). Depending on the size of the operation, the land needed to implement these treatments can be significant, with unpleasant odours being emitted and spent raw ingredients and residue permeating the soil or water table. Small scale or urban distilleries can be constrained by the limited area they occupy so approaches to disposal, used by larger operations on bigger properties, cannot be realised and they are burdened with the significant cost associated with removal from their sites (Hegde et al. 2015).

Anaerobic digestion (AD) has been utilised in Germany (large scale), China (domestic scale) and Africa (small scale AD construction) to be a practical option in managing municipal and agricultural waste streams (Alexander, Harris & McCabe 2019). However, AD technology management of distillery waste has not been widely adopted elsewhere. Scotland is considered an innovator in this arena, with many large whisky operations utilising AD for biogas generation. The Scots have bold net zero targets for the future centred around the use of sustainable energy sources from waste including: biorefineries and the co-digestion of waste (Arnison & Carrick 2015; Gunes et al. 2019; Ricardo Energy & EZWS 2017). They recognise that AD has the potential to offset fossil energy use, provide a clean alternative and reduce waste disposal expenses, whilst having a minimal land footprint (Enitan-Folami & Swalaha 2021; Mohana, Acharya & Madamwar 2009; Sridevi, Sivaraman & Mullai 2014).

AD is a well-established, versatile technology that enables the conversion of complex organic waste streams including agricultural and food wastes, municipal, distillery and industrial wastewaters into energy. AD technologies create a temperate, airtight environment, similar to a stomach, where unique sets of microbes interact in a "symbiotic, synergistic, competitive and antagonistic association" (Mohana, Acharya & Madamwar 2009, p. 14). This flux provides the ideal environment for the archaea microorganisms to decompose waste substrates through fermentation and carbon dioxide (CO^2) to "oxidize hydrogen-releasing methane as a waste product" which can then be harnessed as a clean energy source (Kumara Behera & Varma 2016, p. 36). The AD process undergoes four phases: hydrolysis, acidogenesis, acetogenesis and methanogenesis, with digester temperature and maintaining a stable pH level throughout being prime components for success (Figure 7).

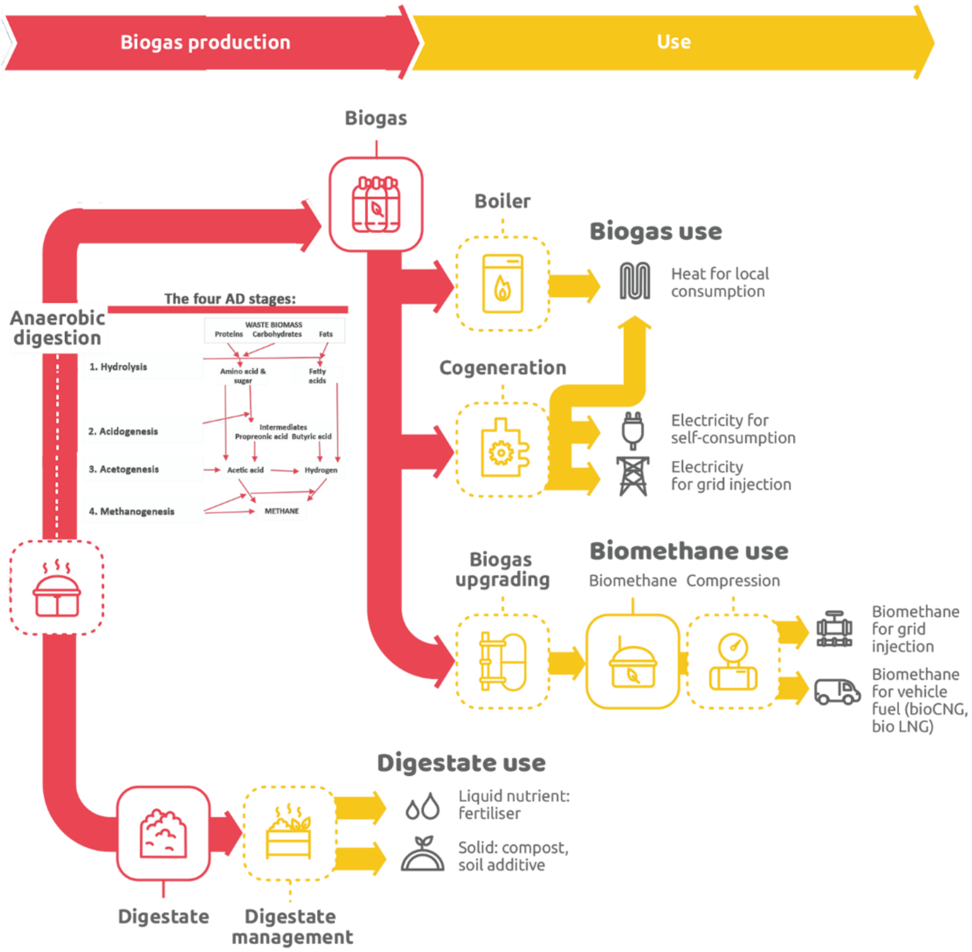

Figure 7: Overview of the anaerobic digestion process Adapted from: (Carlu, Truong & Kundevski 2019, p. 15; Gunes et al. 2019, p. 5; Kumara Behera & Varma 2016, p. 43)

At the hydrolysis stage, thermodynamic reactions occur, where microorganisms convert complex waste streams into smaller molecules such as sugars, amino and fatty acids. Acidogenesis then follows, where the molecules are fermented and refined. Then, the acetogenesis phase commences with bacteria slowly developing acetic acid and hydrogen substrate pathways, thereby creating the ideal environment for the methane production to occur in the methanogenesis phase (Gunes et al. 2019; Kumara Behera & Varma 2016). The methane is then utilised to provide combined heat and power (CHP), importing electricity into the grid, or undergoing further refinement to be utilised as biomethane for fuel or exported to the grid. The other by-product that remains is a nutrient dense sludge which can be used as a liquid fertiliser and soil conditioner.

Untreated wastewater generated from distilled spirit production is very acidic in nature with a low pH value within the effluent, resulting from chemical reactions occurring during production and cleaning protocols utilised (Hidalgo & Martín-Marroquín 2019). Due to DWW's complex nature, a variety of methods and configurations have been investigated to identify further efficiencies in AD performance: granular sludge bed reactors (Lin, Liu & Wang 2020); up flow anaerobic sludge blanket reactors (Enitan-Folami & Swalaha 2021); microbial fuel cells (Makhtar, Don & Tajarudin 2018; Samsudeen, Radhakrishnan & Matheswaran 2015); bioelectrical treatments (Feng et al. 2017); phycoremediation in conjunction with reverse osmosis (Krishnamoorthy, Premalatha & Vijayasekaran 2017); mixotrophic approaches with sewerage wastewater (Nayak, Amit & Ghosh 2018); co-digestion with complimentary waste streams including poultry manure, agricultural wastes, brewery or winery wastes (Golub & Potapova 2018; Hegde et al. 2015; Makadia et al. 2016; Montes & Rico 2021). Regardless of the approach chosen, DWW requires pre-treatment or dilution to ensure the ideal environment is established for effective digestion to occur. Whilst AD technologies require considerable capital expenditure to implement, it provides producers an opportunity to find value within their waste streams, generate a sustainable energy source, offset investment and create environmentally friendly by-products (Hegde et al. 2015; Strong & Burgess 2008; Wzorek et al. 2019). Gebreeyessus, Mekonnen and Alemayehu (2019, pp. 295-300) also maintain that "no single technology can be sufficient to manage stillage", so a multifaceted approach is needed to ensure that DWW's organic potential can be fully realised with minimal harm inflicted on the environment. Within a circular economic context, bioremediation processes such as AD are ranked quite low on the waste hierarchy pyramid (Figure 8) as distillery waste by-products cannot be reutilised in their original state (prior to distillation occurring). There is, however, value within these by-products which should not be downplayed and they need to be redefined as "secondary raw materials" as the high organic content contained within the waste can be transformed into energy and a composting medium that can be returned to the environment to improve degraded landscapes (Philp & Winickoff 2018, p. 12).

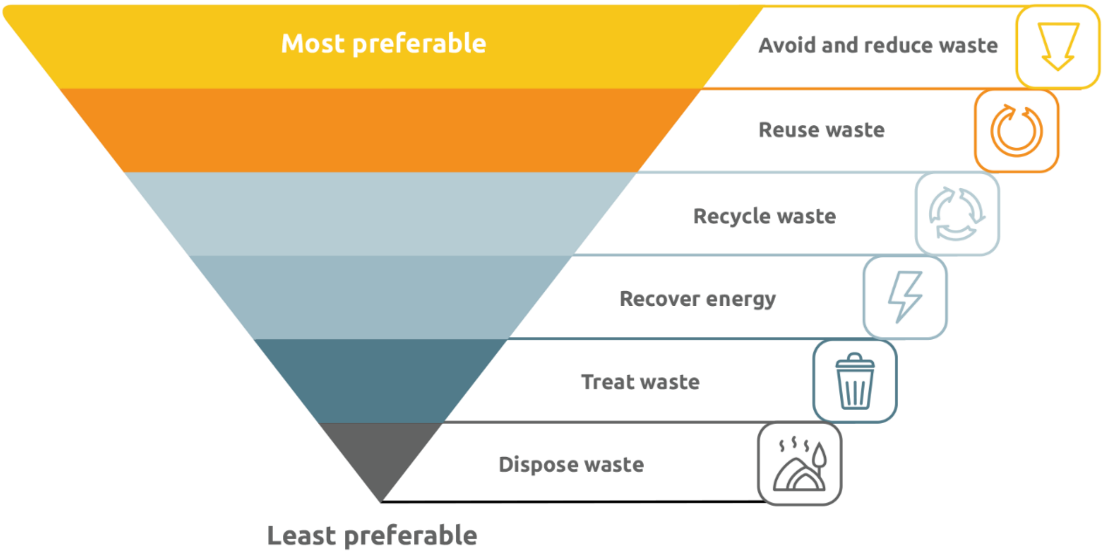

Figure 8: Australia's waste hierarchy pyramid Source: (Carlu, Truong & Kundevski 2019, p. 34)

Although AD offers the potential for distillery waste streams to be disposed of effectively through the recovery of energy via methane production, there are other potential benefits to be derived (Wzorek et al. 2019). Research has identified qualities within DWW that can be used as "nutritional supplements for the production of high-value biomaterials" prior to AD conversions occurring (Gayathri & Srinikethan 2019, p. 950). Bacterial cellulose (BC) has been identified as a promising area of research. Naturally occurring in the environment, cellulose is an essential component within the cellular structure of plants and "microorganisms such as fungi, bacteria and algae" (Wang, Tavakoli & Tang 2019, p. 63). Whilst research in this field shows promise, transforming it into a viable commercial venture is difficult, "due to high fermentation cost, low productivity and expensive culture media" (Hussain et al. 2019, p. 2895). As DWW has a high nutrient content including carbon, nitrogen and phosphorous, it has been identified as a cost-effective substrate for BC growth to occur and in return, lowers the chemical oxygen demand (COD) of the wastewater in the process (Gayathri & Srinikethan 2019; More et al. 2016). As a natural polymer, BC is a valuable material that can be utilised across a diverse range of industries and applications: food packaging, food additives and products, cosmetics and beauty products, regenerative medicine and wound dressings, pharmaceuticals, construction, engineering, textiles, bioethanol production and environmental applications (Hussain et al. 2019; Wang, Tavakoli & Tang 2019).

Aside from DWW, waste stocks from agricultural and industrial processes have been examined as potential mediums for cost effective BC production. These include: ”sugarcane molasses; waste beer yeast; wood sugars; fruit processing waste; lipid fermentation wastewater; dry olive mill residue” (Costa et al. 2017, p. 2). Sharing similar attributes to DWW, olive mill waste presents comparable challenges in terms of ecological impact and disposal. Ling et al. (2019) propose that toxicity of distillery wastewater can be significantly reduced if mixed with waste streams from other industries such as olive growers. Additionally, Huang et al. (2016) contend that the employment of a multiple cultures approach can result in improved BC production. Therefore, a mixed culture of distillery wastewater and olive mill waste - as substrate for biopolymer production and subsequent AD biogas production - is an avenue worthy of exploration, however beyond the scope of this research.

Much of the previous research on distillery waste streams has been focused upon solving a technical problem via a reductionist, or hard systems lens. However, by concentrating on a single feature of an issue, research has not considered all the surrounding complexities and outside influences that could also be contributing to the problem or hindering its resolution. By taking a systems-based approach to the issue of distillery waste, new insights could possibly be uncovered.

4. Methodology and Analytical Framework – why take a systems approach?

Finding solutions to complicated issues has historically been undertaken via a reductionist lens that has narrowly focused upon isolated elements of an issue. Despite a high level of detail being uncovered by concentrating on unique elements, it can be hard to comprehend how they fit together to form a wider perspective of a situation. Use of a reductionist approach often results in unanticipated flow on effects (Checkland 2000; Jackson 2019). Real world problematical situations are not static and simplistic to resolve, additionally, they are multidimensional, in "constant flux, [often] far from equilibrium" (Checkland & Poulter 2006; Hammond 2019, p. 303). Often being referred to as messy or wicked problems, these situations are exceptionally challenging to solve: "a strong political and/or moral focus; no 'right or wrong' finding, but 'good or bad'; no stakeholder consensus and no obvious point at which a solution is reached" (Cordell 2008, p. 2). Systems thinking offers a holistic process of inquiry that can assist in gaining an understanding of a multiplicity of viewpoints and motivations which can be difficult to resolve (Jackson 2019; Midgley 1997).

For this research project, a multimethodological systems approach has been utilised. Sposito's (2021) Rational-Holistic Model of Planning and Decision Making forms the basis of an iterative framework that provides flexibility in being able to tailor the analysis to suit the situation at hand. Drawing upon a mixture of qualitative and quantitative methods from different paradigms, these methods are reinterpreted as tools of analysis and decision making that support the process. To gain a strong understanding of the situation, the author has chosen to adopt Yin's (2018) case study methods, Ulrich's (2020) boundary critique and Checkland and Poulter's (2006) soft systems methods (SSM) into the analytical process to assist in the construction a purposeful activity model that identifies possible actions for sustainable improvement (Figure 9). By opting for a soft systems thinking approach, new insights and interconnections can be uncovered, that would not be uncovered by a hard systems approach such as an LCA. This will enhance our understanding of the system at hand to propose better pathways and sustainable actions for improvement which are continually reflected upon and reviewed (Checkland & Poulter 2020). Due to the scope and timeframe of this research thesis, only the first three stages of the Rational-Holistic Model were undertaken.

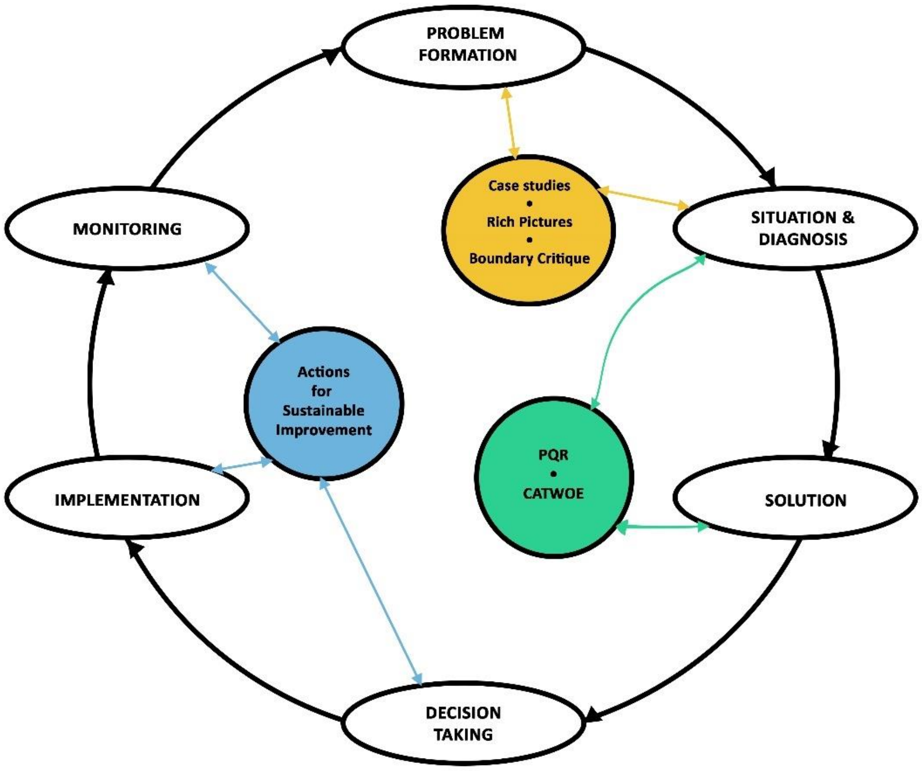

Figure 9: Multimethodological analytical framework Adapted from: (Sposito & Faggian 2021, p. 100)

Guided by the ideals of sustainability, the Rational-Holistic Model is a circular, collaborative planning cycle that consists of six stages which help to create a never-ending process of learning:

1. *Problem formation:* the establishment of aims, goals, and objectives which are framed within the context in question.
2. *Situation and diagnosis:* the collation of data and differing perspectives.
3. *Solution:* the forecasting and proposal of alternative options and evaluating them.

4. *Decision taking:* identifying the best option and setting up action plans and priorities.
5. *Implementation:* putting the best option into practice with relevant support structures to ensure success.
6. *Monitoring:* findings are appraised, key learnings identified, and the process is repeated.

4.1. Data Collection

For this study, data was gathered utilising a mix of primary and secondary resources.

Firstly, a comprehensive review of the current policy environment, as it relates to the distilling industry, was undertaken. Where policy and legislation did not specifically mention the distilling industry, the search was broadened to include beverage manufacturing and industrial waste for an appreciation of the current policy landscape.

Secondly, to further understand the complexities of the situation in an in-depth way, case study methods were used as a device to provide an overview of the current context of the distilling industry and olive grower industries in Victoria, to identify the similarities and differences between them (Yin 2018). Whilst the boundaries of this project are set in regional Victoria and the author is a member of the distilling industry community, it was imperative to keep in mind that their journey, experiences, and acceptance of sustainability concepts, such as doughnut economics may not be representative of the entire industry. In the role of primary producer, distiller, and committee member of the Spirits Victoria Association (SVA), the author was privileged to be able to undertake collegiate discussions with six distilling industry colleagues, two olive oil producers and three government agencies. In the author's professional capacity, it is essential that dialogue of this nature occurs on a regular basis to ensure an awareness of current practices being undertaken within these fields. Through these informal, open-ended conversations it has been possible to elicit the following information: current waste stream management strategies, challenges and barriers to best practice, and issues regarding relevant regulatory frameworks. The insights obtained were then triangulated against multiple sources which included academic literature, and publicly available publications from the Victorian State Government and peak bodies to validate the data uncovered. By gathering perspectives from a variety of stakeholders, a broad understanding of the collective experience has been established.

Greater Bendigo and its surrounds were chosen as the region of interest for this research for several reasons. Food and beverage production and manufacture is an important component of its economy, there has been a shift towards a circular economy model in the region and it is the author's place of residence and business. There are no unique issues in the region that would stop the implementation of circular economy principles in Bendigo – industries and the local council have been supportive in this respect (S Bryant Personal Communication, 13 April 2022).

4.2. Steps 1 & 2 – Rich Pictures and Boundary Critique

Characterising the problem effectively is a vital stage within the entire process, as it can uncover new insights and perspectives. This occurs within the problem formation and situation and diagnosis stages.

4.2.1. What are Rich Pictures?

As people's worldviews, perceptions and lived experience of a problem situation can differ, rich pictures were used as visual narratives to generate a holistic, unbiased perspective of the issues. A picture is worth more than a thousand words and are "windows to the human world" (Barbrook-Johnson & Penn 2022, p. 332). The use of art and pictures to communicate the human experience has been around since time immemorial and has been an effective way to aid the thinking process (Barbrook-Johnson & Penn 2022; Bell, Berg & Morse 2016a). The use of rich pictures as a problem diagnosing device stemmed from Peter Checkland's Soft System Methodology where its use was to explore, depict and understand a problematic situation holistically in picture format to facilitate discussion. People only have a partial view of a system – by communicating “many stories going on simultaneously”, a rich picture articulates complex real-world situations informally by using visual metaphors rather than words to express interconnections, relationships, and hidden meanings which aid in the thinking process (Bell, Berg & Morse 2016b, p. 146; Checkland & Poulter 2006). Through the use of rich pictures for both the distilling and olive grower industries, it is expected that a greater understanding of the barriers faced can be established (Jackson 2019).

4.2.2. What is Boundary Critique?

Once the rich pictures have been formed and reflected upon, utilising the boundary critique method helps to provide a systemic process of inquiry which critiques the facts and values underpinning the situation at hand and the implications that surround them (Ulrich 2005). Linked to Ulrich’s (1996) critical systems heuristics and Midgley’s (2000) systemic intervention, boundary critique is used as a tool to help comprehend situations and establish boundary judgements of how individuals view and perceive a real-world situation. These boundaries characterise the knowledge pertinent to a problematic situation and consider the diversity of stakeholders involved to enable engagement in meaningful dialogue (Midgley 2000). There are twelve categories which are broken up into four areas of boundary issues. These serve as questions that uncover the roles, values and judgements that form and influence the basis of a reference system (Table 3) (Ulrich & Reynolds 2020). The four areas delve into the following boundary issues that inform any system of reference:

1. *Sources of motivation:* what are the stakeholders and system of interest’s sense of purpose? What does value mean to them?
2. *Sources of control:* who holds the power in making decisions and do they have the necessary resources to act? Should other stakeholders be considered within the decision-making process?
3. *Sources of knowledge:* what skills and expertise are presumed to be readily available? Are there any knowledge gaps where this could be improved? How is knowledge produced and shared?

4. *Sources of legitimacy:* the social and legal approvals that legitimise a system. What opportunities or roadblocks exist for those who are negatively impacted? How is their voice heard?

Boundary judgements informing a system of interest (S)				
Sources of influence	**Social roles (stakeholders)**	**Specific concerns (stakes)**	**Key problems**	
Sources of motivation	1) *Beneficiary* Who ought to be/is the client of the system (S)?	2) *Purpose* What ought to be/is the purpose of S?	3) *Measure of improvement* What ought to be/is S's measure of success?	The involved
Sources of control	4) *Decision-maker* Who ought to be/is in control of the conditions of success of S?	*5) Resources* What conditions of success ought to be/are under the control of the decision-maker?	6) *Decision environment* What conditions of success ought to be/are outside the control of the decision-maker?	
Sources of knowledge	7) *Expert* Who ought to be/is providing relevant knowledge and skills for S?	8) *Expertise* What ought to be/are relevant new knowledge and skills for S?	9) *Guarantor* What ought to be/are regarded as assurances of successful implementation?	
Sources of legitimacy	10) *Witness* Who ought to be/is representing the interests of those negatively affected by but not involved with S?	11) *Emancipation* What ought to be/are the opportunities for the interests of those negatively affected to have expression and freedom from the worldview of S?	12) *Worldview* What worldview is underlying the design of S? What worldviews of either the involved or the affected be based upon?	The affected

Table 3: The twelve boundary questions in the "is" and "ought" modes Source: adapted from (Ulrich 1996, p. 44)

For each category, there are two ways to ask each question, firstly the "is" mode which establishes the norms of a system and secondly the "ought" mode of questioning which identifies the ideals. The boundaries identified can enable but they can also constrain, one cannot take one boundary for granted. These iterations are then compared and critically reflected upon to challenge assumptions and help shape the mutual understanding of a situation to determine the best path forward (Jackson 2019; Ulrich 1996; Ulrich & Reynolds 2020). By utilising the boundary critique method, the insights gained from the generated rich pictures can be further examined and reflected upon to map out the reality and boundaries of each respective industry. Understanding each of the case study's entangled facts, values, and influences, helps to set the tone for how change can be achieved and reviewed (Midgley 2000; Reynolds & Wilding 2020; Ulrich & Reynolds 2020).

4.3. Steps 2 & 3 – PQR and CATWOE

The next stage of the process was to create a purposeful activity model as a transformation specifically for the distilling industry, and to do that, the soft system models PQR and CATWOE were utilised. The first step towards that was to clearly articulate the root definition and convey the transformation of the system as a basic statement. This was undertaken using the PQR formula, which is used to define the what, how and why of a situation. The PQR formula is as follows: do P - describing *what* the system does, by Q – *how* it will be done, in order to achieve R – *why* it is needed (Figure 10) (Checkland 2000; Checkland & Poulter 2006; Jackson 2019). By reflecting upon the rich picture and boundary critique, the aim of PQR is to provide clarity of the intended goal, which will assist in the development of the conceptual model.

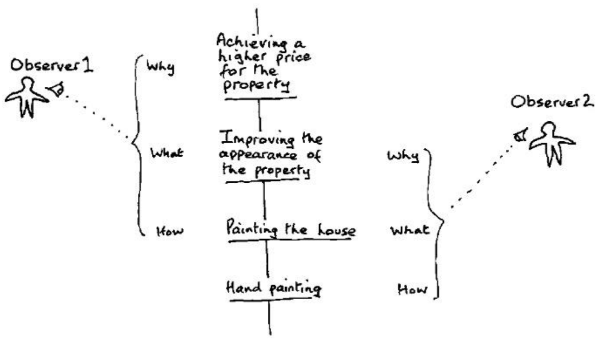

Figure 10: Example of the PQR formula in practise Source: (Checkland 2000, p. S29)

The mnemonic CATWOE model enriches and refines the root definition further by examining the proposed purposeful model's effectiveness and efficiencies to determine the proposed transformation - who the victims or beneficiaries are, environmental constraints and actors who could stop the process from occurring. The developed models are then compared with the current context to determine a pathway forward that is systemically desirable and culturally feasible (Checkland & Poulter 2006). CATWOE stands for the following elements of consideration:

- **C** = Customers – who are the customers, beneficiaries or victims of the proposed actions?
- **A** = Actors – who are the actors or facilitators of change? Who will be involved in ensuring the system works?
- **T** = Transformation – a purposeful activity as a transforming process. What transformation goal can be achieved that is systemically desirable and culturally feasible? What inputs will the system be transforming? What does success look like and how will it be measured for efficacy, efficiency and effectiveness?
- **W** = Worldview – how do our worldviews give the transformation meaning?
- **O** = Owners – who are the owners of the system? Who can stop change from occuring?
- **E** = Environmental constraints – what are the environmental or policy constraints which are taken as given in undertaking the transformation? How does the environment influence the system? What can you realistically change?

Once all levels of analysis have been undertaken and defined, a purposeful activity model of linked activities can be created. The purposeful activity model can then be used as a conceptual tool that provides a structured platform and learning device for further discussion to occur. The overarching goal is to achieve accommodation amongst all actors involved – not to achieve a consensus or have trade-offs, as these aspects mean that someone is losing out. Identifying and articulating a path forward that everyone can and is happy to work with is paramount as all parties need to take ownership for its success. There is no perfect solution or outcome that can be achieved – we can only work with the information we have at that moment which facilitates constant reflection and continual improvement. It is expected that using the PQR and CATWOE methods will help to shape the distilling industry's core purpose and ideal vision for the future.

5. Results and Discussion

This section will be divided into five main areas of investigation. Firstly, a comprehensive policy review will be presented which will analyse the current regulatory context and its relationship with the CE. Secondly, utilising rich pictures and boundary critique methods as devices to understand the real world, the case studies for both the craft distiller and olive grower will be presented and discussed. The key themes that intertwine both case studies will then be discussed. It is important to note the whilst the distilling and olive industries differ, they are both primary producers, with similar nutrient rich wastewater outputs. Olive producers, however, are further along their path towards becoming circularised. The findings will then form the basis for the construction of a conceptual model for the Victorian distilling industry that is framed around the principles of sustainable development. How the industry fits within the eco-economy of the Loddon Campaspe region will also be considered to determine whether a shift towards circularity can be realised.

5.1. Study Region – Greater Bendigo and Surrounds

A city surrounded by Box-Ironbark Forest, on the lands of the Dja Dja Wurrung and Taungurung Peoples, Greater Bendigo is located in the heart of the Goldfields region, approximately 150km north-west of Melbourne (CoGB 2021; Regional Development Victoria 2021). Blessed with an array of scenic tourist attractions and a rich cultural history, the city was awarded UNESCO City of Gastronomy status in 2019 by placing an emphasis on sustainable regional development that supports culture and creativity (CoGB 2022a). The region is also home to a diverse array of food and beverage growers and producers including olive groves, wineries, craft brewers and recently, craft distillers. The acute impacts of climate change have been felt within the region for many years, with increased occurrences of weather extremes, including periods of drought, bushfires and floods which continue to take their toll on the fragmented landscapes caused by mining and land clearance (Figure 11) (CoGB 2021).

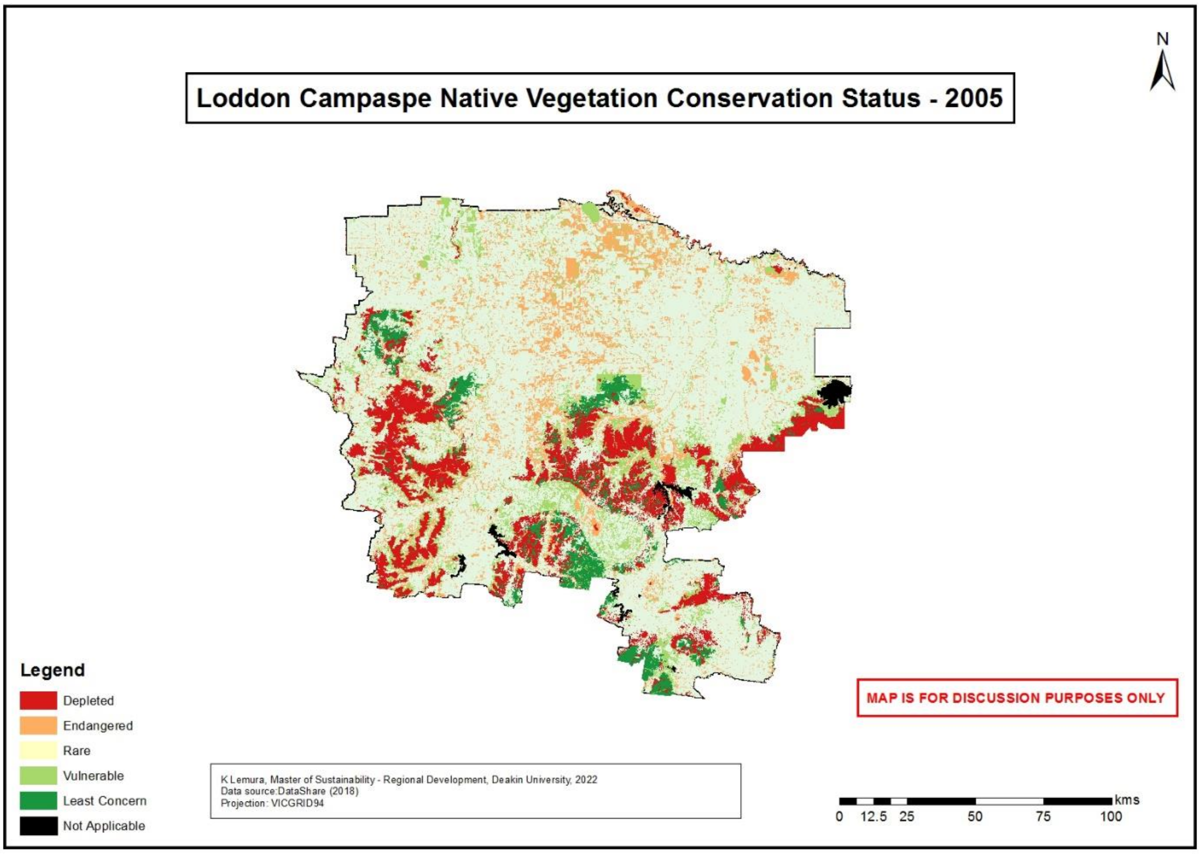

Figure 11: Loddon Campaspe's native vegetation conservation status Source: (DataShare 2018)

Being the third largest regional city in Victoria, Bendigo is also a part of the wider Loddon Campaspe region which boasts strengths in agriculture, food and beverage production, health, research, and advanced manufacturing. These are all central components in the support of the local economy (RDV 2019). Additionally, opportunities exist in the region to be a home for projects pertaining to renewable energy and waste and recovery. The population of Greater Bendigo is forecast to increase, with an expected 155,596 by 2036 (.idcommunity 2017).

Thus, additional pressure will be felt by the region to provide adequate education, employment opportunities, amenities, and services. In particular, waste management also presents challenges for Greater Bendigo. One landfill in Eaglehawk is scheduled for closure in 2023, and three transfer stations, along with 32 identified decommissioned landfill sites which require rehabilitation and constant monitoring (D Wood Letter, 10 December 2019). Adopting the CE ideals in policy has been a priority for local government which saw the amalgamation of the *One Planet Living Environment Strategy* and *Greater Bendigo Waste and Resource Management Strategy 2014 – 2019.* The *Climate Change and Environment Strategy 2021 – 2026* was established and contains ambitious goals for the future on how waste can be minimised, improving biodiversity, encouraging community activism and healing country. Yet there appears to be an assumption that the community already have a baseline understanding of what the circular economy is. Throughout the plan there is a cursory mention of education programs, but no mention of partnerships with the existing education providers within the region such as Latrobe University and Bendigo TAFE on how they can assist in disseminating information and creating awareness across the region. Policy documentation and general information alone does not facilitate an attitudinal shift, however, the creation of community awareness via schools, local events and workshops can empower communities to transform their mindset. Creating a milieu for collective efficacy to emerge rather than relying on the individual can "validate the correctness of their opinions and decisions… if everyone is doing it, it must be a sensible thing to do" (van der Linden, Maibach & Leiserowitz 2015, p. 759).

Whilst local government have investigated new circular pathway opportunities and provided in principle support for two possible options for the Eaglehawk landfill in April 2022 - a local composting site or a small scale Energy-from-Waste plant, no firm announcements have been made regarding its progress or whether it hinges on State Government backing (CoGB 2022b; Korycki 2022). Being the largest municipality within the Loddon Campaspe region, Greater Bendigo will be required to play a key role in supporting the growing population - identifying innovative and novel ways that can encapsulate long-term social, economic, and ecological resilience for the region both now and into the future.

5.2. Victorian Environmental Policy and its Relationship to the Circular Economy

Since the 1990s, government perspectives and policy discourse on waste management have been focused upon short term goals intended to raise revenue by systematically exporting and externalising waste to peripheral regions (Lee 2021). This externalisation has created a significant void in the provision of adequate infrastructure and services capable of enacting the new circular ideals presented by CE (Roberts 2020). For distilling businesses wishing to become more circular within their operations this has presented challenges as environmental regulations have been "designed for linear economy conditions" (Kautto & Lazarevic 2020, p. 218). The onus has been placed upon the producer to identify alternate pathways towards resource recovery with much of the guidance coming from Sustainability Victoria. The guidance offered has focused on improving efficiencies and saving money in the manufacture of products, the ban of single use plastics, e-waste and conducting compost demonstration trials (EPA Victoria 2021c; Sustainability Victoria 2022c). Whilst Victoria's CE policy promises a reform of the waste industry, its alignment with the principles of the CE is unbalanced by prioritising recycling and recovery strategies at a higher level than product life extension, waste elimination or regeneration (DELWP 2020; Iyer-Raniga, Gajanayake & Ho 2022). For a business wanting to become more sustainable, a review of the narrative presented in the Recycling Victoria CE policy, could cause it to prioritise recycling as their strategy towards sustainability and look no further.

The accepted standard for distillery liquid waste is for trade waste disposal methods to be applied, whether that be via onsite recording and treatment processes using a flow meter or carting it to a facility for disposal (Tasmanian Whisky Academy 2018). This provides a cost-effective option for a business. However, it reinforces the idea that liquid waste is an issue that must be externalised - implying it contains little to no value. Once it is out of sight and out of mind, there is no incentive for producers to adjust their practices as the limited CE offerings available in Victoria come at a premium (Aid & Lazarevic 2020; Suez nd). For those investigating value-added pathways such as AD, the Victorian government has developed a waste to energy framework which pledges support for the development of bioenergy projects. However, the level of investment and size of operation required is significant. Moreover, biological waste to energy technologies are not included in the program (DELWP 2021; Sustainability Victoria 2022b). Obstacles still remain, as EPA pilot project approvals and licensing are required before any action can be undertaken. Additionally, the digestate remaining is still classified as industrial waste until proven otherwise (EPA Victoria 2017; McCabe 2016). Furthermore, if the intention is to create a marketable product, further offsite processing may also be required for compost and soil conditioners to meet Australian Standards. However, these standards do not apply when utilising the medium on-site (Department of Health 2022).

Regionally located beverage manufacturers, not connected to town water and sewerage infrastructure, with a "production capacity of less than 300 kilolitres per year, [are able to] discharge or deposit waste solely to land" yet permissions need to be obtained by EPA Victoria before this can occur. However, for the micro producer, the advice by local government is that permission is not required. Paradoxically, this directly contradicts the regulations in place leaving the producer open to punitive measures by the EPA (EPA Victoria 2021b, p. 277). Whilst DWW presents a nutrient rich irrigation medium that can improve the growth and yield of crops, great care still needs to be taken to ensure risks are minimised for the surrounding environment (Umair Hassan et al. 2021). Distillers find themselves working within a precautionary system "where the main function of regulating waste is not the commodification of waste and efficient material use, but the protection of human health and the environment by restricting the use of waste-based materials" (Turunen 2020, p. 232). Additionally, distillers wishing to recycle their cooling wastewater for subsequent still runs (which presents no harm) are also required to have EPA consent before that action can be undertaken (EPA Victoria 2021b).

An examination of the Victorian EPA regulations and legislation, reveals that there is no mention of distilleries throughout and only one mention of wineries (EPA Victoria 2017, 2021b). All forms of beverage production, whether that be alcoholic or non-alcoholic are broadly referred to as beverage manufacturing. Whilst both sectors of the beverage manufacturing industry create organic by-products, there is "great variation in water consumption, wastewater generation" and their characterisation (Hidalgo & Martín-Marroquín 2019, p. 2). All waste streams generated by business, irrespective of the sector, are generally characterised as varying tiers of industrial waste. Rather than gaining an understanding of each respective sector's complexities in a holistic manner, regulatory systems have become reduced to "a set of parts" resulting in generic, place-less solutions that do little to support more circular outcomes (Van der Heijden 2020, p. 5).

5.3. Case Study – The Craft Distiller

As of early 2022, there were approximately 121 distilleries operating across Victoria, all varied in size, type of product offered, and waste output generated, of these approximately 54% produce gin as their primary focus (Figure 12). Whilst some gypsy distil (hire still time to distil their own products) and others have their products produced under contract, the majority distil their own products on site in their respective regions. Approximately 42% of craft distilleries are regionally located, with many of the distilleries clustered around regional centres in the northeast, central and Bellarine Peninsula areas of Victoria. This represents tremendous opportunities for both urban and regional economies through increased tourism, job growth and supporting local supply chains (Spirits & Cocktails Australia & Australian Distillers Association 2022). Within the Loddon Campaspe region, there are approximately 11 distilleries in operation, with three in the immediate area of Greater Bendigo.

Figure 12: Victorian craft distillery map Created from sources: (ABS 2021; Australian Craft Spirit & Cellar Door Directory 2021; The Gin Queen nd; VCGLR 2022)

5.3.1. Rich Picture Examination

According to the discussions had with industry colleagues, the journey to starting a distilling business is not an easy one. Depending on the size of operation, and location can signify a diverse array of challenges and experiences (Figure 13). To become a distiller and be able to legally create, store and sell distilled spirits, several federal, state, and local government approvals are necessary – excise manufacturer's license, relevant liquor licenses, food permits, town planning and waste management strategies need to be in place. Due to the siloed nature of government departments, the negotiation of red tape can present difficulties – some departments are supportive, but many areas fail to see the interconnections between them. This often results in a contradictory message being delivered on the correct compliancy measures (Aebischer 2017; Kautto & Lazarevic 2020). Additionally, the sustainable ideals of the circular economy are not engrained in all aspects of policy development, so unless an obvious connection can be established, circularising processes becomes an afterthought (Elliott-Smith 2022).

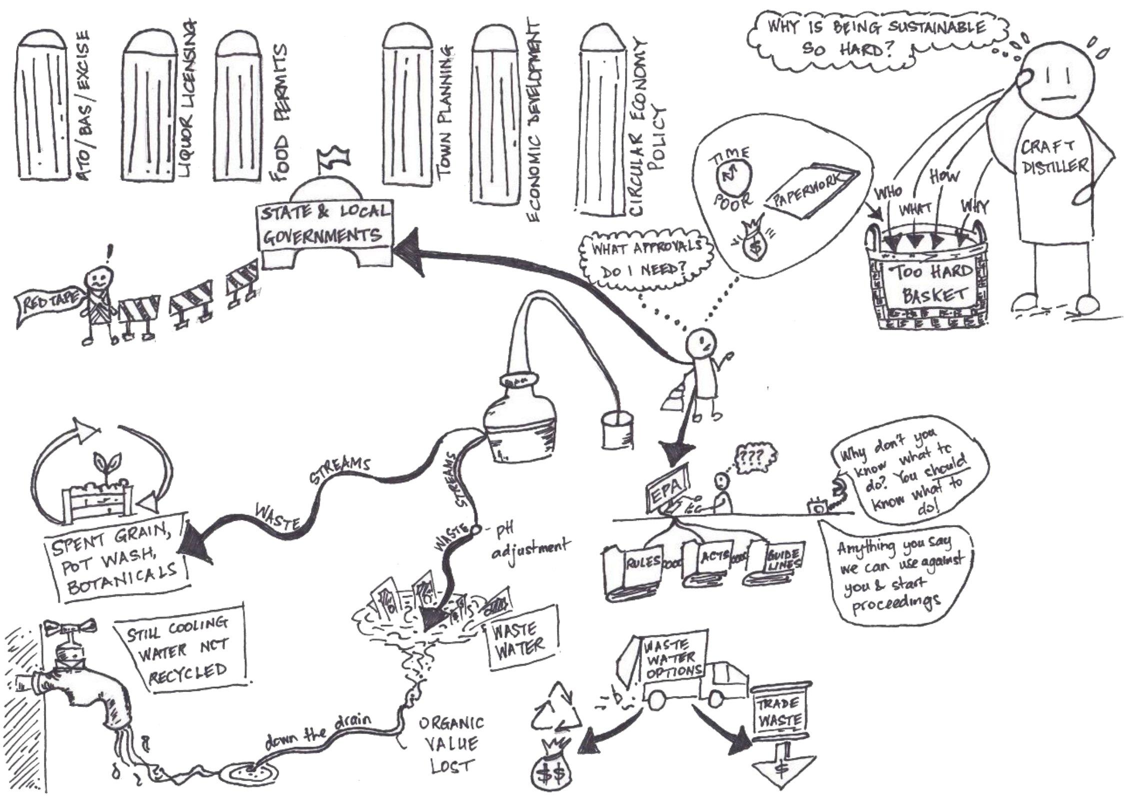

Figure 13: Rich picture of the craft distiller experience Source: author's concept and diagram

To create neutral spirit, raw produce is fermented. The fermented liquid is then distilled to achieve a higher alcohol by volume (ABV) percentage (Gebreeyessus, Mekonnen & Alemayehu 2019). The finished product can be further refined through further distillation and the incorporation of botanicals or barrel aging. The waste streams generated from spirit production can vary depending on the process and methods used, but all processes represent a significant amount of liquid and are classified as priority industrial waste (EPA Victoria 2017). For every litre of spirit produced from scratch, on average, the by-products generated equate to 2.5 kilograms of spent grain, 8 litres of pot wash and 10 litres of spent lees (Okolie et al. 2022). For the gin producer, most opt to purchase ready-made neutral base spirit from large scale distilleries that repurpose agricultural by-products to create ethanol – Manildra in New South Wales (flour by-product) or Tarac in South Australia (wine industry by-products) as the scale, equipment, level of investment and virgin raw inputs required to produce a high quality pure spirit is prohibitive for the small producer (Manildra Group 2022; Tarac Technologies 2015; Ward nd). As such, the waste outputs for most gin producers in Victoria are the heads and tails cuts, spent lees (wastewater) and spent botanicals. Additionally, the water used to cool the still condensers is typically discharged rather than salvaged - equating to approximately 9.86 litres for every litre of spirit produced (BIER 2022). Distiller perceptions of the waste streams generated was mixed – with many considering the physical botanical waste and associated packaging to be more of an issue than the wastewater, with little understanding of the biological value remaining. Efforts made to divert organic by-products ranged from composting, the redistillation of collected heads and tails, using the juice of fruits for new product lines, such as liqueurs, jams and preserves' and dehydrating spent botanicals to use as an exfoliant in soaps or feeding pigs. In most cases however, having a sufficient customer base to sell these repurposed products does not always align as "the economic costs and energy demand of collection and recycling may outweigh the benefits" (Bocken & Short 2020, pp. 251-2). For the management of spent lees after a still run, providing the pH value is within range of 6.0 -10.0 and the temperature under 38°C and a volume of no more than 5,000L a day, it can be discharged to the sewer (Coliban Water 2011; EPA Victoria 2021b).

EPA guidelines and regulations are difficult to navigate, with an apparent expectation that new entrants should already have a sound knowledge of the protocols required and "take proactive steps to manage waste" (EPA Victoria 2021c, p. 5). Navigating the EPA Victoria website to locate distilling industry specific information as found on the South Australian EPA website yielded no results. Without deeper investigation or input gained from local authorities some novice distillers may think that the South Australian rules do not apply in Victoria. Many defer to local government and water authorities for clarity, however the advice provided varies considerably between municipalities, in terms of required record keeping, municipal waste infrastructure available and disposal protocols administered.

Whilst most consider sustainability to be an important area to incorporate into the day to day running of their businesses, the reality of sustainable measures being implemented were often minimal, with financial and time constraints often being a barrier to action. As such, sustainable measures get placed in the "too hard basket" being a nice thing to have, a possible marketing tool, but not an essential component of doing business. DWW conversion to organic fertilisers and feed services are available yet are not commonplace. Therefore, applying circularity concepts to waste by-products becomes an expensive exercise with little appetite from beverage producers to shift from the cheaper, traditional, regulated trade waste measures already in place (Donner, Gohier & de Vries 2020).

5.3.2. Sources of Motivation

In the current context governments at a local, state, and federal level appear to be the key beneficiaries of the system through the collection of revenue through GST and excise duty tax, which increases every six months (ATO 2022). Whilst distillers have an excise rebate scheme in place, it is still largely stacked in the government's favour with Australian spirit producers tax being the third highest in the world (Spirits & Cocktails Australia & Australian Distillers Association 2022). Distilling businesses still benefit through the generation of sales and increasing their customer base - however as the number of industry entrants increases, distillers need to identify new ways to solidify their competitive advantage through improving production efficiencies and increasing consumer consumption of products. Success is therefore measured in quantitative terms – GDP, litres of alcohol (LALs) produced and waste reduction. Circularising the economy is still very much in its infancy across Australia with many narrowly viewing it "as a waste management solution" highlighting that existing regulatory frameworks are no longer fit for purpose (Braun, King & Philippe 2022, p. 12). Viewing it as simply a waste-centric solution has shaped policy development and the distilling community's understanding. There is a focus on end-of-life aspects via the separation of waste streams and recycling rather than rethinking how design improvements can be made throughout the entire business: production efficiencies, power choices, value adding through resultant by-products.

5.3.3. Sources of Control

Based upon the perspectives generated from the distiller rich picture, it can be seen that the decision-making power is held by several competing state and local government departments (Aebischer 2017). For a prospective entrant deciding whether to enter the industry or not, at a state level, the information available online is scant. Undertaking a Google search, 'how to start a craft distillery in Victoria, Australia', yielded a limited and uninformative set of results, that were geared towards contract distilling services, blogs, and news articles. Whilst the Australian Distillers Association website appears within the first page of results, any information, that may assist in navigating the process, is behind a membership paywall, with state associations communicating a similar message (Australian Distillers Association 2022b). Despite being the peak industry body, for those just trying to determine whether to proceed any further, paying for a membership is not of their highest priority and highlights a gap in providing a supportive environment for new entrants. Searching specifically for Victorian regulations ('craft distillery regulation Victoria') yielded similar results. The only official website providing helpful information was the Victorian Liquor Commission. This was primarily in relation to liquor licensing requirements for producers, however, directly accompanying the approval of a producer's liquor license are obligatory local council planning permissions, Responsible Service of Alcohol training and excise manufacturer approvals (VGCCC 2022). Dependent on the location of an operation, barriers may still exist, as home-based distilling businesses are often unable to gain council approval due to a clause within a producer's license automatically granting the option for a cellar door on site (VGCCC 2022). Whilst local council issue planning permission, the associated food registration, that is required to operate, is often missed, in part, because beverage manufacturing is not listed (Department of Health 2022). Waste management requirements are stipulated by local government, deferring to the EPA for waste discharge approvals if required. However, these will only flag as requirements when a distilling business is set up within an industrial estate and not for the home-based business (CoGB nd). Only upon the registration of a food permit, would this be picked up and discussed with local council authorities. Issues such as sustainability and circular practices are not considered at any stage through the application process.

5.3.4. Sources of Knowledge

Entrants into the distilling industry come from a diverse range of professional backgrounds ranging from hospitality professionals to accountants. When applying for an excise manufacturer's license, an applicant must provide evidence of their relevant skills and expertise (ATO 2021). Given the diversity of applicants applying, according to the Australian Taxation Office (ATO) (2021), a distilling course is the first step required in being able to obtain one. However, opportunities for novice distillers are limited in scope, with, in most instances, informal short courses (three – five days duration) in Tasmania and Adelaide, being the only offerings. Attendees are taught the basics of spirit production, safety and navigating excise tax laws and the ATO (Tasmanian Whisky Academy 2018). Whilst the courses assist in providing a baseline of knowledge on how to distil, very little insights are provided around waste management regulation or sustainable processes and how they can be applied at a micro scale. Additionally, within Victoria, no such courses exist which highlights the fact that the knowledge gained in relation to regulatory requirements may not be compatible with their local regulations. Furthermore, the nationally recognised course - Certificate IV in Artisan Fermented Products "offers specialisations in brewing, distilling, food and non-alcoholic beverages" could provide a consistent baseline to develop the industry, however no education providers across Australia offer the qualification (My Skills nd, p. para 4; Spence 2021).

Internationally, formal qualifications can be gained by sitting the International Brewing and Distilling courses, which provide a comprehensive understanding about the science of distilling processes, maintenance, waste treatment options and the environment. However the regulatory requirements within an Australian context are not considered (IBD 2022). The only assurances that government authorities require for distillers to be lawfully compliant are from them to abide by the laws and regulations in place: lodging excise returns accurately and on time, abiding by liquor licencing and council by-laws and following waste management protocols set out either by the EPA, local government, or water authorities.

Circularising processes and being more sustainable are not baseline measures of success – only abiding by the law and the minimum standards set in place. However, just because it is legal does not mean it is sustainable for the environment. If state and federal governments are wanting to transition to a circular economic model, the regulations that are in place need to be adjusted to reflect the new ideals (Brinkmann 2021). Rather than sustainability being seen as an added extra, it needs to be viewed as an integral component of operating a business to ensure the long-term holistic success of society – not just because it serves an economic purpose, but because it is the right thing to do (Roobeek, De Swart & Van Der Plas 2018).

5.3.5. Sources of Legitimacy

Circular business transitions remain largely out of reach for the small distilling operation, which is hamstrung by higher costs and linear regulations and is simply unable to match the level of investment that the larger players, such as Four Pillars, can achieve (Climate Active 2022; Four Pillars 2022). Whilst the success of Four Pillars can inspire ambitious goals and legitimise a transition towards the CE, their methods can also be hard to apply to the smaller distilling operation because of the high cost (Roobeek, De Swart & Van Der Plas 2018). However, in spite of this, there are small operators in Victoria that are actively embedding circular measures into every aspect of their operation (That Spirited Lot 2021). Distiller legitimacy in the current context, however, is all about compliance regulations – abiding by local government by-laws, the EPA, liquor licensing and lodging their excise and tax accurately and on time. Despite state and federal governments indicating that there has been a shift to CE thinking, bureaucratic inertia, due to the siloed approach of government departments, hinders progress. Change needs to occur at a systems level in all areas. At present, economic development continues to drive decision-making, with short-term cost saving and efficiency measures steering the sustainability conversation. This approach is underpinned by the assumption that people are only motivated by financial gains. However, "many people intrinsically care about the well-being of others and the environment" so there is a need to have a mixture of extrinsic incentives that connect with intrinsic values (van der Linden, Maibach & Leiserowitz 2015, p. 761).

5.4. Case Study – The Olive Grower

Analogous to the craft spirit industry, the olive industry in Australia has also experienced a similar growth trajectory. It has seen “in one generation, a niche product sold at markets and fetes to supermarket shelves and restaurants all over the world” (Neubauer 2020, p. para 2; RIRDC 2010). It is an experience that is similar to the wine industry. Olive groves are located all across Australia, and Victoria, with growing areas encompassing 12,129 hectares, is responsible for approximately 65% of total production (Australian Olive Association 2018a; Australian Olive Industry 2020b; Cobram Estate Olives 2022). Moreover, the Loddon Campaspe region has been responsible for 42% of the total olive output for the state (Figure 14) (Infra Plan & Geoff Anson Consulting 2015). Producers in the region range from small to very large, with Boundary Bend Olives, in Boort, being “one of the world’s largest single estate olive groves” (Australian Olive Industry 2020b, p. para 4).

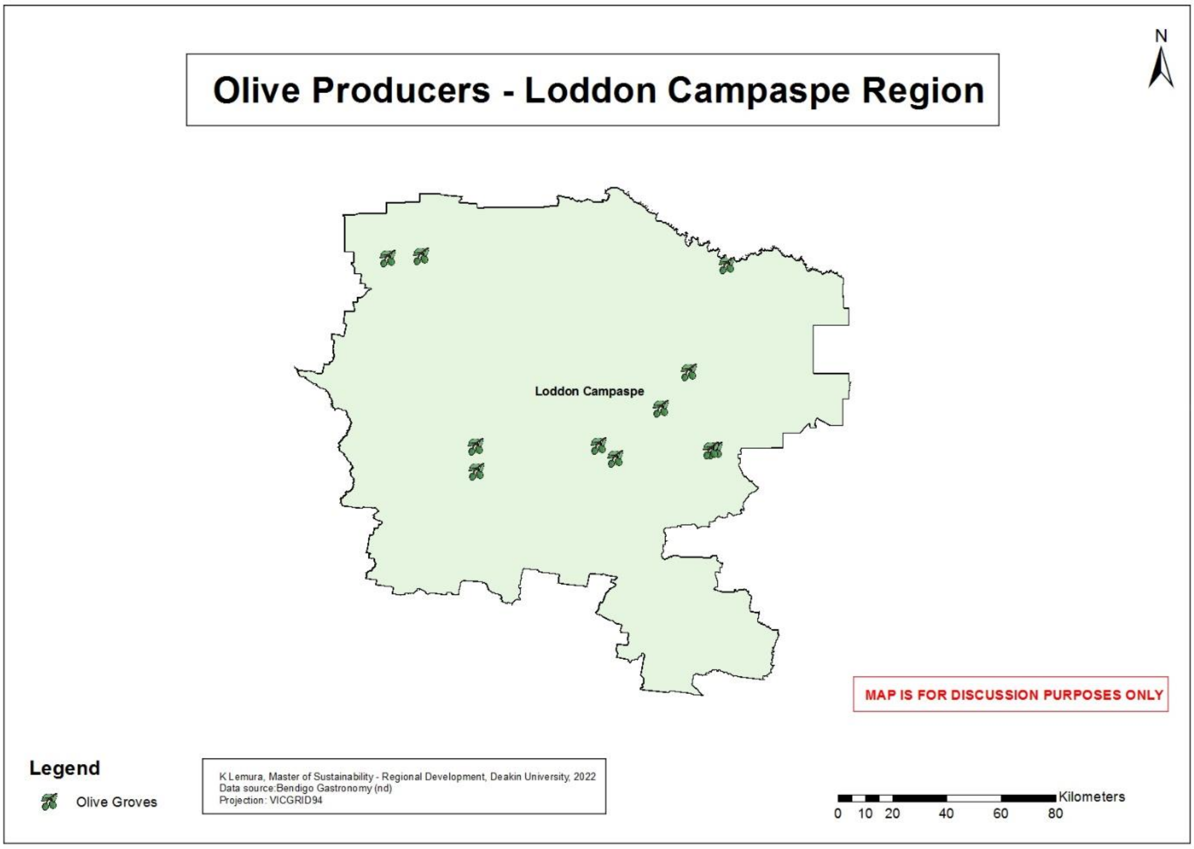

Figure 14: Olive producers – Loddon Campaspe region of Victoria Source: adapted from (Bendigo Gastronomy nd)

5.4.1 Rich Picture Examination

The cultivation of olives and the harvesting of oil involves several stages which include the pruning of branches, leaf removal, olive picking and the washing of olives in preparation for oil extraction (Figure 15). 2-phase or 3-phase olive processing equipment is then used to mill and separate the oil from the olive seed and husk. On average, the oil yielded from a harvest is only 20% of the total input, the remaining 80% consisting of a pomace-like slurry containing the flesh, seeds and wastewater which cannot be handled, only pumped and could have a serious detrimental effect on the environment if poorly managed (Donner & Radić 2021; Nair & Markham 2008; RIRDC 2010). The extraction system used determines the ratios of solid and liquid waste created, with the 3-phase method producing a higher quantity of wastewater than the 2-phase approach (Nair & Markham 2008).

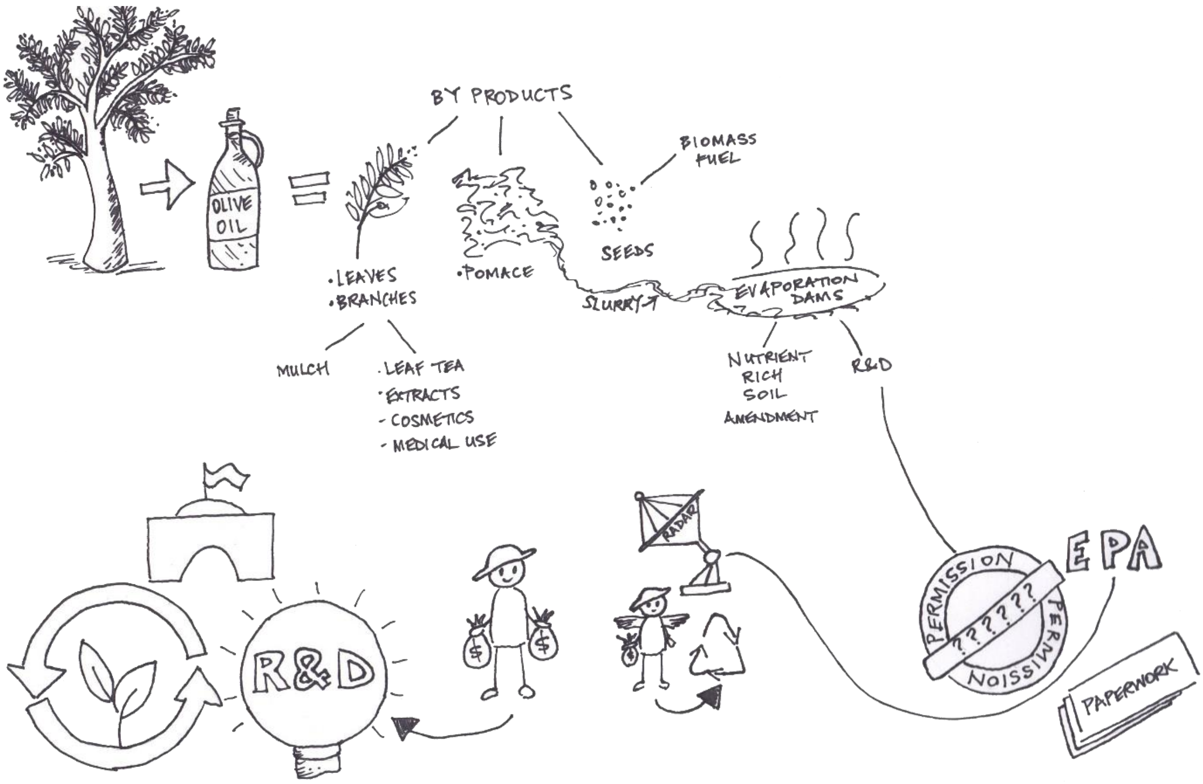

Figure 15: Rich picture of the olive producer experience Source: author's concept and diagram

Containing a high phenolic load, the solid and liquid outputs can cause significant environmental issues if mismanaged, posing threats such as the eutrophication of water supplies, foul odours and the modification of soil integrity therefore presenting challenges on how it can be managed effectively (González-González & Cuadros 2015; Mateo & Maicas 2015). In most cases both in Australia and abroad, the by-products are disposed to the land, with the pomace being pumped out to evaporation storage dams before being applied to farmland after the aerobic process has been completed. Despite these challenges, the producer's relationship with the land places them in a position to appreciate the nutrient value of the resultant by-products (Quinn 2011). All agricultural producers are required to proactively implement "reasonably practical measures to eliminate or reduce harm to people and the environment" (EPA Victoria 2021a, p. 8). Information relating to EPA guidelines are easily accessible with a series of guides offering support on how agricultural producers can effectively manage the risks of production, which is unlike the information available for distillers.

A great deal of research has been undertaken in Australia and abroad to develop best practice standards that identify new production efficiencies, value-added pathways and to improve resilience against the effects of climate change. Value has been identified in by-products throughout the product lifecycle: the leaves - olive leaf teas or olive leaf extracts for medicinal use; the pomace – extracting olive squalene for skin care and cosmetic use, dried pomace and seeds as a biomass fuel or as an addition to fertiliser and compost (Di Giacomo & Romano 2022; Stone & Grove 2022; Wellgrove nd). Research and development (R&D) in Australia have been largely funded by the olive levy. This requires producers to pay a levy of $3 for each tonne sold, to provide a repository of knowledge that all olive industry stakeholders can access that has focused upon cultivar health, improving crop yields and determining best practice (AgriFutures Australia nd; OliveBiz 2018; Southan 2022). For the large producer this presents opportunities for new product lines to be developed by applying CE ideals, however the price tag for product development research to occur can be sizable.

Additionally, the EPA approvals required before any steps can be taken, can hinder the implementation of innovative advancements (Turunen 2020). For the small producer, natural remediation processes such as composting are the most cost-effective options for the development of improvements (Ruggieri et al. 2016). Depending on the size of the operation, this could result in a new revenue opportunity or the residue could be utilised as a soil conditioner on their groves, reducing the need for chemicals (Nair & Markham 2008). However, in contrast to larger operations, small producers' waste management practices are not scrutinised to the same level and can often fly under the radar. Whilst the majority act as stewards of their landscapes, financial constraints limit more innovative strategies being put in place (Andrews 2020).

5.4.2. Sources of Motivation

According to Agriculture Victoria (2020), the key beneficiaries of the system appear to be olive producers through the generation of revenue and the identification of new markets both domestically and abroad. Local, state, and federal governments also benefit through the collection of taxes and contribution towards the broader economy. Additionally, the federal government and Australian Olive Association support the industry by dedicating research funding to assist in creating a buoyant industry with increased productivity that continues to hold high standards of authenticity, production and quality (Southan 2022). Sustainable farm practice and production are also key drivers for the industry, with the Australian-Grown Horticulture Sustainability Framework and OliveCare® Code of Practice setting the standards for best practice across the industry (Australian Olive Association 2018c; Hort Innovation 2021a). Success is measured primarily in quantitative terms, further advancement will rely heavily upon sustainable land management and stewardship that nurtures and protects landscapes both now and into the future (Chapin 2017).

5.4.3. Sources of Control

The key decision makers within the system are the olive producers themselves. This is, in part, due to industry led self-regulation, advocacy, and research, as each producer contributes to an olive levy fund and R&D can be undertaken that directly relates to the improvement of the sector. As the industry has become more established, the research focus has evolved to encompass more than just production efficiencies, signifying that financial outcomes are no longer their only focus as environmental and social pressures are interlinked. Failing "to manage environmental issues effectively will inevitably lead to the demise of the industry because of declining terms of trade, public opprobrium and restrictive regulation" (Quinn 2011, p. 1). Environmental impacts, pest and disease management, managing waste and understanding how to improve crop resilience in the face of climate change - all take priority to ensure that the implementation of best practice and that recognised benchmarks can be established and maintained across the entire industry irrespective of the grower's Olive Association membership status (OliveBiz 2017).

According to the Australian Olive Industry Survey, not all growers felt that up-to-date knowledge and research project awareness were being actively disseminated across the industry. This indicates that more work is necessary to ensure that information is promptly circulated and the industry promoted (Australian Olive Industry 2020a). Government departments, such as EPA Victoria, play a more supportive role when working with agricultural producers than distillers. This is evident from the array of information available that favours agricultural producers and the censorial tone used in communicating a distiller's environmental obligations (EPA Victoria 2021a). Whilst agricultural by-products are considered industrial waste, there is more focus on the value of the residue than with distiller's waste. However, to investigate and implement new valorisation techniques requires approval before new initiatives can take place and there are challenges in seeking more beneficial alternatives if the theory has not yet been proven by research.

5.4.4. Sources of Expertise

Many entrants into the olive industry draw upon knowledge that has been gained from lived work experience in agricultural businesses, and qualifications gained through agricultural colleges. Although, there are some who have entered the industry with no prior experience and have learned through trial and error. As the olive industry in Australia has evolved, so too have the training opportunities such as olive oil sensory evaluation and processing workshops. The ongoing training opportunities, however, are mostly informal in nature with very limited options available for formal olive culture qualifications to be undertaken. Many producers believe that a higher priority should be placed on this training (Australian Olive Association 2018b; Australian Olive Industry 2020a). As a part of the olive industry's *Strategic Investment Plan 2022 - 2026*, extending skills, capabilities, and the encouragement of adopting a circular business model has been prioritised. This is a vital step forward in ensuring that high production and quality standards can be maintained through the development of an innovative knowledge network focused upon continual improvement (Hort Innovation 2021b).

5.4.5. Sources of Legitimacy

Government departments such as the EPA Victoria, North Central CMA, Landcare groups and DELWP appear to be representing the interests of local communities to ensure that the environmental impacts associated with olive production are actively monitored and responded to. This is done in partnership with olive producers to improve biodiversity and land health. The adoption of holistic, eco-economic principles for the industry has been actively pursued despite neoliberalism being the dominant way of thinking, partially due to a grower's direct connection to the land (Quinn 2004). As a result, best practice has been legitimised by the Australian Olive Association and Hort Innovation, who actively champion the continual improvement, ecological sustainability and food safety standards of the industry through research, knowledge sharing and the setting of voluntary code of conduct benchmarks (Quinn 2004; Southan 2022).

5.5. Synergistic Themes

Now that the case studies for the distilling and olive industries have been presented utilising soft systems methods, several underlying themes have emerged which would not have become apparent had a different methodology been chosen. Whilst both industries are based upon primary production and share similar waste streams, how they have been perceived and regulated by government has differed. This has influenced their journeys and worldviews on what a sustainable industry should be. Based on the insights uncovered through the construction of rich pictures and boundary critique, the following themes have been uncovered: skills, industry knowledge and training, and government policy and support.

5.5.1. Skills, Industry Knowledge and Training

Both the distilling and olive industries share similar growth trajectories to that of the wine industry, however the level of support provided by the state and federal governments is quite different. For the olive producer, research and knowledge is centred around improving adaptive capacity, olive grove ecology health and the creation of knowledge networks which in many instances lies outside the principles of CE. Whilst there are still improvements that can be made in terms of formal training, the success of the industry has hinged upon producers all contributing towards a levy to fund research. Federal and state governments contribute towards this, as it is viewed as way to boost the economy. However, for the most part, it is left to the industry associations to champion and this has enabled them to establish a set of benchmarks for the industry as a whole (Jones 2021). The environment is deeply embedded into the socio-cultural fabric of the olive industry - issues are considered holistically, with the industry acknowledging that neglecting to protect the environment would result in the demise of the industry. This is an ideal that both DE and EE ideologies both share (DELWP 2018; Marsden et al. 2010; Quinn 2011; Raworth 2017). These embedded socio-ecological values help to frame improved standards of practice, which, once adopted, become commonplace (van der Linden, Maibach & Leiserowitz 2015).

In contrast, there is a significant void in the quality and level of training that is offered domestically for distillers. In general, there is a dearth of knowledge across Victoria (and the country) regarding distillery best practice, environmental regulations, and management of risk and safety (Spence 2021; Spirits Victoria Association 2022). The federal government led Artisanal Food & Beverage Project in 2018 resulted in the development of the FBP40619 Certificate IV in Artisan Fermented Products qualification in 2020. This project focussed specifically on regulation, licensing and best practice, however, two years on, education providers are yet to offer the qualification (Skills Impact 2022). Whilst the impacts of COVID may have slowed its roll out, the question to why this is still the case is puzzling. It is a possibility that there may not be a sufficient pool of experts to deliver it. Firms have traditionally responded to evolving "resource demands by 'poaching' readymade talent from competitors to address immediate talent needs. However, this approach rests on the assumption that the required skills already exist within the system" (Whysall, Owtram & Brittain 2019, p. 119). With the Victorian government establishing a $10 million grant fund for distilleries - to focus on creating rich distillery door tourism experiences - it is also hoped that the funding will assist in creating a baseline of skills for the industry (Spirits Victoria Association 2022). However, it cannot be assumed that financial support will continue indefinitely. If this were to be the case, it would probably be advantageous for a R&D training levy scheme for the distilling industry to be adopted as occurs in the olive growing industry (Doherty 2021).

5.5.2. Government Regulatory Support and Policy Intervention

Both industries have a phenolic, nutrient rich waste stream, however, the general classifications assigned to each industry are very different – olive production being classified as rural because of its location on zoned farmland and distilling often being classified as industrial, because many are located in zoned industrial areas (PPV 2018). As such, the perception of each industry's resultant waste streams differs. For the olive grower and producer, with a strong connection to the land, the adoption of dynamic approaches that align with natural systems are prioritised in the management of generated by-products. By-products are not viewed as waste but as something of value, either by being transformed into new products or by being returned to the soil. Whilst it can be argued that a distilling operation shares similarities with a winery agri-business, ambiguity remains on how a distillery is defined in the context of statutory planning. Primarily, this is because of a distillery's location, as they are often "situated within urban areas and therefore within proximity to sensitive land uses" (PPV 2018, p. 46). Therefore, in most cases, trade waste disposal measures become the only viable option to dispose of distillery effluent efficiently and cost effectively. Because of this ambiguity and the disconnection with the land, distillers do not always consider the organic value remaining in the generated by-products or consider that there are other waste management options beyond the traditional options presented by water authorities, municipalities, and the EPA.

For distillers and olive growers wanting to create new product lines through the use of their by-products, tensions and contradictions arise when policy discourse does not always align with legislation (Kautto & Lazarevic 2020). What constitutes waste and non-waste within the Victorian EPA regulations and Catchment and Land Protection Acts is not clearly defined. Irrespective of whether actual harm to people or the environment could occur, precautionary measures and proportionate controls must be put in place to "mitigate or minimise the risk of harm" to ensure that land is conserved and people are protected (EPA Victoria 2021a, p. 8; Quinn 2011; Turunen 2020). Whilst each set of circumstances is unique and measures adopted need to be tailored to the situation, it is up to the producers to determine the best course of action with no suggestions from the EPA as to how that may be achieved. Transitioning to a circular business model therefore becomes challenging as "legislative constraints [limit and hinder] the potential of waste transfer and reuse, especially when these uses are not explicitly considered by the regulation itself" (Ruggieri et al. 2016, p. 9). Therefore, the sustainability measures employed become focused upon reconfiguration rather than transformation, failing to strike a balance between the pillars of sustainability "and in reality, [get] labelled as old wine in new bottles" (Lazarevic & Brandão 2020, p. 17).

Throughout this investigation, it has become apparent that Victoria's transition towards circularity has been narrowly viewed as a technological market-based tool designed "to stimulate economic recovery" rather than advocating for a regenerative, distributive, and resilient economy that considers things holistically (Iyer-Raniga, Gajanayake & Ho 2022; Lee 2021, p. 1). The transition towards a circular ideal for the distilling industry has become a messy problem. Treating social, ecological and economic outcomes as separate objectives rather than a "single unified goal" has resulted in a fragmented approach towards sustainability (Roobeek, De Swart & Van Der Plas 2018, p. 57). As such, many aspects of environmental and economic policy have remained stuck within a linear framework due to conflicting and competing priorities and viewpoints (Elliott-Smith 2022). By mapping out the systems of both the distilling and olive grower industries, some key learnings have emerged on how challenges can be overcome if socioecological objectives drive the decision-making process.

5.6. Purposeful Activity Model Development

The development of a purposeful activity model helps to reorientate thinking about what the future vision should be (Jackson 2019). The key learnings from the distiller and olive grower experiences, formed the basis from which to construct a model that enhances the learning process by establishing a “way to look at a complex reality” in a structured way (Checkland & Poulter 2020, p. 228). As the concepts of Sustainable Development and the CE are being advocated for by government at all levels, by viewing the Victorian distilling industry through this worldview, a purposeful activity model can be constructed. This prompts structured discussion about how the transition to a circular business model can be mapped out and effectively achieved.

5.6.1. Root Definition

Based on the findings uncovered from the rich picture and boundary critique analysis, the fundamental purpose of the system could be established through the root definition. The root definition provides the foundation for describing the system and the PQR formula was utilised to establish the what, how and the why as statements (Checkland & Poulter 2020). These statements then helped to shape the construction of the root definition (Table 4).

PQR Formula	**Statement**
P – description of <u>what</u> the system does	To produce quality alcoholic beverages.
Q – <u>how</u> it will be done (transforming process)	Implementing environmental and sustainably focused circular production methods and standards.
R – <u>why</u> is it needed	To create a robust and sustainable distilling industry focused upon the environment, knowledge exchange, innovation, and continuous improvement.

Table 4: Use of PQR in the development of the root definition

The following root definition of the system was created:

"A distilling industry owned system that aims to produce internationally recognised high quality alcoholic beverages by adhering to ecologically driven circularity production methods and standards, in order to create a robust, innovative and sustainable industry built upon collaborative knowledge exchange, ecological resilience and continuous improvement."

5.6.2. CATWOE

To ensure that the root definition was communicated as effectively as possible, and the subsequent transformational activity model easily implemented, it was necessary to articulate the associated actors, values, power structures and norms. The CATWOE process ensured that the transformation identified within the root definition was appropriate and to appreciate the environmental and human aspects that could influence or hinder its success. Articulating the desired worldview helps to generate new insights and identify potential conflicts that may arise in the implementation of the purposeful activity model (Table 5) (Basden & Wood-Harper 2006).

CATWOE Analysis	
Customer	• The beneficiaries are distillers, their respective industry, and policymakers.
Actor	• Distillers, distilling industry associations.
Transformation	• A governance framework that supports distillers to operate in a sustainable manner that adheres to the principles of the circular economy. • Socio-ecologically driven industry circularity standards and best practice. • R&D and industry driven training that fosters a culture of best practice and continuous improvement. • Decentralised, sustainable governance frameworks that support community led place-based projects that are distributive and regenerative by design.
Worldview	• If the principles of sustainable development (CE, DE and EE) drive the decision-making process, a circular distilling industry transition can be achieved.
Owner	• Distillers, local and state governments, third party waste valorisation providers.
Environment	• The existing regulatory frameworks – EPA, excise tax. • Financial constraints of small – medium businesses.

Table 5: CATWOE analysis of the transition towards a circular distilling industry

Based upon the root definition and characterisation of the CATWOE elements, the distilling industry system conceptual model was constructed which was then compared with the distilling industry's current context.

5.6.3. Developed Conceptual Model for Distilling Industry

The conceptual model devised presents the key human operational activities that are necessary to carry out the transformation presented within the root definition (Figure 16). Each activity is linked by arrows of dependency offering a series of seven steps to facilitate structured discussion, develop networks and to appreciate current constraints and environmental regulations. The goal of the system is to devise a set of distilling industry-specific sustainability production standards. These will help to create a platform for determining supportive policy frameworks and regulation. Directly outside of the operational subsystem are the iterative activities which monitor and review its progress to ensure the actions taken are achievable, efficient, and effective (Burge 2015; Checkland & Poulter 2020).

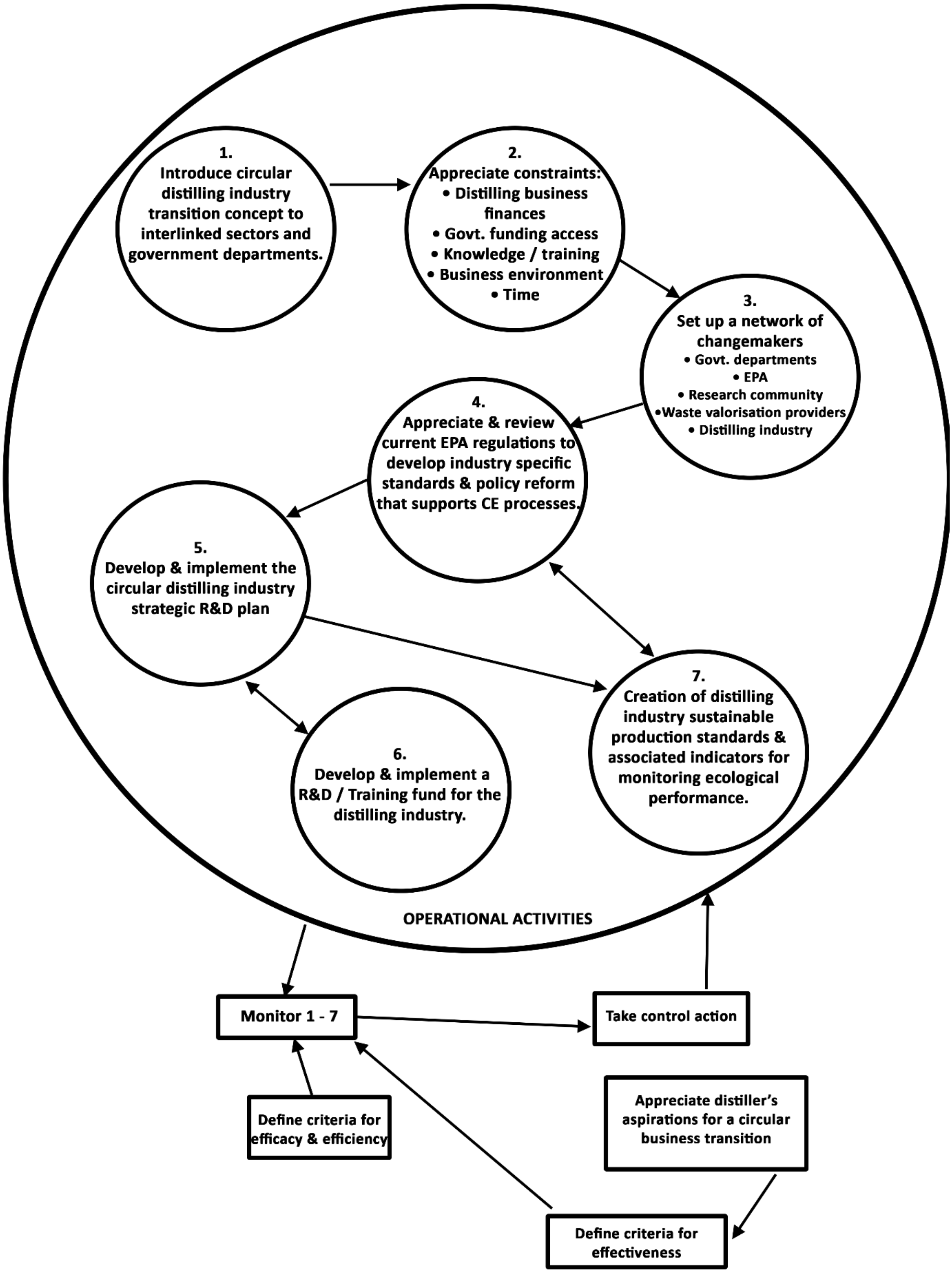

Figure 16: Distilling industry purposeful activity system model Source: author's concept and diagram adapted from (Checkland & Poulter 2006)

5.7. Comparison of the Conceptual Model with the Current Distilling Industry Context

In comparing the conceptual model with the current context of the distilling industry, the conceptual model acts as a tool to gain new insights, question assumptions and identify new pathways towards improvements that align with the proposed system transformation that is agreeable to all parties. The juxtaposition of the conceptual model and current situation of the distilling industry has revealed potential fields of development that could assist in the realisation of the transition towards a circular economic model for the distilling industry.

5.7.1. Existing Roadblocks

Numerous constraints presently exist that have slowed the transition towards a circular business model. These constraints can be categorised into four areas – regulatory, cultural, market and technological barriers (Figure 17).

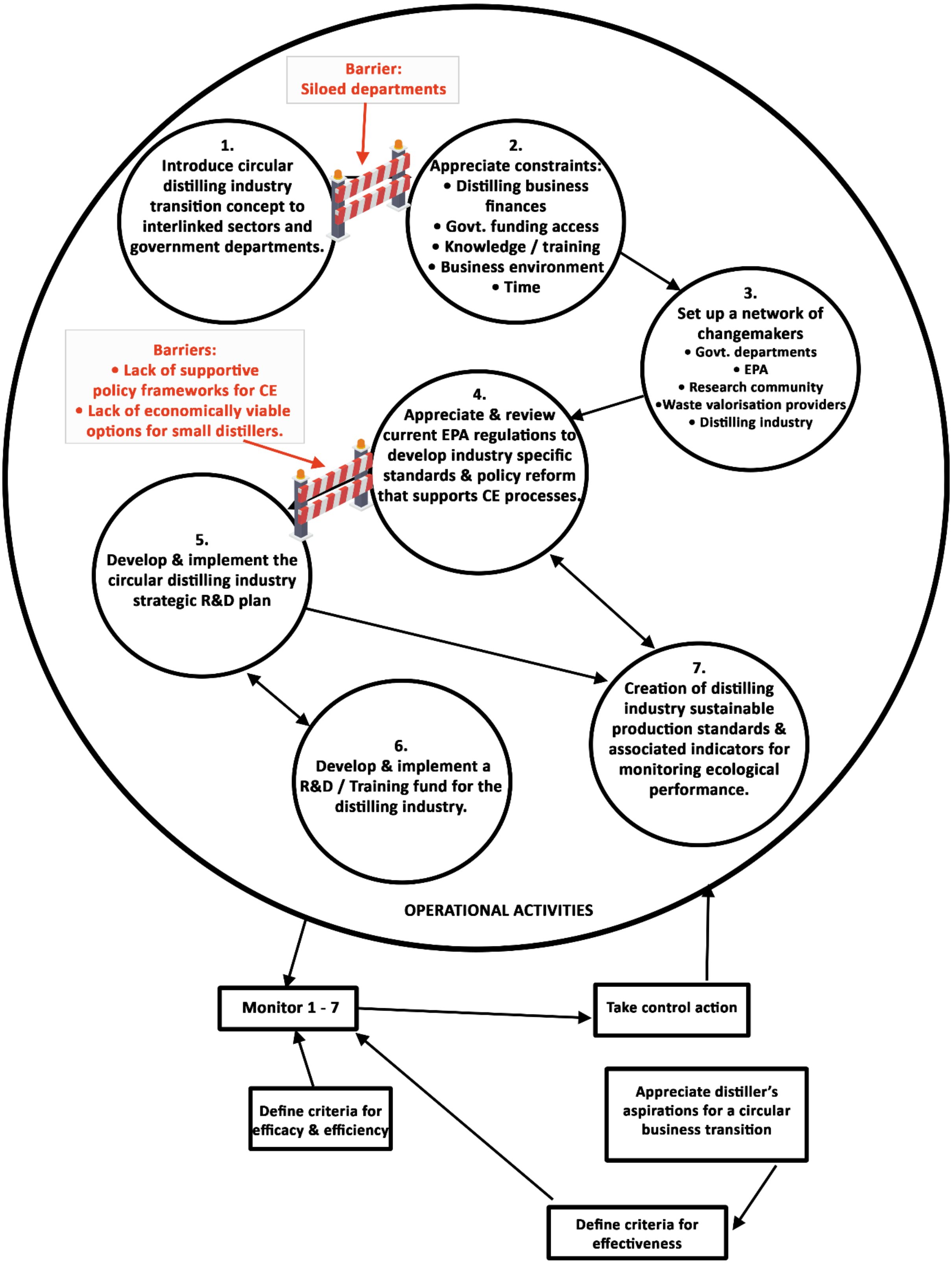

Figure 17: Barriers to CE in the distilling industry current context Source: author's concept and diagram

5.7.2. Regulatory Barriers

In the current context, distillers are not incentivised to look beyond existing waste management practices because present EPA regulatory frameworks have been devised for linear conditions. Attempts to shift towards circularising processes are generally hindered by bureaucracy. Whilst state and federal governments advocate for circular business initiatives to be adopted, the regulatory support and grant assistance provided is minimal. The responsibility for adopting sustainable practices lies solely with the producer. Coming up with innovative strategies that repurpose by-products in new ways can be hard to achieve when constrained by contradictory regulations currently in place. Additionally, the lack of consensus on how CE is defined often limits how policy gets shaped and how outcomes are measured, with generic, technological, market-based solutions "overlain with green considerations" being the only measures sought (Brandão, Lazarevic & Finnveden 2020; Kitchen & Marsden 2011, p. 758). Little consideration is given to the application of measures designed to reduce consumption or to how they can be applied in a regional setting. A siloed institutional environment has played a constraining role in the shift towards the CE. Whilst the Victorian Government is focused on the establishment of a green economy to drive innovation, job growth, and reduce red tape, the regulatory obstacles have increased. This does little to encourage business investment in circular measures and, subsequently, creates barriers in the development of new products and markets (Henrysson & Nuur 2021; Macklin 2020; Victorian Government 2020).

5.7.3. Cultural Barriers

Whilst businesses are expected to be the main initiator of circular practices, the collective understanding about what sustainability and the CE represents is disparate, with many perceiving it to be just an advanced version of recycling (Iyer-Raniga, Gajanayake & Ho 2022; Parry-Husbands et al. 2020). This, in part, stems from a reductionist lens being applied to Victorian Government policy which, to date, has only narrowly focused on the reformation of the recycling and waste industry. Whilst there have been calls for a more holistic viewpoint to be employed that incorporates the ideals of the CE and DE ideologies, this has yet to be put into practice at a government level, which hinders the prospect of systemic change being realised (Victorian Circular Activator nd). How the CE has been socially and culturally framed by government has a significant impact on how it is perceived (Iyer-Raniga, Gajanayake & Ho 2022; Korhonen, Honkasalo & Seppälä 2018). Businesses from all sectors are actively encouraged by government to innovate and be proactive with their sustainability efforts, however the financial stability of their business takes is their highest priority. This sentiment is true for many distillers. Constrained by rising input costs and taxes, "it [can be] hard for an enterprise in the red to be green" (Quinn 2004, p. 1). Unsupportive regulatory frameworks, competing objectives and financial constraints also influence a company's sustainable aspirations for the future. Failure to embed circular ideals into a company's strategic plan often results in no meaningful change to business behaviours with weak sustainability measures, such as carbon offsetting, being the only measures employed (Brandão, Lazarevic & Finnveden 2020; Kitchen & Marsden 2011; Monbiot 2022). However, R&D and improved training opportunities will serve to strengthen the distilling industry in becoming more resilient and, also, assist in the development of holistic solutions focused upon the pillars of sustainability (Iyer-Raniga, Gajanayake & Ho 2022).

5.7.4. Market Barriers

Adopting long-term sustainable measures into business practice can be a tall order for small businesses to undertake. For distillers, the capital requirements necessary to kick start their business are sizable and the maintenance of cash flow for survival in the start-up phase represent significant challenges (Hernyk 2022). Irrespective of whether a business has a profit motive or not, sustainability initiatives will only be adopted if they are financially viable and subsidies are available (Iyer-Raniga, Gajanayake & Ho 2022). The capital expenditure needed to circularise processes, whilst potentially representing cost savings in the long-term, can be cost prohibitive in the short term (Corvellec, Stowell & Johansson 2022). Much of the CE literature is centred around the idea of product service systems, reverse logistics, the sharing economy, and businesses retaining ownership over the products they have created - these do not always equate to environmental benefits (Bocken, Schuit & Kraaijenhagen 2018). However, for the spirits manufacturer, a CE style of business model cannot be easily applied (Donner, Gohier & de Vries 2020). Once the liquid is consumed and enjoyed by the consumer, it is gone. Therefore, shifting thinking from regarding by-products as a waste stream to be externalised to seeing the regenerative value distilling by-products possess, is an important step to take. For many, this undertaking cannot be done alone, and the establishment of cross-sectoral waste valorisation partnerships are necessary. However, in contrast to the traditional waste management measures available, this is not the most cost-effective path to take until demand for these services increases.

5.7.5. Technological Barriers

Technological advancements on the management of DWW have centred around AD and this technology has been proven to be effective from an international standpoint, particularly in the management of whisky production. Within distilling training course content, AD technologies are presented as examples of waste management practice in large scale operations in Scotland, however there is a disconnect on how those measures can be applied on a small scale. The capital investment, infrastructure, scale and organic by-product inputs required to make AD a viable option are simply out of reach for the small producer (Donner, Gohier & de Vries 2020). Whilst political support exists for waste to energy projects and creation of recycled organics markets, it is geared towards large, centralised waste valorisation providers to undertake (Sustainability Victoria 2017). Concentrating solely on end-of-pipe solutions, however, does little to reduce inputs (Corvellec, Stowell & Johansson 2022). Rethinking and redesigning products and processes to improve eco-efficiencies in all areas of a distilling business is just as important. “Technological innovation by itself does not automatically guarantee business or economic success;” social and ecological factors need to be given equal consideration (Teece 2010, p. 183). Testing new ideas and experimenting with new processes and products “often takes place under the radar”, in part, to keep costs low, but to also determine if an idea is worthy of further exploration before seeking EPA approvals for pilot programs to take place (Bocken & Short 2020, p. 80; EPA Victoria 2021b).

5.8. Opportunities

5.8.1. Alternate Pathways

The main waste streams that emanate from gin production in Victoria are the ingredients' packaging, spent fruit and botanicals, the captured heads and tails, spent lees and cooling water. Whilst DWW contains concentrated levels of organic compounds, which can lead to environmental issues if mishandled, it can, however, represent opportunities if channelled in the right direction (Strong & Burgess 2008). The diagram below illustrates the by-products of distillery production and the valorisation options. The current standards that apply are indicated along with the alternate pathways that would enhance circular outcomes (Figure 18).

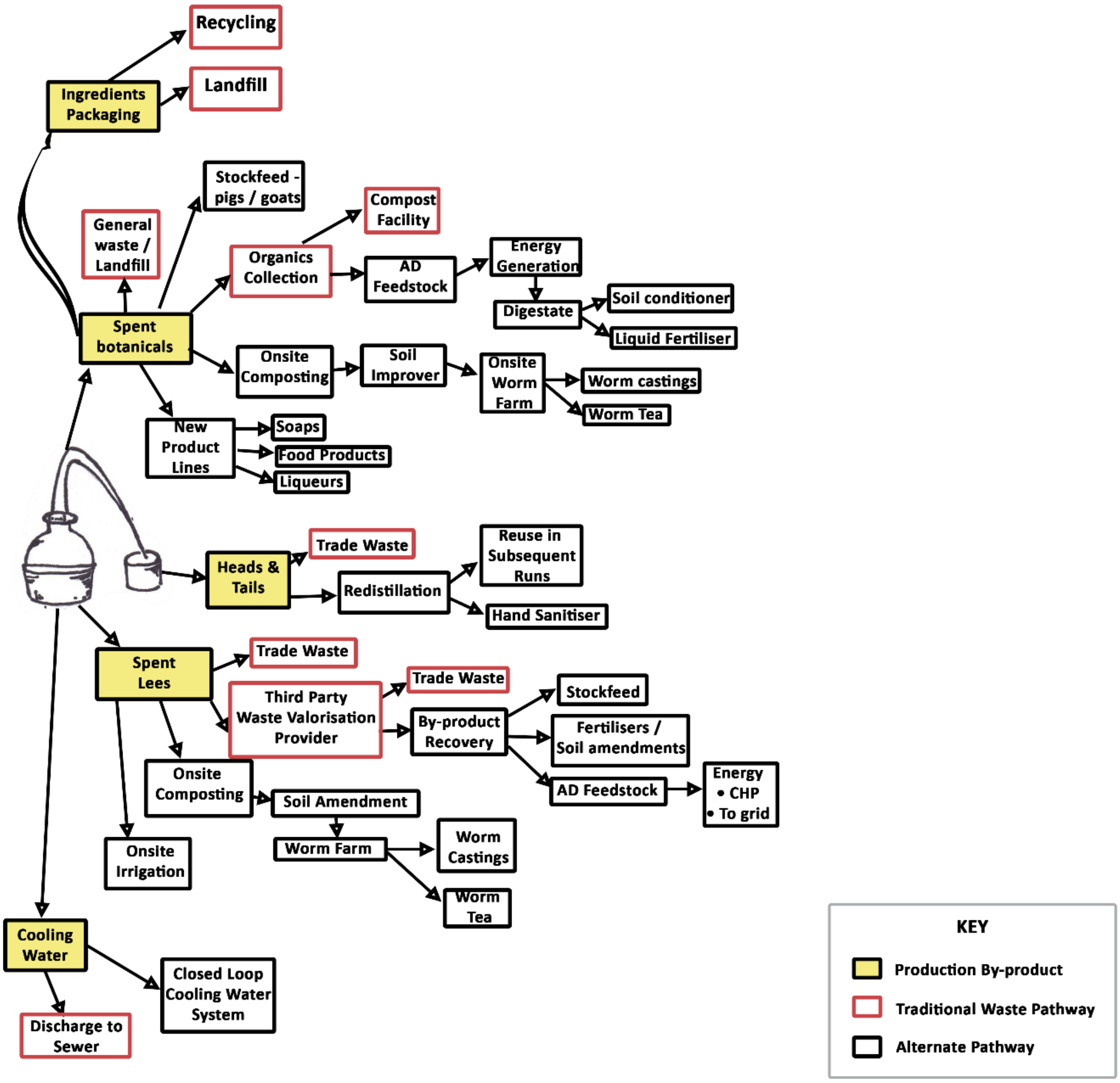

Figure 18: Gin production by-products – traditional and alternative pathways Source: author's concept and diagram

Even prior to the still being turned on, waste is generated from the botanical ingredients packaging. Depending on the size of the operation and the quantities required, this can result in a large amount of packaging waste if ingredients are not ordered in bulk. Additionally, herb, spice and botanical providers are obliged to adhere to certain standards to ensure the products provided to distillers are safe and packaged correctly (Food Standards Australia & New Zealand 2021). In most cases however, the packaging cannot be reused or recycled and ends up in landfill. Working with ingredient processors and suppliers to modify their packaging materials to more sustainable solutions would benefit not only the distilling operation in reducing waste, but other businesses that utilise their services (Rashid, Roci & Asif 2020).

Traditional approaches utilised in the management of spent botanicals can include disposing of it in general waste or sending it offsite for organic food recycling where it is processed into compost (Speedie Waste 2022). Food and garden organics (FOGO) collection is a relatively recent occurrence for households and businesses in Victoria, with the state government stipulating all municipalities must offer the service by 2030 (DELWP 2020). However, transparency is currently an issue as existing infrastructure across the state has been inadequate to keep up with the demand and, as such, much of the organics collection ends up in landfill (Waters 2022). AD services do exist, however much of this is still in its infancy within Victoria, with the responsibility being left to a limited number of providers such as the ReWaste facility in the Yarra Valley (DELWP 2019). For the regional producer, capable of composting onsite, further refinement of the compost can be achieved through worm farms. The compost can then be utilised on site as a soil conditioner and organic fertiliser (Wang et al. 2022). Additionally, spent botanicals can also be utilised as a supplementary feedstock, as exampled by both Four Pillars and Brogan’s Way sending their by-products to surrounding pig farms (Best 2016; Brogan's Way 2021). New products can also be generated from the by-products either through on-site development or through collaboration with other food businesses. The challenge is to ensure there are sufficient markets in which to sell these repurposed products.

The heads and tails cuts from the distillation process are often discarded and incorporated into the spent lees disposal. However, it is possible for them to be collected and recycled as neutral spirit, onsite cleaners or made into hand sanitiser. Spent lees are often disposed of via trade waste pathways. Once the physical organic components are separated, the liquid by-product is pH tested and adjusted, cooled to 38°C and then discarded. Third party waste valorisation providers offer a variety of services for spent lees (for distillers not wanting to treat their waste onsite) however the process that is undertaken to dispose of or recover nutrients varies considerably in price (Table 6). For regional distillers (as for wineries) not connected to town water, spent lees can be utilised as onsite irrigation, however great care must be undertaken to ensure the sites it is administered to vary, as prolonged application in one area can affect seed germination and microorganisms within the soil (Strong & Burgess 2008). Evaporating spent lees through composting also offers another pathway where nutrients can be recovered and returned to the soil. Large amounts of fresh water are used to cool the still condenser and in many cases is discharged (BIER 2022). With Australia being no stranger to extreme periods of drought “the value of water should be recognised in a more meaningful way” (Kiem & Austin 2013, p. 1307). As this water has no contact with the product being produced, it can be recirculated and reused rather than discharged.

By-product	Option	Cost to business	Benefit
Ingredients packaging	General waste	Bin hire & collection frequency	
	Recycling – comingle	Bin hire & collection frequency	• Landfill diversion
Spent botanicals	General waste	Bin hire & collection frequency	
	Food organics collection	Bin hire & collection frequency	• Landfill diversion • Compost
	In-vessel composting unit	$55,000 – $380,000 (DHHS 2016).	• Landfill diversion • Reduces weight of organics • Reduces frequency of organics collection • Compost can be used on site
	Onsite composting	$0	• Landfill diversion • Soil conditioner • Worm tea • Worm castings
	Worm farm	$380 - $21,500 (DHHS 2016).	• Soil nutrients • Worm castings • Worm tea
	Onsite AD	$450,000 – $5million + approx. (depending on size and technology utilised) (DHHS 2016).	• Landfill diversion • Energy production • Power to grid • GHG emission reduction • Soil conditioner • Fertiliser

Heads & tails cuts	Incorporated into spent lees & disposed via trade waste	Cost of inputs	
	Capturing & recycling back to neutral spirit	Electricity use for stripping run	• Neutral spirit • Cleaning product for distillery • Hand sanitiser
Spent lees	Onsite trade waste	$140 per quarter	
	3rd party trade waste	$0.35c per litre	
	3rd party valorisation	$1.00 per litre	• AD • Agricultural uses • Bio products • Biofuel • Ethanol
	Onsite composting	$0	• Soil conditioner • Worm tea • Worm castings
	Onsite irrigation	$0	• Water saving
Cooling water	Discharge to sewer	$2.7584 per kilolitre (first 440L) $3.2411 per kilolitre (>440L) (Greater Western Water 2021).	
	Closed loop water recycling system	Cost of water tank and small pump/fittings (size and price dependant on size of still used)	• Water saving

Table 6: Cost summary of traditional waste management and alternate pathways

In reviewing the costs associated for the management of spent lees within the table above (Table 6), onsite trade waste measures are the most cost-effective solution for a business. However, if the overarching directive from the Victorian government is to circularise the economy, then the remaining organic value contained within the by-product would need to be captured rather than discarded. For instance, on the average still run, the spent lees component equates to approximately one-third of the total charge (Wisniewski nd). If we assume that the 121 distilleries currently in operation in Victoria have an average still size of 385L, conservatively doing two production runs a week, the total spent lees generated in a 12-month period would equate to approximately 1,598,797.20 litres. An individual distillery, utilising the standard trade waste route would spend approximately $560 per year. However, the distillery wishing to utilise a circular valorisation pathway instead could expect to spend approximately $13,213.30 per year. From a financial standpoint, a distiller is incentivised to continue with the linear pathway and make no changes to their business practice thereby undermining the ambitious zero waste goals set out by the Victorian Government.

Much of the CE literature and government discourse focuses on creating new revenue streams, however many of the alternate pathways for distillery by-products cannot be undertaken alone. Collaborative partnerships are a vital component and can have significant multiplier effects for other supporting industries which are based around a distillery business. Whilst a distiller may not always see the financial benefits of CE practices, their social and environmental responsibilities should not be disregarded. Unfortunately, if financial viability comes into question, there may be reluctance to implement them (Iyer-Raniga, Gajanayake & Ho 2022).

5.8.2. Research, Development and Training

As the shift towards sustainable development and the CE continues to gain momentum, the eco-integrity of the spirits industry has come into focus. A failure to have a consistent baseline of training and development has shaped industry and policy development to date. This has, primarily, focused upon regulatory compliance and economic growth rather than a decarbonising of the industry. As demonstrated within the Australian olive industry, the development of a strong knowledge base has been achieved via the introduction of the olive levy R&D fund. This has been a key driver in strengthening the industry and raising the bar on sustainable measures being applied through the production process. Industry specific training and R&D can play a vital role in the establishment of an innovation system for the distilling industry, but this cannot be undertaken alone. An innovation system relies heavily upon the expertise from multiple sectors to achieve goals and assist in the transition to a circular model (Martin 2020). By developing collaborative partnerships from industry, academia, society, and government there is the potential for a creative milieu to emerge (Carayannis & Campbell 2019; Marsden 2010; Raworth 2017). The people within the distilling industry and their local communities matter and play a central role in being the supporters and facilitators of systemic change (Kolehmainen et al. 2016). By focusing upon an industry's social capital through research, education, and collaborative partnerships the industry can empower its people, create new knowledge, and become an exemplar of sustainable production standards and practice.

5.8.3. Interlinkages with Regional Economies

Within Loddon Campaspe, Greater Bendigo has been leading the charge in the transition towards the CE, being nominated as a finalist in the Premier's Sustainability Awards (Sustainability Victoria 2022a). In line with Recycling Victoria's directives, this has been primarily focused upon resource management solutions. However, throughout Greater Bendigo's Climate Change and Environmental policy, there is a great sense of urgency for holistic solutions to be adopted which extends beyond the Victorian Government's CE narrative and is more aligned with the DE and EE paradigms (CoGB 2021; Ghisellini & Ulgiati 2020). This advocates for new values and norms to help shape the community and industries that live within the region (Henrysson & Nuur 2021). Whilst distilling businesses may be a welcome addition to the region in terms of increased tourism, they also have the potential to place additional pressure upon existing waste management infrastructure. As it is the region's aim to create a sustainable and resilient eco-economy, the inclusion of the distilling industry in the region provides an opportunity for the industry to work in partnership with the community and local agricultural industries to be an innovative agent to devise meaningful, sustainable, place-based solutions (Figure 19). By creating a collaborative network of knowledge guided by the principles of DE and EE, industries can work together to coevolve and adapt with the nature (Roös 2021).

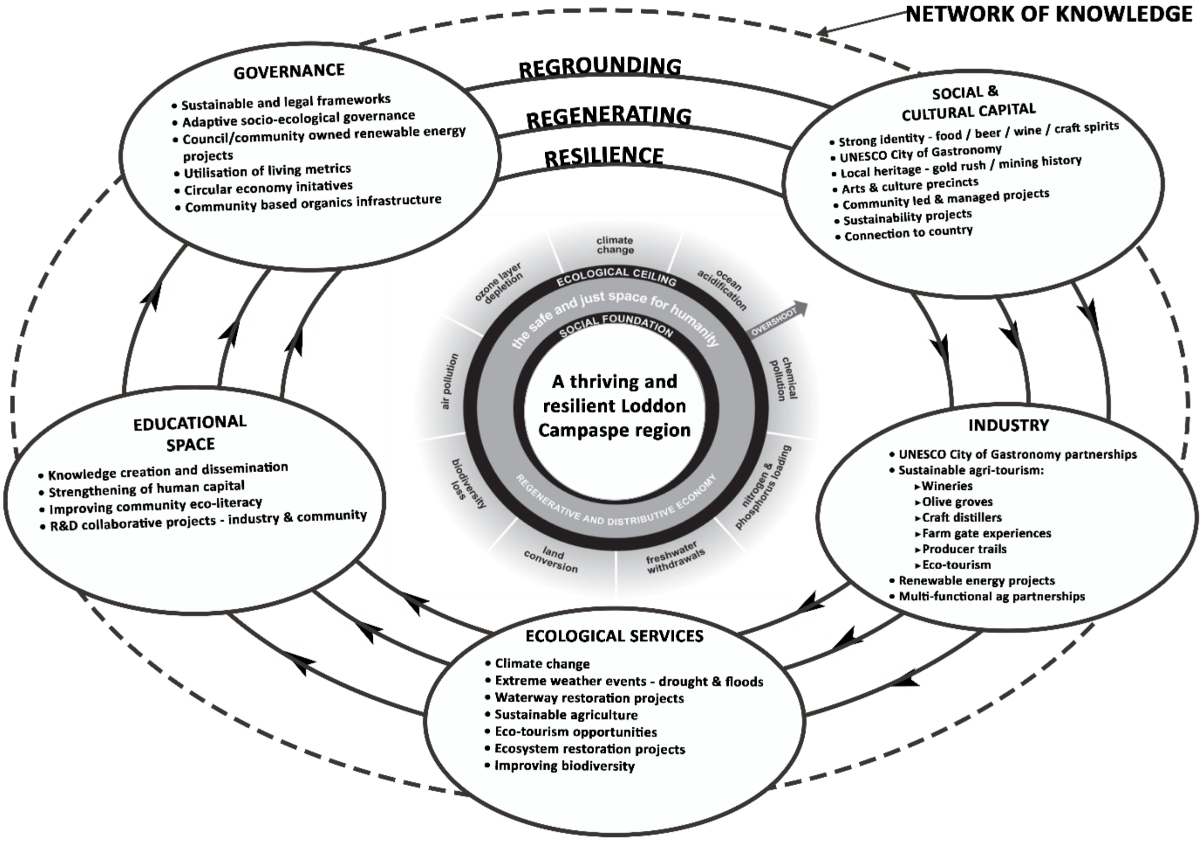

Figure 19: The Loddon Campaspe holistic rural ecosystem Adapted from: (Carayannis, Barth & Campbell 2012; Ellen MacArthur Foundation 2019; Marsden 2010; Raworth 2017)

6. Conclusion and Future Research

The main objective of this thesis was to ascertain the best way to introduce the principles of the circular economy to the craft spirits industry and to determine what improvements could be made in respect to the management of by-products from the distillation process. Much of the literature to date, regarding circularising the distilling industry, has used a scientific or hard systems lens to solve a technical issue. The adoption of a soft systems multimethodological approach, allows for a deeper appreciation of the surrounding influences and issues of the distilling industry. Coming from an insider's perspective of the distilling industry, my initial perception was that it was simply a technological problem that needed to be solved. However, upon investigating why AD processes were not commonplace in Australia (as they are in many other regions of the world) my implementation of the methodological approach towards the issue uncovered underlying concerns that would have been undetected had a different methodology been selected.

The examination of the Victorian environmental and circular economic policy uncovered a chaotic situation. Many aspects of environmental policy have remained stuck within a linear framework, due to conflicting and competing priorities and viewpoints, and, in many cases, economic policy does not incorporate the ideals of CE. Any attempts to shift towards circularising processes are generally hindered by bureaucracy, as the Victorian Government has positioned itself to encourage and promote only limited and weak sustainability measures that do little to reduce consumption or change behaviour. By considering a variety of perspectives, all with differing worldviews, a soft systems approach has enabled the author to gain greater insights into the collective experience of the distilling and olive industries. By mapping out the systems of both industries, key learnings have surfaced on how challenges can be overcome if socioecological objectives drive the decision-making process. Via the soft systems methods PQR and CATWOE, an ability to map out a trajectory towards a more circular future for the distilling industry has developed.

Whilst the CE has the potential for communities and businesses to start the transition towards a more sustainable future and be a "tool for transformative change" within the Victorian context, it has been narrowly viewed as a solution to the waste management crisis and nothing more (Friant, Vermeulen & Salomone 2020, p. 15). To achieve transformative change, a more holistic lens needs to be applied. By amalgamating the principles of CE, DE and EE, the holistic rural ecosystem provides a helpful model to encourage ecologically focused place-based solutions to be tailored specifically to a region.

This research provides a starting point for the development of sustainable production standards for the distilling industry. As the distilling community expands, the adoption of these standards, accompanied by supportive regulatory frameworks, will be a vital component in the transition towards circularity. Whilst this research has generated a new appreciation of the system, and has identified a knowledge gap, future research will be necessary to generate further insights and to determine refinements in the identification of actions for improvement in the industry.

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Appendices

Appendix A – Boundary Judgements – Ideal Map, Distilling Industry

Boundary Judgements – Ideal Map, Distilling Industry – “ought mode”				
Sources of influence	**Social roles (stakeholders)**	**Specific concerns (stakes)**	**Key problems**	
Sources of motivation	1) *Beneficiary*	2) *Purpose*	3) *Measure of improvement*	The involved
	• Distilling industry • Policy decision makers • Future generations • Communities that surround distillery • Environment, native flora and fauna	• To enable distilling industry to transition to a circular economic (CE) business model • To recirculate and channel distillery wastewater streams into avenues that create value/revenue and benefit the environment. • EPA acting in a consultative manner that supports industry in new Circular pathways for waste.	• Circularity standards for distilling industry • Cost effective waste valorisation support services. • DWW diversion • Open and transparent networks using waste as resources	
Sources of control	4) *Decision-maker*	5) *Resources*	6) *Decision environment*	
	• Distillers • Third parties - Waste valorisation providers Circular start-ups using waste as a resource	• Companies that offer Distillery waste (physical & liquid) value conversion services that is financially viable for distillers to access • Composting organics • Partnering w/ others to create new products using by-products • CE business training and transitional support	• Expertise not bound to decision maker. Must draw upon academic knowledge/R&D to determine best pathways. • Overarching goals from Fed & state govts – i.e. climate change mitigation & $C0_2$ emission targets.	

		• Grant support for new technologies/equipment to be implemented.		
Sources of knowledge	7) *Expert*	8) *Expertise*	9) *Guarantor*	
	• Accredited distilling training courses that provide detailed training on all aspects of distilling, sustainability and waste management • Resource that provides all • Industry bodies – SVA, ADA	Technical knowledge and skills: • Environment impacts of distillery by-products • Valorisation pathways for distillery by-products • Knowledge of support services available • Understanding of circular benefits for DW mgt • Understanding of CE business models • Social and environmental responsibilities.	• Comprehensive distilling industry professional working knowledge of CE business practices. • Knowledge dissemination across all levels of distilling industry, irrespective of industry body association memberships	
Sources of legitimacy	10) *Witness*	11) *Emancipation*	12) *Worldview*	The affected
	• Professional industry bodies – advocating for distillers who lack financial resources to enact change in practice • Collective CE/Sustainability community advocacy groups • Local community	• Distillery waste stream pathways be open to challenge to ensure the best options continue to be utilised.	Manage conflicts of interest between: • Siloed government departments • The pursuit of unbridled economic growth • Regional livelihoods • Distillers who do not want to adopt circular practices. The system should be based upon the ideals of the circular economy and sustainable development.	

Appendix B – Boundary Judgements – Current Map, Distilling Industry

Boundary Judgements – Current Map, Distilling Industry – "is mode"				
Sources of influence	**Social roles (stakeholders)**	**Specific concerns (stakes)**	**Key problems**	
Sources of motivation	1) *Beneficiary*	2) *Purpose*	3) *Measure of improvement*	
	• Federal & state governments (taxes – GST & excise) • Distilling industry	• Economic development • Creation of new markets overseas (export)	• GDP • LALS produced, excise paid.	
Sources of control	4) *Decision-maker*	5) *Resources*	6) *Decision environment*	
	• EPA • Local & state governments • ATO	• Trade waste permit • Trade waste cartage?	• Alternate by-product pathways require EPA approval	
Sources of knowledge	7) *Expert*	8) *Expertise*	9) *Guarantor*	The involved
	Existing training providers in Aust. (informal 5-day course): • Distillers Institute (Tassie) (bus side of things. Not practice) • Adelaide Uni (SA) • Drinkmakers Australia (Old Norfolk Dist) • Old Kempton (Tas) • IBD – online (UK based course)	• To gain an excise manufacturer's license you need to have undertaken a 1-week course. • No formal credentials are required. Distillers come from many different backgrounds, most not related to hospitality, wine or food production industries. Level of knowledge very mixed.	• Being compliant with ATO, Liquor Licensing and Council by-laws • Following trade waste or EPA procedures for waste management	
Sources of legitimacy	10) *Witness*	11) *Emancipation*	12) *Worldview*	The affected
	• Local government • ADA and SVA, but only advocating for tax relief, govt grants, safety. In order to access these benefits you have to be a paid member of the associations. Sustainability and the CE are not actively pursued.	• The affected are not given a voice to advocate for alternate pathways. • Those that choose alternative pathways often pay high costs to be sustainable in their operation. •	• The worldview that is underlying the design of the system is neoliberal/capitalist in nature. This is beginning to change with the SDGs and CE being incorporated into policies, however the underlying processes are still	

			linear, and profit driven.	

Appendix C – Boundary Judgements – Ideal Map, Olive Industry

Boundary Judgements – Ideal Map, Olive Industry – "ought mode"				
Sources of influence	**Social roles (stakeholders)**	**Specific concerns (stakes)**	**Key problems**	
Sources of motivation	1) *Beneficiary*	2) *Purpose*	3) *Measure of improvement*	
	• Olive grower/producer • Regional communities • Future generations • The environment.	• To identify value in all by-products of olive industry production and create new value pathways that benefit the environment and regional community.	• Waste stream diversion. • Regeneration of surrounding environment of operations. • Reduction of resource inputs for production (energy, water, chemical)	
Sources of control	4) *Decision-maker*	5) *Resources*	6) *Decision environment*	
	• The olive grower/producer	• Grant support for new technologies/equipment to be implemented. • To recirculate and channel olive mill waste streams into avenues that create value/revenue and benefit the environment. •	• Expertise not bound to decision maker. Must draw upon academic knowledge/R&D to determine best pathways. • Overarching goals from Fed & state govts – i.e. climate change mitigation & $C0_2$ emission targets.	The involved
Sources of knowledge	7) *Expert*	8) *Expertise*	9) *Guarantor*	
	• Agricultural education providers • Academic research • Olive growers	• Knowledge of the possible valorisation pathways for olive grove waste streams	• Comprehensive olive industry professional working knowledge of CE business practices.	

		• Social and environmental responsibilities • Knowledge of circular business models	• Knowledge dissemination across all levels of olive industry, irrespective of size of operation. • Standard environmental practices adhered to, reviewed and constantly improved.	
Sources of legitimacy	10) *Witness*	11) *Emancipation*	12) *Worldview*	The affected
	• DELWP • Respective Catchment Management Authorities • Local regional community residing in area of olive grove operation.	• Olive grove waste stream pathways be open to challenge to ensure the best options for environment continue to be utilised.	• The design of the system should be based upon the ideals of the circular economy and sustainable development	

Appendix D – Boundary Judgements – Current Map, Olive Industry

Boundary Judgements – Current Map, Olive Industry – "is mode"				
Sources of influence	**Social roles (stakeholders)**	**Specific concerns (stakes)**	**Key problems**	
Sources of motivation	1) *Beneficiary*	2) *Purpose*	3) *Measure of improvement*	The involved
	• Olive growers • Federal & state governments (taxes)	• To produce olive oil to a high standard which can be sold domestically and into export markets. • Production processes to reduce the impact caused to the environment.	• Abiding by EPA regulations • Financial outcomes/ increased business growth.	
Sources of control	4) *Decision-maker*	5) *Resources*	6) *Decision environment*	
	• Olive grower/producer	• Two phase or three phase decanters in use for processing olives. • R&D research from a Fed govt level that identifies new	• Environmental regulations • Permissions required for valorisation techniques which have already been proven by research to be effective and	

		efficiencies and environmentally friendly waste processing techniques.	environmentally friendly.	
Sources of knowledge	7) *Expert*	8) *Expertise*	9) *Guarantor*	
	• Agricultural colleges & TAFE courses – content presented: broad, agriculture, horticulture, organic farming. Nothing specifically tailored for olives. • Olive industry associations • Agrifutures resources & research • Olive grower workshops	• None – anyone can enter the industry, some are self-taught and have undertaken short courses or work experience. Very limited formal training opportunities for oliveculture (Australian Olive Association 2018b).	• Abiding by EPA regulations • Consitent product produced	
Sources of legitimacy	10) *Witness*	11) *Emancipation*	12) *Worldview*	The affected
	• Community can be affected by malodours from evaporation ponds (depending on size of operation and proximity to neighbours) • Country Management Authority • Agrifutures • EPA	• Neighbours can complain about producer via local government channels or EPA	• The government, industry and society operate under a capitalist economic system – pursuit of financial growth reigns supreme. • Environmental regulations geared around disposal and protection of human health – whilst documentation encourages looking at other pathways, the responsbilibty of that lies solely with the producer – EPA do not provide suggestions for alternate pathways for by-products. (same is true for distillers)	