

**Changing Nappies: Understanding the persistence of disposable nappies and
evaluating the potential of compostable nappy services**

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Certificate of original authorship

I, Jason Graham-Nye declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy in Sustainable Futures, in the Institute for Sustainable Futures at the University of Technology Sydney. This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Publications included in thesis by compilation

Paper 1. “Windows of opportunity: The power dynamics in the disposable nappy regime and opportunities for niche innovations”. Published in “Cleaner and Responsible Consumption”, Volume 12, March 2024, 100169 <https://doi.org/10.1016/j.clrc.2024.100169>

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Declaration by co-authors

In the case of Paper 1, the undersigned agree that the nature and extent of the contributions to the work was as follows:

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Preface

Before commencing the introduction to this thesis, I have set out below my research motivations and background to the research.

Research Motivations

This research marks the continuation of a 22-year sustainability journey that started when my first born, Fynn arrived in September 2002. At that time, my wife and I read a statistic that a cup of oil is needed to make each of the 5,000 disposable nappies we were about to use on our son. We also discovered that each nappy is disposed of in landfill where it would stay for up to 500 years. As new parents faced with a plethora of new consumption decisions and the thought of what kind of world we would be leaving our children, we decided to leave our careers and turn our attention to solving this subset of the plastic waste crisis. At the time, plastic waste was not a significant topic, and we were sure that a five-year focused effort would see us solve the problem (!). We chose to take a commercial route, identifying novel design patents for a more sustainable, hybrid nappy moving to the US from Sydney, Australia, securing venture funding and building a business.

Along the way curious phenomena emerged which confounded not only us, but larger groups of sustainably minded entrepreneurs we encountered. We were all attempting to engage with consumers and encourage more environmental purchasing decisions. These issues were continually being discussed at sustainability conferences, industry events and trade shows. They continue to do so to this day. We encountered what I now understand is the “attitude-action gap”, where most consumers surveyed would say they would make the greener product choice, while in fact a far smaller number actually do so. Greenwashing also emerged, muddying the waters for unsuspecting consumers unaware that the product claims being presented to them did not equate to a sustainable nappy option. This included claims with partial information, misrepresentations, and products that were not supported with appropriate systems. Positively though, we observed the impact of pro-environmental new parents embracing this unique life stage and actively pursuing a whole range of new consumption habits. The emergence of the

Circular Economy as a response to the unsustainable nature of the linear, take – make - waste economy also offered hope. These represented flickers of possibility. Collectively however, these were just loosely connected observations without a strong anchor. In 2019, reflecting on the on-going degradation of the planet, particularly the plastic waste crisis since we started the company and the lack of scale of so many consumer-facing businesses, I saw that the business world had few answers to these conundrums. I therefore chose to pursue the academic path to seek out new insights that could perhaps anchor these disparate thoughts, potentially benefit future researchers and be applied in the business world. Since commencing this research, ever- increasing natural resource use globally is accelerating climate change, pollution and biodiversity loss (United Nations Environment Programme 2024). This has further motivated me to seek solutions through research.

Leveraging prior skillsets

Prior to my career change into the world of eco-friendly nappies, I worked as a Japanese interpreter and translator. The academic discipline to gain language proficiency, complete a Masters of Japanese Sociolinguistics and work as a simultaneous interpreter offered me some of the skills that I understood were required to conduct higher degree research in the field of sociology. These skills included the ability to read and listen carefully, assess for context and remain as objective as possible. This last point is of paramount importance from an ethical standpoint in interpreting. I felt that as someone who did not follow the usual path to higher degree research (undergraduate, Masters, Doctorate) these skills would nevertheless stand me in good stead as an early-stage researcher. As I commenced my literature review, I was relieved to find a key additional parallel between the Japanese language and sociological concepts that has helped ground my research. As a high context language, the on-going and recursive interactions between the Japanese language and culture are similar to those that exist between society and culture described by sociologists like Bourdieu (1984). I had a familiarity with this notion and one which formed one of the foundations of my research.

Addressing Research Risks

I have come to higher degree research to investigate nappy consumption practices after 20 years' operating an eco-friendly nappy business. While bias is a risk when conducting any research, I am cognisant of a significant additional risk that my professional background could influence my research activities. There is evidence of bias in academic research in the consumer field to use the discipline of higher degree research to steer a conclusion about a certain topic for commercial gain (Lesser et al. 2007, Stewart and Niero 2018, Rao 2022). A specific example in the nappy industry is the production of paid academic research highlighting the benefits of the sponsors product over a competitor's product such as (O'Connor et al. 2019). In this case, of the seven authors, five are full time employees of Proctor & Gamble, the largest nappy manufacturer in the world while the remaining two were paid by the company for this research. One of the two products assessed in the research was made by Proctor & Gamble and the results found that this product had superior attributes. While the required conflict disclosures were made, headline academic research results can often form the basis of claims made in marketing materials targeting consumers of the product. These can often set aside the caveats and disclosures of the research itself (Lesser et al. 2007, Shafer et al. 2019, Rao 2022). Over the course of my research, I have been very mindful of these issues and made my best effort to address it with on-going conversations with my supervisors. Somewhat like my previous work as a Japanese interpreter, the test is to remain objective to the content of the words to be interpreted and be steadfast in simply interpreting them with objectivity. In pursuing academic research, my commitment is to generate objectively new insights in the field that can benefit all stakeholders whether they be future researchers, industry actors including direct competitors and policy makers. I detail more of my positionality in Chapter 3 of this thesis.

With this personal background established, Chapter 1 that follows introduces the terrain that this thesis attempts to cover.

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Glossary

| Key Term | Definition |
|----------------------------------|--|
| disposable nappies | single-use absorbent garments used for infant sanitation. |
| reusable nappies | washable, reusable absorbent garments used for infant sanitation. |
| compostable nappies | A type of nappy designed to compost under specific conditions, typically through industrial composting. |
| Global North | Refers to countries with higher income levels and developed economies |
| Global South | Refers to countries with lower income levels and developing economies. |
| Circular Economy | An economic system aimed at eliminating waste and promoting sustainable resource use through recycling, reuse, and reduction of resource consumption. |
| Extended Producer Responsibility | Concept where manufacturers are responsible for the environmental impact of their products throughout their lifecycle, including disposal |
| Socio-Technical System | A system comprising technological elements and social practices that interact to achieve a common goal. |
| Multi-Level Perspective (MLP) | A theoretical framework used to analyse transitions in socio-technical systems, focusing on interactions between niche innovations and dominant regimes. |
| Social Practice Theory (SPT) | A framework that explores how social practices are formed, sustained, and changed over time through the interactions of materials, meanings, and competencies. |

Abstract

Disposable nappies have become a major source of global plastic waste since their widespread adoption in the 1980s, prompting various efforts to mitigate their environmental impact. These include industry attempts at downcycling, policy-driven bans, and subsidies for reusable alternatives, but these approaches have proven ineffective. Concurrently, new sustainable nappy innovations and business models offer promising solutions to this escalating environmental crisis. Given the United Nations' initiative to coordinate a treaty on plastic waste (United Nations Environment Programme 2022), there is a pressing need for comprehensive research into the dynamics and potential resolutions of the disposable nappy waste issue.

Existing research has primarily focused on reusable nappies' viability as an alternative but lacks insights into why disposable nappies dominate and hinder the emergence of environmentally friendly alternatives. To fill this gap, this study explores the dominance of disposable nappies and investigates the feasibility of a novel compostable nappy service as a viable alternative. It employs Sustainability Transitions and Social Practice Theory frameworks, using the Multi-Level Perspective (MLP) to analyse industry dynamics and Social Practice Theory (SPT) to understand household-level nappy practices.

The research unfolds in three phases: The first phase takes a macro view using MLP, identifying key stakeholders at regime and niche levels through interviews. It applies the "windows of opportunity" framework to assess a compostable nappy innovation's potential threat to the disposable nappy regime, highlighting regulatory barriers and lack of composting infrastructure as hindrances.

The second phase adopts an SPT approach at the household level, conducting a field trial of a compostable nappy service with 20 families in Sydney, Australia. It examines nappy practices, observing that convenience, reliability, and cost-effectiveness heavily influence mothers' choices. Resistance to compostable nappies stemmed from new competencies required and reliability issues.

In the third phase, MLP and SPT intersect to identify barriers including convenience and normative preferences that sustain the disposable nappy regime. Proposed interventions include the development of one-piece compostable nappies and policies such as Extended Producer Responsibility to accelerate sustainability transitions.

This research contributes to the literature by applying MLP and SPT uniquely to the nappy industry, examining niche-regime dynamics and identifying potential pathways for sustainability transitions. It underscores the need for systemic interventions and shifts in consumption practices to mitigate the environmental and health impacts of disposable nappy waste globally.

Chapter 1. Introduction

“Single-use nappies are one of the biggest contributors to plastic waste globally”

(United Nations Environment Programme 2021)

1.1 An introduction to Disposable Nappies and their Environmental Impacts

The 2024 Global Resource Outlook report estimates that in the absence of interventions, material resource extraction including oil to make plastics could increase by 60% from 2020 levels by 2060 (United Nations Environment Programme 2024). In 2023, annual production of plastic disposable baby nappies reached 157 billion units, generating revenues of USD \$57 billion (World Economic Forum 2023, Statista 2024). Disposable nappies have considerable negative environmental impacts, due to three factors. Firstly, the production of the plastic films used in disposable nappies depend heavily on oil. Secondly, their disposal in landfills leads to the emission of greenhouse gases, driven by the decomposition of organic components. Lastly, the durability of the plastic materials in the environment after disposal raises ongoing ecological concerns. Disposable nappy waste is particularly severe in Global South contexts which often have inadequate waste management systems (Khoo et al. 2019). Notably, disposable baby nappies constitute 27% of household waste in the 15 island nations of the South Pacific, where around 800 million units are used each year (Khoo et al. 2019). The United Nations Environment Programme has recognised disposable baby nappies as a major source of global plastic waste (United Nations Environment Programme 2021).

Responses to these circumstances have yielded little results. At a country level and reflecting the scale of the problem for Global South countries, Vanuatu announced a world-first ban on the importation of disposable nappies in 2019 (Olivo 2019). It was then paused in 2020 due to protests by mothers who felt they were being forced to use reusable, washable nappies which were less convenient (RNZ 2020). This response suggests the complexity of the issue, beyond the product to the user and their needs and the importance of careful consideration of any policy interventions. In 2022, in response to Vanuatu’s experience, the Secretariat of the Pacific Regional Environment Programme (SPREP) made up of 21 South Pacific member nations

conducted a review of alternatives to disposable nappies. It concluded that challenges emerge with all nappy formats and additional research was needed (European Union et al. 2022).

The United Nations Environment Programme's commitment to tackling the broader plastic waste issue was highlighted by the announcement of a globally binding plastics treaty in March 2022 (United Nations Environment Programme 2022). Its goal is to end plastic waste pollution globally by 2040. After four rounds of negotiation however, divisions between stakeholders over how to tackle the issue persist. These range from whether restrictions on single-use plastic should be introduced, whether chemicals that have known health risks should be banned or whether limitations should be put on the production of plastics (Reuters 2024). Tensions are also evident between Global North and Global South countries and the question of who pays for these initiatives (Dreyer et al. 2024). These two examples show the complexities involved in developing solutions to address the plastic waste crisis (Discussed in more depth in Chapter 2).

This research seeks to understand why disposable nappy practices dominate. It also explores one potential solution and, in this context, seeks to understand constraints and possible intervention points that might support the adoption of the alternative nappy technology. Insights from this one potential solution could then inform other solutions. This thesis serves to offer additional potential responses that are more nuanced than outright bans on products and involve stakeholders at the industry and user level rather than at a national or international level.

1.2 Parenthood and Nappies

Becoming a parent is one of the most significant experiences in a person's life (Fillo et al. 2015). From the very first day a baby is born, one key component of this care is managing their hygiene needs. In the developed world, the use and disposal of disposable nappies (also known as "diapers" in North America) are an everyday part of life for parents (Fillo et al. 2015).

Disposable nappies are also growing in popularity for parents in emerging economies where large populations are entering the middle class (Homi 2010, World Bank 2018). Notwithstanding the many non-heteronormative family structures that exist, the literature maintains a focus on heteronormative family structures. Within this structure, while the involvement of fathers in changing nappies has increased over time (King 2012), it is the mother who typically manages the hygiene needs of their children (Scott 2000, Parker and Wang 2013). There are implications

for the way mothers handle this transition as they attempt to meet societal expectations of being a “good” mother which includes their choice of nappies. Sharon Hays’ seminal work “The cultural contradictions of motherhood” (1996) introduced the notion of “Intensive Mothering” as a way to understand what it is to be a “good mother” after researching mothers across a broad range of socio-economic levels. Intensive Mothering describes good parenting as child-centred, time-consuming, and self-sacrificing. Despite the passage of time, this ideology remains dominant. There are strong societal expectations pressuring mothers to conform to social norms related to being a good mother. These include unattainable expectations of maintaining a clean home, healthy meal preparation, and meeting the needs of their family as the main care giver along with their choice of nappies (Huisman and Joy 2014). In the face of these expectations women often feel they are failing to meet these standards. Bourdieu (1984) captures the inherent complexity of such phenomena and takes a broad view by suggesting that the agency of individuals and the structures they interact with are recursively related. This implies that agency influences structure and structure influences agency. My research broadly adopts Bourdieu’s perspective to investigate how mothers navigate the practice of infant sanitation within the context of sustainable consumption. A detailed literature review in Chapter 2 identifies additional theoretical frameworks that have been useful in understanding consumption at both a macro, socio-technical level and at a micro, household level.

1.3 Research Purpose

Given the destructive environmental impacts of disposable nappies set out above, the purpose of this research is to improve our understanding of disposable nappy practices in order to provide possible alternatives to move the industry in a more environmentally sustainable direction. The ultimate goal is for the insights from this research to help inform future research agendas, policy makers, along with public and private institutions who are grappling with environmentally unsustainable nappy consumption practices. Despite significant amounts of evidence showing the growing negative impacts of plastic waste in the environment, including the relatively high proportion of plastic nappy waste, effective interventions to address the problem have yet to be thoroughly explored and tested (Khoo et al. 2019, United Nations Environment Programme 2021).

As a daily, mundane consumption practice, conducted mostly by mothers, disposable nappy practices have, to date gone relatively unnoticed in the literature. There are gaps in our understanding of what makes disposable nappy use so persistent, and which limits our ability to identify viable solutions to address the problem. This includes understanding the dynamics between the key stakeholders that surround the practice at a macro level such as manufacturers, retailers, childcare centres, waste management companies and waste regulators and the practitioners and associated elements that make up the practice at the micro level. To understand the macro and micro levels of the problem, I separately employed two theoretical frameworks, the Multi-Level Perspective and Social Practice Theory. I then combined them to conduct a dual lens analysis of the socio-technical nappy system and the practices that sit within it. This is discussed in detail in Chapter 2.

1.4 Research Scope

My research is centred around two focal areas based on the gaps that emerged in my literature review (Chapter 2). Firstly, I explored the reasons why disposable nappy practices are so persistent. Secondly, I tested whether a compostable nappy service could present a viable alternative.

I selected a compostable nappy service as the subject of this research for several reasons. Firstly, through the course of my career, I had been searching for more sustainable nappy options. This led me to focus on compostable nappies. I then reviewed the literature to understand what was known of alternatives to disposable nappies. I found that reusable nappies had been the subject of a great deal of research however prospects in becoming mainstream appears limited (Kamat and Malkani 2003, Aumônier and Collins 2005, Environment Agency 2005, Bowery 2006, Pendry et al. 2012, Wilks 2013, Klein 2018). I also found that while there have been attempts at recycling disposable nappies, these processes can be more accurately described as downcycling and prior work have offered no tangible results that might support the establishment of new recycling industries for nappies (Fater SpA 2017, Nonwovens Industry 2017, Warner et al. 2017, CSIRO 2022, Welsh Government 2022). Recycling disposable nappies also fails to address the use of oil in the nappy's upstream production.

Two factors made the compostable nappy particularly compelling. Firstly, it was yet to be fully commercialised, presenting an opportunity to create new insights. Secondly, the offering is unique in that it is a product offered with a delivery, collection and composting service known as a “Product-Service System”. Product-Service Systems are an example of a Circular Economy business model, for which real world examples have received limited research attention. The notion of a Circular Economy is a contested concept in the literature. There is however evidence that it may hold promise as a way forward for sustainable consumption if the broadest definition of the concept, known as the “10R” framework is adopted (Hartley et al. 2020, Kirchherr et al. 2023).

The nappy used in this study is made up of a commercially compostable, absorbent chassis and a reusable, washable belt. Parents dispose of the compostable chassis in a dedicated receptacle for collection and wash the reusable belt. The belt requires washing approximately once per week. See Figure 1 below. This product was invented in Australia by Kuver Designs Pty, Ltd. My company, gDiapers has a license to market this product in all regions outside Australia and New Zealand. As such, I have limited conflict of interest conducting this research as I have no commercial gain from the results pertaining to adoption in the Australian context. There will be potential benefits for my company if the findings are applicable in overseas markets where my company operates. This is a sociological rather than technical study, and consequently, I will not be assessing the compostability of the product as that research has been conducted elsewhere (Ellen Macarthur Foundation 2020, Australian Broadcasting Commission 2022).



Figure 1. A compostable nappy featuring a commercially compostable chassis and a reusable, washable belt.

I targeted both practitioners actively engaged in enacting nappy practices every day to understand the various pressures, constraints and ideas guiding their behaviour, and the actors that help create this pressure at a system level. At the systems level, I identified stakeholders at the niche and regime levels as described in the Multi-Level Practice (MLP) (Geels 2010) across industry, policy, regulatory bodies who surround the nappy practice. These included nappy manufacturers, supermarkets, childcare centres, state government waste regulation authorities, waste management companies, local government waste educators and maternity hospitals. MLP has proven effective in gaining insights into the dynamics between niche innovations attempting to threaten dominant, regime level stakeholders in other fields. This suggests that the application of this approach holds promise for the nappy industry. I then applied Social Practice Theory (SPT) at a household level (Shove and Pantzar 2005). These two research projects form the first two research papers that make up this thesis. I then reanalysed the data using the SPT – MLP dual lens approach to develop a third research paper.

Data collection for my research was restricted to Sydney, Australia which limits the applicability of findings in other geographies. Given the city has a large, heterogenous population with variations in socio-economic and cultural backgrounds, representative sampling was not possible. Further research is required to assess whether the findings of this research project can be replicated in different contexts. In aggregate, my focus was to understand the dominance of disposable nappy practices and how new nappy practices offering better environmental outcomes can emerge.

1.5 Research Questions

Based on my research purpose set out above, I developed two primary research questions to interrogate firstly, the factors that keep the current dominant nappy practices in place and secondly, how a compostable nappy and service might threaten the nappy regime. I have also developed sub-questions to gain further insights into each of the primary questions.

Primary research question 1:

What are the dynamics that influence the persistence of disposable nappies as a normative practice?

Sub-question 1.1:

In the nappy regime, what are the power dynamics across the incumbent stakeholders ?

Sub-question 1.2:

What is the relationship between domestic scale, everyday nappy practices carried out by individuals and stakeholders in the nappy industry that produce a persistent nappy practice

Primary research question 2:

Are there ways that a compostable nappy service can overcome adoption constraints?

Sub-question 2.1:

What are the challenges and opportunities encountered by parents using a compostable nappy service?

These questions collectively support the primary contention: that shifts to sustainable nappy consumption necessarily involves change at the regime level and practice changes. This requires new understanding at both these levels to understand what the constraints are and to inform effective interventions. Responses to the three sub-questions appear in three separate research papers which form the core of this thesis.

Disposable nappies are a significant contributor to household waste, with substantial environmental implications due to their non-biodegradable components and the resources required for production and disposal. Understanding the factors that sustain their widespread use can inform strategies to mitigate their environmental impact, promoting more sustainable consumption practices. While there is extensive research on the environmental impact of disposable nappies, less is known about the socio-cultural and economic factors that perpetuate their use. These research questions aim to address this gap by exploring the interplay of various dynamics—social norms, economic factors, convenience, marketing influences, and cultural practices—that maintain the prevalence of disposable nappies. These questions seek to uncover the motivations and practices that underlie the continued use of disposable nappies. By identifying these dynamics, the research can contribute to the development of targeted

interventions to shift consumer behaviour towards more sustainable alternatives. Insights from this research can aid policymakers in designing effective regulations and incentives to reduce reliance on disposable nappies. The findings can also help manufacturers and retailers of baby products to develop and promote more sustainable options, aligning business practices with environmental goals.

As the literature review in Chapter 2 highlights, the user within a Circular Economy is often ignored. This research attempts to address this gap by focusing on the various elements of consumption including the user. I move from what has been commonly regarded as a product that is used by a parent to the concept of “practices” as introduced by SPT (Shove and Pantzar 2005). This theory attempts to depict the complexity of consumption, involving not just the product and a user but the many other factors and actors that make up the practice.

1.6 Significance of Research

This research has the potential to benefit society broadly by offering insights into why alternatives to disposal nappies struggle to gain dominance and how things might change. The research also offers both academic contributions and practical applications. In academia, insights from this research have the potential to inform the fields of social practice and the dynamics of transitions in socio-technical systems. In industry, research discoveries can help guide public and private sector actors grappling with sustainability challenges, especially at a household level. Household consumption contributes to around 72% of global Greenhouse Gas emissions when considering the entire lifecycle of products and services, including production, transportation, use, and disposal (United Nations Environment Programme 2019). Efforts to curb Greenhouse Gas emissions must therefore include efforts in the realm of household consumption. Beyond contributions to academia and industry, a broad adoption of the insights from this research could have positive impacts on the environment. This research may lead to new nappy practices that create fewer damaging impacts on the environment in the upstream, manufacturing stage, use-phase and downstream end of life stage.

1.6.1 Contribution to Knowledge

This research sits at the intersection of two academic fields, namely sustainability transitions and social practice theory. Sustainability transitions is an interdisciplinary field that examines the processes and dynamics involved in shifting socio-technical systems towards more sustainable modes of production and consumption. It involves understanding how technological, institutional, economic, and cultural changes interact to enable large-scale transformations necessary for achieving long-term environmental sustainability. This field explores the pathways and strategies that can facilitate the adoption of sustainable technologies and practices, considering the complex interplay between different actors, institutions, and systemic factors. Social practice theory, on the other hand, provides a framework for analysing the routine behaviours and practices that constitute everyday life. It emphasizes the importance of understanding how practices are socially and culturally embedded, focusing on the elements that sustain and change these practices over time. Social practice theory looks at how material arrangements, skills, competencies, and meanings interrelate to shape the way people behave and interact with their environments.

By combining insights from both the sustainability transitions field and social practice field, this research aims to offer a comprehensive understanding of how sustainable practices can be effectively promoted and integrated into daily life. It seeks to identify the factors that influence the persistence of certain behaviours, such as the use of disposable nappies, and to explore the potential for systemic change towards more sustainable alternatives.

The research offers three innovative theoretical applications which in turn produced a set of unique insights. It is the first application of MLP to a specific product rather than a system and did so in the nappy category for the first time. It tested and confirmed the “windows of opportunity” framework developed by Tongur and Engwall (2017) and suggested how future windows of opportunity can remain open to accelerate sustainability transitions in the nappy industry. It is also the first application of SPT to the practice of nappies showing how the various elements that make up a practice interact and stabilise the current, dominant practice. Much of the research to date using SPT has focused on systems-level fields such as energy, food and mobility. By applying SPT to a lower order field and specifically on a practice that is both high frequency (five to seven nappy changes per day) and with a plastic disposable product at the

centre of it, new insights emerge. Lastly, it is the first time the dual theoretical lens approach using both SPT and MLP has been applied to nappy practices at a micro-level and the socio-technical system within which the practice sits at a macro level. This burgeoning theoretical approach produces unique insights that can contribute to both the practice and socio-technical transitions debate.

The research shows for the first time the significant barriers that exist for socio-technical transitions to take place in the nappy industry as it relates to shifting to a product service system. To date there has been little understanding of how stakeholders in the industry would respond to such a transition and what it would take for niche innovators to threaten the regime. The research supports previous studies that showed that changing conventions are one of the most difficult elements of a practice to shift (Hargreaves 2011, Sahakian and Wilhite 2014, Jack 2018, Gazull et al. 2019). The research also shows that existing communities of practice established for new mothers to learn new parenting practices could be leveraged to introduce new, more sustainable nappy practices (Sahakian and Wilhite 2014).

1.6.2 Practical Applications

There are several practical applications of the research insights. For disposable nappy manufacturers, developing a one-piece compostable nappy at scale would deliver the performance, reliability and price point that practitioners demand and generate better end of life outcomes, environmentally. The UN Plastics Treaty to be announced in December 2024 may have implications for nappy manufacturers in terms of their access to and use of plastic films at current prices (Dreyer et al. 2024). There could be applications of the findings in this research that can support regime actors introducing more sustainable nappy practices to the market. For policy makers, considerations ranging from expanding the scope of compostable items accepted in existing Food Organic Garden Organic (FOGO) waste collections to the role of a mandated Extended Producer Responsibility (EPR) scheme for all nappy manufacturers could be made. In the case of waste regulations in New South Wales where the research was conducted, currently only food waste and garden waste are accepted in FOGO programs (Proust 2022). Mandated EPR as a policy tool is growing in popularity in Europe (Nelles et al. 2016, Lifset et al. 2023)

and may be a consideration in the Australian context as the government develops its 2030 Circular Economy roadmap (Department of Climate Change 2023). In addition, opportunities emerge for other stakeholders including hospitals, waste management and childcare centres to adjust their approaches in order to support alternative nappy practices. Further afield, and as mentioned previously, in Global South countries such as Vanuatu, outright bans on the importation of disposable nappies were announced before being paused. This was to allow for a more thorough investigation of alternative nappy products (Olivo 2019, RNZ 2020, European Union et al. 2022). While SPREP's research found reusable and compostable nappies held promise, there was no consideration of the nappy practice as a whole and how regime actors can be encouraged to participate. This approach would provide a more holistic assessment. Insights from the research in this paper could be applied to future research projects for Global South countries assessing interventions to address their plastic nappy waste issues.

1.7 Thesis Overview

There are three papers that form the core of this thesis. Paper 1 starts with an investigation of regime and niche actors in the nappy industry. Barriers and enablers that might affect a pro-environmental, niche innovator's progress toward joining the regime were identified. Paper 2 centres on a field trial of a novel compostable nappy and service practice with 20 families in Sydney which highlighted the challenges of adopting product-service systems in the context of nappies. Paper 3 brings the two previous papers together by offering a dual lens analysis of both the regime and the practice and developing a range of interventions to support new sustainable nappy practices. Chapters 2 and 3 support the core argument with a thorough investigation of the theoretical and methodological approaches used in this research. Chapter 7 concludes the thesis with concluding reflections and considerations for future research. As is often the case with theses by compilation there is a degree of repetition between the papers particular in the building of arguments to justify each piece of research. The insights presented and contributions offered in each paper are however unique and together support the overarching argument.

1.7.1 Overview of chapters and summary of papers

Following this introduction in Chapter 1, Chapter 2 reviews the various fields of inquiry to conduct this research. This includes the key concepts and theories in the literature and identifies gaps that support the rationale for pursuing this line of research.

Chapter 3 presents the methodologies reviewed and adopted to conduct this research. An exploration of the Theory of Planned Behaviour and its role as the dominant framework for behaviour change is conducted as are investigations of MLP and SPT. My ontological and epistemological positions are set out as are reflections on my positionality as a researcher and ethical considerations. The research design is presented along with methods for data collection and analysis.

Chapters 4 to 6 feature the three research papers that have either been published or have been submitted for publication. A summary of these can be found below in Table 2. This is a thesis by compilation in accordance with UTS' Graduate Research Education Framework. Each of these has responded to the three sub-questions above. Below is a summary of each paper and its publication status as of the submission date for this thesis.

Chapter 7 sets out overarching conclusions and reflections on the research along with implications for practice and policy areas and considerations for future research.

Paper 1. Windows of opportunity: The power dynamics in the disposable nappy regime and opportunities for niche innovations.

Authors:

Jason Graham-Nye

Nick Florin

Monique Retamal

Published in "Cleaner and Responsible Consumption", Volume 12, March 2024, 100169

<https://doi.org/10.1016/j.clrc.2024.100169>

Paper 2. Challenging the durability of disposable nappy practices with a novel compostable nappy and service.

Authors:

Jason Graham-Nye

Nick Florin

Monique Retamal

Rachael Wakefield-Rann

Submitted to “Consumption and Society” on 31 January 2024. Feedback was received and an amended manuscript was submitted on 5 June 2024.

Paper 3. Normalising compostable nappy practices: A zoom out, zoom in approach to unlocking sustainability transitions in the nappy industry.

Authors:

Jason Graham-Nye

Nick Florin

Monique Retamal

Rachael Wakefield-Rann

Submitted to “Sustainability: Science, Practice and Policy” on 10 June 2024.

Chapter 2. Background and Literature Review

2.1 Chapter introduction

In order to address the two primary research questions developed for this project, I conducted a review of relevant literature to contextualise my study and identify the research gaps. This process involved a selective approach to ensure that the review remains focused on the core objectives of my research, which examines the persistence of disposable nappy practices and the potential for sustainability transitions. This chapter is divided into two sections. The first section presents a review of the literature that describes a brief history of disposable nappy practices, their environmental impacts and attempted interventions to contextualise the problem. This background literature helps sets the scene for, but I make no claims to contributing new knowledge to the fields within which this literature sits, namely material sciences, product design, lifecycle analyses and business models.

In the second section, I start with a focus on two broad fields, parenting practices and sustainable domestic hygiene and cleaning practices. I then narrow the focus and review literature in the sustainability transitions field to the extent it can illuminate insights on household practices. In doing so I identify research gaps that this research attempts to address and suitable theoretical frameworks to apply to the research. The review in this section is not comprehensive as each of the three papers that form the core of this thesis have their own literature reviews, specific to the research question they are addressing.

2.2 Background

This section is focused on literature related to the nappies themselves, the scale of the waste that the dominant nappy practice creates and attempts at addressing this waste issue. I included literature on nappy practices, including disposable, reusable, hybrid, and compostable nappies to understand the practical, economic, and environmental aspects of these choices. Studies examining the environmental impact, consumer preferences, and market dynamics of nappy use were prioritised. I included a review of the emerging concept of the Circular Economy and

interventions that could enable circularity to address the waste created by the dominant nappy practice. I did so to address my second primary research question that introduces a possible solution. I excluded technical literature on the manufacturing of nappies and detailed chemical analyses of materials unless it had direct implications for sustainability transitions. Examples of technical literature that was included are product end-of-life research including landfilling, recycling, and composting that helped inform the design of this research. This review helped inform other key research decisions, including understanding what interventions had been attempted to date, which novel nappy technology to select for this research project and which geographical context to conduct the research.

2.2.1 Nappies past and present

For many parents in developing economies and a minority of parents in developed economies, nappies are not used. Instead “Elimination Communication” is used to detect a baby’s cues and provide the parent with time to take the baby to a toilet of some kind (Jordan et al. 2020). However, the majority of the world’s parents use a form of nappy to manage their infant’s hygiene. The two dominant styles of nappies are reusable nappies and disposable nappies. Reusable nappies using washable textiles were the first mass produced product designed to manage a baby’s eliminations. They were first marketed in the US in 1887 (United States Patent Office 1887). The nappy was made up of a simple piece of linen and safety pins along with cloth wipes to clean a baby’s bottom upon each change. Absorbency was relatively poor due to the nature of the materials used. They therefore required parents to change the baby frequently, and this consequently meant interrupted sleep at night to avoid bed wetting. The need to repeatedly wash and dry reusable nappies along with their poor performance were two unavoidable inconveniences for parents for the first two years of a baby’s life.

In 1961 a new kind of baby nappy, commonly referred to as a “disposable” nappy was launched in the US. It featured newly developed materials including layers of polypropylene plastic, elastics, fluff pulp, adhesives and the use of sodium polyacrylate to absorb moisture (Ratnapandian and Warner 1996). The nappy could be discarded immediately after each use offering significant convenience for the parent over reusable nappies (Prasad et al. 2004). The product could keep a baby drier for a longer period due to the sodium polyacrylate allowing the

baby and parents to sleep through the night (Clark-Greuel et al. 2014, Counts and Helmes 2014). This made for better-rested parents which made the disposable nappy a compelling proposition (Ratnapandian and Warner 1996, Kamat and Malkani 2003). There were however unexpected environmental consequences of this new form of nappy which are discussed in detail in a following section.

2.2.2 Current nappy options

Disposable nappies today are made up of layers of plastic material (Ratnapandian and Warner 1996). Plastic tabs are used to fasten the nappy onto the baby. Absorbency is achieved using wood fluff pulp and super absorber (Garrett et al. 2008). They are designed to keep a baby dry for extended periods of time (Ratnapandian and Warner 1996). The dominant disposable nappy products that the small number of large multinational nappy brands manufacture are nearly identical in construction and dominated by plastic (United Nations Environment Programme 2021). This means that while the small group of companies that make disposable nappies can be regarded as an oligopoly, because the product format and raw materials are identical across the brands, disposable nappies are a monopoly. As a result, regardless of brand, they all produce the same environmental impacts. Recent variations of disposable nappies include products that use some biodegradable elements. Their end-of-life pathway is however the same as regular disposable nappies (O'Connor et al. 2019). Since their introduction in 1961, up to 95% of parents in the Global North¹ use disposable baby nappies for infant sanitation (Klein 2018). Annual production of disposable baby nappies reached 157 billion units in 2023 (World Economic Forum 2023), generating USD\$57 billion in revenue, highlighting the significant scale of the consumption (Statista 2024).

¹ The term "Global North" refers to a group of countries or regions that are typically characterized by higher income levels, greater industrialization, and relatively stronger political and economic influence on the global stage. These countries are often considered to be part of the more economically advanced and developed world. The Global North is commonly contrasted with the "Global South," which includes less economically developed and less politically influential countries.

At the same time developing economies have begun to shift away from Elimination Communication and reusable nappies toward the use of disposable nappies. This is likely due to the fact that parents in developing economies are entering the middle class and looking for the conveniences of a developed economy (SIS 2014). It may also reflect the impact of significant marketing budgets which have been able to normalise the use of their products in developing economies. Regardless of the reason, disposable nappies have a large market share and could be seen as the social norm amongst parents in the developed world and increasingly in the developing world.

Modern reusable nappies are made from a variety of durable, washable materials including cotton, hemp and PVC (United Nations Environment Programme 2021). They are fastened around the waist using hook and loop material or snaps. Some configurations offer one size that adjusts to fit babies from newborn to potty training (Garrett et al. 2008, Waste360 2021). Others use a reusable cloth insert that sit in a reusable pant. Reusable nappy services where nappies are delivered, collected and washed each week by a nappy company gained a degree of popularity in the US and UK in the 1990s (Baker 1998). The use of nappy services and reusable nappies have fallen out of favour with parents over time. Research from 2012 showed that reusable nappies were unlikely to find appeal in the mass market (Pendry et al. 2012). This is in spite of the efforts made by reusable nappy manufacturers to promote their products (NLWA 2018). Factors that may have caused the decline in the use of reusable nappies could include an increase in the well-funded global marketing campaigns by disposable nappy companies (Brunsman 2019). Proctor & Gamble's "Pampers" brand of disposable nappies are the global leader generating annual sales of USD\$10 BN (P&G Management meeting February 2019). They commit USD\$8.3 BN per year to market the brand (Business Chief 2016). This places Pampers as the largest advertiser in dollar terms of all major US consumer brands despite relatively low revenue as a proportion of marketing spend. However, sales growth opportunities for nappy manufacturers are limited by low and slowly declining birth rates in developed economies (World Bank 2019).

The use of disposable nappies becomes, in effect, the social norm. A related factor is the increasing lack of availability of reusable nappies in locations where parents would expect to buy nappies. The lack of visibility of the product could reinforce the idea that using reusable nappies is not a social norm which could further deter parents from buying it (Muranko et al. 2021).

Another factor is the increasing number of mothers who are in the work force. This may see more infants in the care of others in the form of professionally managed childcare centres, family- run day care centres, extended family, or individual caregivers (Craig and Mullan 2011, Department of Education 2021). There has been a lack of broad market acceptance of reusable nappies over many years and as such they remain a niche product. Today the global reusable nappy market is worth USD \$600 million (Market Growth Reports 2023) which represents 0.7% of the value of the global disposable nappy market.

Over the past decade new niche nappy companies have developed alternatives to disposable and reusable nappies. Hybrid nappies offer a combination of features from disposable and reusable nappies (Walker 2006). They are made up of an outer pant that is washable and reusable and an insert that is absorbent and disposable (Waste360 2021). Some variations include an insert that is commercially compostable. While this is an interesting innovation, the prevailing regulations in most developed economies prevent the composting of human faeces (EPA 2004, WRAP 2019, Ellen Macarthur Foundation 2020). In addition, the lack of broadly available commercial composting facilities limits the environmental benefits that these products offer. While a fully compostable disposable nappy has yet to be developed, a nappy made up of components that can be composted with a reusable, washable wrap has been developed and piloted (Klein 2018). The product is delivered, collected and composted by the manufacturer or a third party. For these alternatives to come to fruition, a system change is required to accommodate composting. These companies are also still limited in scale and do not have the ability to impact the global nappy market. Because of this, there is limited research demonstrating their viability. This research gap includes the question of whether consumers would broadly accept these new product formats. The following section explores the size and scale of the environmental problems created by the mass adoption of disposable nappies since 1961.

2.2.3 The significance of the disposable baby nappy waste problem

The consumption of disposable baby nappies has caused substantial damage to the environment since their introduction 60 years ago. The United Nations Environment Programme (UNEP) commissioned a report published this year exploring disposable nappies and their alternatives (United Nations Environment Programme 2021). The report stated that disposable nappies are

one of the biggest contributors to plastic waste globally (p.2). This observation sits within the context of the current global plastic waste crisis. UNEP (2021) predicts that by 2040, the amount of plastic entering oceans alone will triple to 29 million tonnes per year. That equates to 50kg of plastic per metre of global coastline (p. 2). The most recent available consumer market research shows that in 2017, 167 billion disposable baby nappies were produced in the world (Olivo 2017). There are two major environmental impacts caused by this scale of production and consumption (Khoo et al. 2019), including upstream resource consumption and downstream disposal. The upstream impact is owing to the use of non-renewable crude oil to make the plastic layers in a disposable baby nappy. One cup of crude oil is used to make each nappy (Sanderson 2008). This equals approximately 248 million barrels of crude oil to make the annual volume of disposable baby nappies. The use of oil to make disposable nappies has negative impacts both in the supply chain and in emissions. Disposable baby nappies are manufactured globally including in Asia, North America, South America, Europe, the Middle East, and Africa (EDANA 2005).

The major downstream environmental impact of disposable nappies is the 38 million tons of solid waste (Ellen Macarthur Foundation 2020) that is landfilled, incinerated or finds its way into oceans and waterways each year (Wang et al. 2016). In developed economies, waste management facilities have been established to manage waste streams (CRC 2014). Landfills are the final resting place for 85% of used disposable nappies in developed countries such as the UK (Warner et al. 2017) and throughout the European Union (Colón et al. 2013, Thaman et al. 2014). Disposable nappies are the largest non-recyclable item in landfills in the US and the largest single product category in landfill by volume (US EPA, 2019). They make up 2% of total municipal waste in the UK (UK Environment Agency Lifecycle Analysis 2008) and 1.7% of total municipal waste in Europe (Tsigkou et al. 2020). While some estimates suggest that each nappy takes 500 years to biodegrade in a landfill (Khoo et al. 2019) other research suggests that due to the durable nature of plastic, they may persist in the environment from hundreds to thousands of years (Wang et al. 2016). Landfills are the third largest contributor to anthropogenic methane in the USA (US EPA 2019). While the human waste element of nappies may contribute to emissions, the plastic elements do not. Landfill gas capture does mitigate the negative environmental impacts to a degree. All landfills in the EU are required to capture gas however just 22% of US landfills and 1.7% of UK landfills capture landfill gas (EPA 2020). If incinerated

however the plastic layers in disposable nappies will contribute to greenhouse gas emissions (WWF 2021).

In developing economies, waste management infrastructure is less established and less available, which increases leakages into the environment (Srivastava et al. 2015). Pacific island nations for example are facing particular risks in relation to disposable baby nappy waste (Filho et al. 2019). Nappy waste makes up to 25% of total municipal waste in the most vulnerable developing economies including Pacific Island nations (William et al. 2019). In a 2021 waste audit conducted by the Pacific Region Infrastructure Facility (2021), found that 40% of the Cook Islands waste stream was made up of hygiene products including nappies and feminine hygiene products. Marine plastic waste in the region is also predicted to grow by 40% over the next decade with Indonesia and the Pacific Islands being the most vulnerable (Trisia et al. 2021). Disposable nappies are the main driver of this growth. In the Brantas river basin in Indonesia, it is estimated that 90% of the 750,000 children living in the area use disposable baby nappies (Waterkeeper 2018). Incineration is a common waste management practice in developing economies (Gunamantha and Sarto 2012) with plans for more incineration facilities to be built in Indonesia (Gokkon 2019). However, an estimated 5 million disposable baby nappies are discarded into the river each month. This makes nappies a larger marine polluter than single-use plastic bags in Indonesia (Waterkeeper 2018).

The disposable baby nappy waste issue is exacerbated by four critical factors facing the Asia-Pacific region. The first is birth rates which are double that of developed countries such as the UK, US and Australia (World Bank 2018). This high rate increases the volume of nappy waste for every family who chooses to use disposable nappies. It may also explain why disposable nappy sales growth in developing economies is exponential according to Hoffmann et al. (2020). The disposable nappy industry journal, Nonwovens Industry (2020) predicts that while the global nappy market will grow at a Cumulative Annual Growth Rate (CAGR) of 3.5% over the next 4 years, expected CAGR in Indonesia is 11.8%. Alternatively the major nappy manufacturer's significant marketing focus on developing economies to take advantage of these high birth rates is acting as a significant driver of sales growth and subsequent waste (Brunsmann 2019). The increasing number of people entering the middle class and looking for developed economy

conveniences is also contributing to the growth in disposable nappy sales and waste (Homi 2010, World Bank 2019). The second factor is the lack of waste management infrastructure. The third factor is a lack of waste management policies by government (Morrison and Munro 1999). The absence of infrastructure and policies contribute to nappy waste leakages into the environment. The fourth factor is that the region will be one of the first to experience the effects of global warming via rising sea levels (States News Service 2018). In combination, these factors create a level of urgency to address the issue. One goal of this research is to provide novel solutions to address this problem in the Asia-Pacific region.

Compounding the problem is the unique combination of characteristics associated with disposable nappy consumption. These include the significant volume of nappies consumed by a small percentage of the population, the concentrated period that the product is used and a lack of viable alternatives. The average baby uses between 4,000 and 6,000 nappies from birth to toilet training (Warner et al. 2017, Klein 2018). This is a large number for a single-used product given only 5% of the population (Global Health Metrics 2018) use it for 3 to 4 hours at a time (Griffin 1995). Their use is limited to, on average 3 years of a baby's life (Dey et al. 2016). Relative to the well documented environmental damage caused by single-use plastic shopping bags which are used by a much larger proportion of the population (Weinstein 2010, Wagner 2017, Global Health Metrics 2018), disposable baby nappies represent a far larger source of environmental damage on a per user basis. They have however attracted much less attention in the literature which creates a gap that this research attempts to address.

The academic and market research and waste data above establishes the size and scale of the disposable nappy waste problem. Lifecycle Analysis (LCA) is a common method to quantify the environmental impacts of products more deeply. There has been much debate in the literature since the early 1990s about whether disposable or reusable nappies are superior in terms of environmental impacts. At least eight published Lifecycle Analyses (LCA) have been conducted (Sauer et al. 1994, Vizcarra et al. 1994, Aumônier and Collins 2005, Garrett et al. 2008). These LCAs were limited to developed economies, and each assessed upstream and downstream impacts of each product. All but one LCA was inconclusive in terms of identifying a product that definitively caused greater negative environmental impacts. The most recent LCA and the most

extensive and referenced was conducted in 2005 by the UK Governmental Body, the Environment Agency (Aumônier and Collins 2005). After initial results supported those of earlier LCAs, a revision conducted in 2008 showed that reusable nappies could have a 40% lower CO₂ impact than disposable nappies depending on laundering choices (United Nations Environment Programme 2021).

In 2020 the UK Government launched a new LCA comparing reusable and disposable nappies along with an assessment of novel recycling technologies to process disposable nappy waste (DEFRA 2020). The inability of multiple LCAs conducted in this product category to determine a clearly superior option supports growing criticism of LCAs to accurately describe the impacts of these products on the environment. LCAs are seen as not being fit for purpose, can often deliver conflicting conclusions when used in comparison to other LCAs, and if used as a policy decision tool can leave governments with no clear direction (Finnveden 2000, Mirabella et al. 2019). Such is the case here where multiple LCAs over 30 years have failed to deliver a conclusive determination. It is interesting to note that in the reanalysis of the 2005 LCA, the only way to achieve a superior environmental outcome was to rely on just one actor, namely mothers to buy the most energy efficient washing machine (Aumônier and Collins 2005). Other possibilities exist if a more holistic view is taken involving more than one actor. For example, a manufacturer could offer a used nappy take back program or governments could provide a collection service. In the next section, I explore the Circular Economy and enabling interventions that include alternative solutions and a broader range of actors.

2.2.4 The Circular Economy and enabling interventions

This section introduces a framework aimed at addressing the disposable nappy waste issue, broadly under the "Circular Economy" (CE) concept. The CE contrasts with the dominant "Linear Economy" of resource extraction, product consumption, and disposal (Rizos et al. 2017). The Linear Economy perpetuates economic growth tied to environmental degradation (Michellini et al. 2017, Wagner 2017, Zhang et al. 2019).

The Recycling Economy attempts to integrate a return loop within the Linear Economy, processing used materials to create new ones (Gregson and Crang 2015). In contrast, the CE

strives to decouple economic growth from natural resource extraction, gaining traction in academia as a sustainable consumption and production path (Kirchherr et al. 2023).

Research shows a significant increase in CE-related literature, reflecting academic interest (Ruiz-Real et al. 2018). However, practical implementation in business remains limited (Kirchherr et al. 2018). Attempts to measure global circularity indicate a modest level, with recent challenges impacting progress (Haas et al. 2015).

Despite growing research, challenges include the lack of a consensus CE definition due to diverse perspectives (Hartley et al. 2020) and insufficient consideration of user roles and social aspects (Gregson et al. 2015, Moreau et al. 2017). Moreover, assumptions of rational consumer behaviour, central to economic theory, behavioural economics, and human behaviour, face increasing scrutiny (Ajzen 1991, Schroeder and Chester 2014, Sniehotta et al. 2014, Armitage 2015, Ogden 2015).

Several reviews highlight the complexity of defining the CE, with Kirchherr et al. (2023) identifying 221 definitions, including varied "Rs" such as Reduce, Reuse, Recycle (Potting et al., 2017). Potting et al. (2017)'s 10R definition is a suitable framework and one that will be used for this research project. Figure 1 below captures this framework.

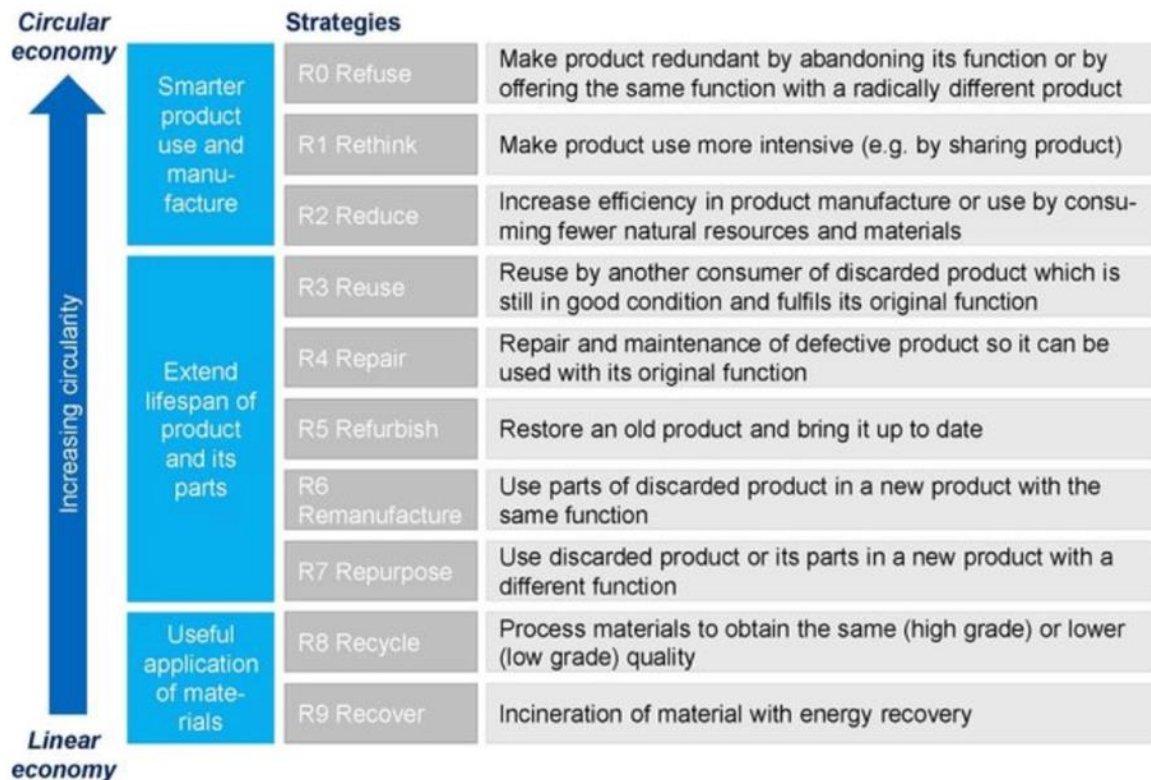


Figure 1. Potting, Hekkert et al's "10 R" framework

2.2.5 The Circular Economy and Recycling

Recycling is featured in all CE definitions (Ghisellini et al. 2016, Lewandowski 2016, Lieder and Rashid 2016, Sauvé et al. 2016, Alan et al. 2017, Blomsma and Brennan 2017, Kirchherr et al. 2018, Skene 2018, Borrello et al. 2020). In frameworks that include a hierarchy from a Linear Economy to a Circular Economy such as Potting et al. (2017)'s 10 R framework, Recycling is positioned closer to the Linear end of the scale. Recycling is a relatively simple step that has the possibility of income generation while ignoring the other elements of CE that are more circular and are more important in the waste hierarchy. In addition, in the absence of policy reform the global impact of recycling is limited. Policies that encourage more recycling and investment in recycling infrastructure would increase recycling's impact (Haas et al. 2015). The result is that the concept of CE is diluted down to the act of recycling while ignoring the larger and more complicated work of systems change. This includes the role not just of the user, but other elements needed to achieve a sustainability transition. The focus on recycling is also reflected in research on how circularity is measured. In Kristensen et al. (2020)'s review of 30 indicators of a

CE, recycling featured in the top three categories that are most commonly measured. Recycling ranks high in terms of measurement as a CE activity and yet it doesn't deliver the results that a broad definition of the CE expects. This may be due to the fact that measuring recycling is a relatively easy thing to do. As discussed previously, attempts at nappy recycling date back to 1995 in various countries. Nappy recycling is the current and sole focus of the large nappy manufacturers' attempts to manage their disposable nappy waste (Fater SpA 2017, Khoo et al. 2019). In doing so they are able to minimise any changes in the way they make and sell their product. They can maintain their existing manufacturing processes including the use of oil-based polypropylene. There is also no demand on the consumer or the retailer to change behaviour. Despite the many years and multitude of attempts by the largest nappy manufacturers, it remains to be seen if nappy recycling can in fact work and become a scalable solution to address the nappy waste problem.

2.2.6 The missing elements of the Circular Economy

The role of the user in a Circular Economy (CE) has yet to gain prominence (Gregson et al. 2015). When the user is placed within a CE, it is often assumed that their act of consumption is rational and easily adjustable (Mylan et al. 2016). There is also limited research that focuses on the CE in the domestic sphere where a significant amount of consumption and waste production take place (Mylan et al. 2016). Consumption is a relatively new consideration with regard to CE, as it appears in CE literature for the first time in 2015 (Camacho-Otero et al. 2018). According to a search of article titles, consumption still makes up just 10% of the reviewed CE research. Most of the CE literature is focused on a small number of very developed countries in Europe and North America. Only a limited number of product categories have been examined to consider their potential to become circular. Consumer electronics and car sharing are the most popular subjects of such research (Camacho-Otero et al. 2018). Baby products rank at the bottom alongside food, buildings, heating, waste collection and packaging.

A prioritisation of business growth over environmental sustainability and the need for new business models to realise a CE are also commonly omitted in many conceptualisations. Ghisellini et al. (2016) cite the need for an economic return on the transition to a CE for investors and companies to adopt it. They also note that to date the adoption of CE is limited to a

handful of countries. Only Linder et al. (2017), Fang et al. (2007) and Yuan et al. (2006) highlight the holistic nature of a true CE including wholesale shifts at the policy, manufacturer and user level. Definitions also minimise the possible benefits that CE offers to social equity and future generations (Alan et al. 2017). Similarly Moreau et al. (2017) identify key missing elements required for societal transitions to a CE including institutional and social predispositions. In that sense the CE appears relatively limited with little discussion about the requirement for systems-level change.

3 Circular Economy business models and baby nappies

The CE concept is realised in practice through a variety of business models (Geissdoerfer et al. 2017, Linder and Williander 2017, Calvo-Porràl and Lévy-Mangin 2020). Lacy et al. (2020) suggest five CE business models which offer value creation options based on the nature of the wasted resource. The models are *Circular Inputs*, *Product Use Extension*, *Resource Recovery*, *Sharing Platforms* and *Product as a Service*. The introduction of these models has been slow, limited, uneven and disparate across industries and geographies (Lacy et al. 2020). Three models (Circular Inputs, Product Use Extension and Resource Recovery) are focused on the manufacturer while two are orientated around the consumer (Sharing Platforms and Product As A Service). In Section I, I highlighted three nappy offerings that could be regarded as circular in nature. These are disposable nappy recycling services, reusable nappy services and compostable nappy services. Recycling disposable nappies fits within the Resource Recovery model and is driven by the manufacturer. Reusable baby nappy services fits across three models including Product Use Extension, Sharing Platform and Product as a Service. (Muranko et al. 2021). It involves both the manufacturer and the consumer. Compostable nappy services fall into four business model categories. These include Circular Inputs, Product Use Extension, Sharing Platform and Product As A Service. Like reusable nappy services, compostable nappy services involve both the manufacturer and the consumer. Table 1 below summarises the five business models along with the three nappy offerings.

Table 1. Lacy et al. (2020)'s five CE business models applied to three nappy offerings

| Business Model | Key Actors | Example | Disposable nappy recycling | Reusable nappy service | Compostable nappy service |
|---------------------------------|-------------------|--|-----------------------------------|-------------------------------|----------------------------------|
| 1. Circular Inputs | Manufacturer | Use of renewable energy and bio-based materials | | X | X |
| 2. Product Use Extension | Manufacturer | Products are reused, repaired, reprocessed, repurposed and resold | | X | |
| 3. Resource Recovery | Manufacturer | Waste is recovered or converted into energy or a new resource | X | | X |
| 4. Sharing Platforms | Consumer | Access rather than ownership models | | X | |
| 5. Product As A Service | Consumer | Product is delivered, collected, refilled / washed and offered again | | X | X |

As discussed previously, attempts at recycling disposable nappies over the past 25 years have yet to succeed. In addition, while recycling is regarded as a significant CE activity, it occupies the narrowest definition of the concept. The process fulfills just one of five Circular Business models set out above and ignores the role of the consumer. As discussed in the previous section, recycling nappies in many developing countries is unlikely to succeed given the disparate islands and remote communities that make up many of these countries. As such, it holds limited promise as a solution to addressing the disposable nappy waste problem. For these reasons I will set aside nappy recycling as the subject of this research and consider reusable nappy services and compostable nappy services.

While a reusable nappy service satisfies three Circular Business models, historical efforts to deliver a reusable nappy service have not been viable for mass consumption due to low uptake (NLWA 2018). They therefore offer limited prospects as a viable CE nappy solution. As a result, I am choosing not to use reusable nappy services for the purposes of this research. Compostable nappy services fit within three of the five CE business models. This includes models that involve

both the manufacturer and the consumer. The consumer element is an important consideration for this research as my focus is on parents and the factors that surround their nappy consumption. Unlike nappy recycling services and reusable nappy services, there is very little research about compostable nappy services. This is a knowledge gap that is useful to fill in order to understand the prospects of CE solutions.

4 Enabling Interventions

This section reviews a range of interventions that enable the CE and are designed to address the negative environmental impacts caused by nappies. Interventions have generally been driven by non-government organisations (NGO), governments, and nappy manufacturers. Most of these interventions have occurred in the US and Europe except for one instance in Vanuatu. Table 2 below, sets out a summary of the interventions, the entities who conduct them, the desired behaviour and an evaluation of their effectiveness based on this review. The review and discussion follows this table.

Table 2. Categories of interventions and their results.

| Intervention category | Example | Organising Entity | Desired product choice | Results |
|------------------------------|-----------------------------------|------------------------------|--|-----------------------|
| Informing | Awareness campaign | Non-Government Organisations | Reusable nappies | Limited effectiveness |
| Incentivising | Subsidies | Governments | Reusable nappies | Limited effectiveness |
| Regulating | Bans & taxes | Governments | Reusable nappies | Not enacted |
| Recycling | Recycling disposable nappies | Major nappy manufacturers | Disposable nappies | Limited effectiveness |
| Redesigning | Smaller products | Major nappy manufacturers | Disposable nappies | Limited effectiveness |
| | Products designed to be composted | Niche nappy manufacturers | Redesigned nappy accompanied by a delivery, collection | Too early to assess |

| | | | | |
|--|--|--|---------------------------|--|
| | | | and composting service | |
|--|--|--|---------------------------|--|

Awareness campaigns are an example of an *informing* intervention. They have been used in the UK and lead by NGOs such as the Women’s Environmental Network (WEN). In 2001, the first “Real Nappy Week” awareness campaign was launched by WEN to encourage the use of reusable baby nappies. While there is some evidence demonstrating the efficacy of this intervention, there was no measurable increase in the 5% share of the market that reusable nappies enjoyed prior to the launch of the campaign (Klein 2018).

Incentivising behaviour using financial subsidies have also been used to encourage the use of reusable nappies. The UK Government has used financial subsidies to induce users to invest in reusable baby nappies. The North London Waste Authority (NLWA) in partnership with the London Boroughs of Camden, Hackney, Haringey and Islington and a private reusable nappy brand, “Nappy Ever After” launched a one-time £35 cashback incentive scheme to encourage parents to choose reusable nappies (Warner et al. 2015). The initial response from users was positive with an increase in reusable nappy usage. Consequently the program was expanded to all Boroughs in the North London region (Warner et al. 2015). In 2004 the UK Government contributed £2.3 million to reduce the amount of landfill-bound disposable nappy waste by supporting the same initiative across the country. A part of this funding was used by the aforementioned Women’s Environment Network (WEN) to create their London-wide “Real Nappies for London” reusable nappy subsidy scheme (Warner et al. 2015). While there was an initial enthusiasm for the scheme in the first six years, that subsided in the latter six years (Warner et al. 2017). The disposable nappy trade association, the Absorbent Hygiene Products Manufacturers Association criticised the UK Government’s decision to subsidise reusable nappies, stating that 95% of UK parents used disposable nappies as they were quick, clean and easy to use (Klein 2018). They added that the Government should not make parents feel guilty about using disposable nappies as there was no evidence that reusable nappies were more environmental than disposable nappies (Bowery 2006). Large disposable nappy manufacturers have played a significant role influencing nappy waste management policy in the United Kingdom.

Regulating interventions such as bans and taxes on disposable nappies have also been contemplated over the past 40 years. After an investigation of the contents of landfills in the state of Oregon in the US, it was found that disposable nappies made up between 16% and 32% of landfills and consequently state-wide nappy bans were considered (Schmitt 2003, Allred 2009). The bans were however never enacted due to a lack of scientific evidence establishing nappy waste as problematic (Allred 2009). Growing public awareness of waste management problems in the US prompted further attempts to legislate bans on the sale of disposable nappies. Starting in 1990, 22 states introduced legislation to tax or ban disposable nappies (Allred 2009). An AP survey showed that 43% of users supported such bans and a Wall Street Journal - NBC poll showed support for a ban by a ratio of 3 in 1 (Kinney 1990). Nonetheless these bans were also never enacted. One possible reason was a significant nationwide marketing campaign in 1991 by disposable nappy market leader Proctor & Gamble. The campaign set out to convince users and lawmakers that disposable nappies were compostable in 90 days and posed no environmental damage (Kinney 1990). It was supplemented by industry-paid research by Arthur D. Little (Rockney et al. 1991). The advertisement which can be seen in Figure 2, below was deemed to be deceptive by the Fair Trade Commission given that plastic does not compost (Baker 1998).



Figure 1. A 1991 Procter & Gamble advertisement in the New York Times in response to an attempted policy intervention by the US Government.

The Arthur D. Little research is no longer publicly available, and the company has since ceased trading. The International Non-Woven and Disposables Association (INDA), the US trade association that represents all disposable nappy manufacturers was also vocal in denouncing any policy interventions (Mayberry 1991). Over the proceeding ten years the 400 reusable nappy

companies operating in the US were reduced to just 50 (Baker 1998). Many factors may have caused such a decline, but one may have been the disposable nappy manufacturer's marketing campaign and INDA's response to the proposed ban. Disposable nappy market share grew to 85% during this period (Rockney et al. 1991) and in 2018 reached up to 95% in most developed economies (Klein 2018). Like the United Kingdom, the same very large nappy manufacturers and trade associations in the US may have had an impact on policy decisions related to managing plastic nappy waste. Mothers in the US have limited choice when it comes to nappies, with disposable nappies being the dominant option. Given that the market share of disposable nappies in the US has grown from 85% to 95% (Klein 2018) over the past 30 years, it could be said that disposable nappies have become the norm for multiple generations of mothers.

Vanuatu also attempted a ban on disposable nappies commencing in December 2020 (Olivo 2019). In October 2020 however the Government announced a delay in introducing this intervention. Unlike the US experience, the response to the ban was unrelated to the actions of large nappy manufacturers. It was led by Vanuatu's mothers who felt that banning disposable nappies would put an unreasonable burden on them as they would be forced to use reusable nappies that required daily laundering (RNZ 2020). This is a unique example of consumers pushing back on a policy intervention that would adversely affect them and force the government to rethink its approach.

In September 2021, media reports emerged that the UK Government was contemplating taxing disposable nappies at the point of sale to reduce landfill-bound waste (Ellicott 2021). That produced a significant negative response from commentators who described the move as class warfare. Their argument was that lower socio-economic parents would be affected hardest. That is because they would be unable to purchase the more expensive eco-friendly nappies and do not have the time to wash and dry reusable nappies (Vine 2021). The Government immediately denied that they were considering such a tax (Heffer 2021). The UK's reusable nappy industry association, the Nappy Alliance appealed to the UK Government to offer a nationwide subsidy to parents to purchase reusable nappies. Their argument was that this was a fairer and more effective way of handling the environmental effects of disposable nappies (Wood 2021). This sequence of reports from the initial newspaper article to the industry association's appeal took

place over just 48 hours. This illustrates a number of phenomena. Firstly, the issue of managing baby nappy waste is one that is very much alive today. Secondly, the mere suggestion of a possible intervention can prompt rapid negative responses from potentially affected consumers and manufacturers as it did in Vanuatu's case with their proposed nappy ban. Finally, a tax of this kind, namely at the point of sale on this particular product category appears to have minimal viability as it puts the burden solely on one actor, the parent and variably affects different socio-economic levels.

Attempts at *recycling* interventions to manage disposable nappy waste emerged in the mid 1990s and continue today. These can be more accurately described as downcycling as the value of the output is worth less than the inputs. Major nappy manufacturers are currently working with independent companies to develop pilots to test disposable nappy recycling technologies. An example is Procter & Gamble's partnership with Fater SpA, an Italian based engineering company (Khoo et al. 2019). The process sterilizes the used nappies before separating the product into pulp, plastics and absorbent material. For each tonne of used nappies the process captures 225kg or 22% of cellulose material and 75kg or 7.5% of plastic (Fater SpA 2017). These materials are then used to make products such as cat litter, park benches and anti-flooding barriers. This project has been in a pilot stage for three years. In 2020, Asaleo Personal Care Pty Ltd received Australian Government funding to explore the possibilities of recycling nappies (Australian Government 2020). Similar pilots are being conducted in Wales (Welsh Government 2022). Other examples of nappy recycling pilots dating back 25 years include PHS in the UK, Knowaste in Canada along with Super Faiths and Unicharm, both in Japan (Khoo et al. 2019). None of these projects were successful.

There are several limitations to recycling disposable nappies. Firstly, it ignores the upstream impacts on the environment including the use of oil to make a disposable nappy. More significantly however, nappy recycling is not available in developing countries which are located at the epicentre of the disposable nappy waste problem. It is also because of the low level of awareness of the problem of disposable nappy waste in developing economies (Khoo et al. 2019). A third issue may be the large scale of the process which isn't suitable for some developing economies where populations are dispersed across wide geographies. In addition, the

yield is relatively small, where 22.5% of the inputs are recovered as cellulose fibres and 7.5% of the inputs are recovered as plastic. The remaining material will be landfilled (Fater SpA 2017). There are also questions about the sustainability of the process. Significant energy is required to recycle layers of durable, flexible plastics into usable products and do so while eliminating pathogens created by the human waste component (Klein 2018). Given that only 9% of all plastics have ever been successfully recycled (Geyer et al. 2017) it is difficult to imagine that a multi-layered plastic product infused with human faeces could be successfully recycled in a way that is cost effective. These limitations may explain why no nappy recycling pilot has progressed to full commercialisation despite 25 years of efforts.

Redesigning interventions have also been attempted. Since the 1990s the focus of the major nappy manufacturers has been to reduce the size of disposable nappies to reduce raw material use and consume less space in landfills (Olivo 2005). The Absorbent Hygiene Manufacturers Association, claims that from 1990 to 2005, manufacturers have reduced the size of their nappies by 40% (Olivo 2005). This is an effective intervention as it reduces the impact of each nappy unit, however, the growth in nappy production means that the overall impact of waste from plastic nappies is growing and the nappies are still sourced from fossil fuel derived resources. More recently, product redesign interventions have come from small niche nappy manufacturers. An example is Kuver Designs Pty Ltd based in Tasmania, Australia. The company has developed nappy products using alternative designs and materials to allow for regenerative end of life options (Kuver Designs 2021). A regenerative end of life option sees products processed into useful materials at the end of their first life. In this case the product can be composted, and the compost sold. Rather than a nappy with a body and tabs made of plastic, the company has developed a two part nappy system made up of an outer pant that is washable and reusable and an insert that is made from corn starch instead of polypropylene (Kuver Designs 2021). Because of the redesign including the use of compostable materials, the nappy can be home composted if it is only wet and commercially compostable if it is soiled (Khoo et al. 2019).

Kuver Designs is operating a service in Hobart, Australia that allows users to add their nappies to the council-provided weekly kerbside composting collection (Kuver Designs 2021). The City of Hobart composts the material with garden waste and food waste. The material is certified and

sold for agricultural purposes (Ellen Macarthur Foundation 2020). A similar pilot was completed in Bega, New South Wales (NSW), Australia in 2020. In both cases Kuver Designs was required to apply for an exemption from the Tasmanian and NSW Environmental Protection Authorities to allow the composting of human faeces. Composting of human waste is not legal in most geographies and poses a significant regulatory barrier to the adoption of this approach (EPA 2004, Ellen Macarthur Foundation 2020). The company has licensed the technology to other brands in New Zealand and in other international markets. The New Zealand licensee, Little & Brave offered a similar service in Auckland for a time (EcoCircle 2020). They offered a collection service and the option for customers to bring their nappy waste to a central location where a dedicated composting facility was established. These services no longer operate, and the reasons have not been made public. My company, gDiapers owns the global license for this technology outside Australia and New Zealand.

This review of interventions that can enable the CE is reinforced by research published in 2021 by United Nations Environment Programme (2021). They analysed the eight LCAs referenced in Section I and developed recommendations for interventions. They included *Informing* campaigns that advocate for the use of reusable nappies. This includes educating parents about efficient laundering practices, shifting to a more sustainable source of electricity along with the possibility of using reusable nappies on multiple children. They suggest *Incentivising* interventions including offering financial support for reusable nappy services (where companies collect, wash and deliver reusable nappies). The authors also suggest *Redesign* interventions that disposable nappies could lessen their environmental impact. This would be achieved by making sure there are adequate collection services available. They included the development of compostable options including the provision of infrastructure to compost these alternatives. This is similar to the aforementioned Kuver Designs' (Kuver Designs 2021) new composting product and service.

A key limitation of some of the interventions is a failure to consider how consumers will engage with the alternative and incorporate it into their daily life. This insight is likely needed to support successful innovations and scale-up. UNEP's analysis is one of the few to mention the need to address broader consumption practices beyond just the choice of nappy when considering sustainable nappy choices. It includes the need to consider associated practices such as laundering, the choice of energy sources and maximising the use of reusable nappies across

multiple children. In other realms of daily consumption and waste generation, similar conclusions have been drawn. Mylan et al. (2016)'s research on food consumption and waste concurs that interventions of the kind set out above have limited efficacy. This is because consumption is framed as a rational act which can be corrected by changing a consumer's desires. Top-down interventions such as regulating food labelling and more transparent supply chains designed to enable consumers to make better choices have had limited effect (p.2). Boons et al. (2020) suggest that for interventions to have a long-term impact on consumption, the focus needs to turn away from the choices of individual consumers and move to a broader sociological consideration of all the factors that impact people's behaviour. This includes social, structural, material and personal elements (p.23). In the next section of this chapter, I investigate theoretical frameworks including Social Practice Theory that Mylan et al. (2016) employ, which include this broader view of consumption.

5 Summary

The limited number of interventions have failed to stem the tide of disposable nappy waste over the past 40 years. Interventions have, on the whole assumed consumers have agency and that by changing a consumer's attitudes and beliefs, this will change their behaviour. This has proven to be a flawed assumption. Attempts over the past 25 years to introduce nappy recycling that allow manufacturers to maintain their current products' design including the use of plastic have failed to produce a viable alternative. Recycling nappies ignores the system-level changes that are required to address this waste issue. Reusable nappy services while representing multiple CE business models have not been able to gain a foothold in the market. Niche innovators have developed a compostable nappy and service which does contemplate a system-level change and may hold promise with more investigation. The CE is a popular yet contested concept with a wide range of definitions. Several key components critical to successful sustainable transitions are missing in many definitions including societal and institutional considerations. The focus of the interventions has been mostly on the product (subsidising, banning, recycling) and the user (raise awareness, offer subsidies) while ignoring other factors that may influence consumption behaviour. The lack of effective responses and the possibilities of a CE-inspired solution have yet to be thoroughly researched.

In the following section, I set out my findings from a selective sociological literature review. I begin by focusing on two broad fields: parenting practices and domestic sustainable consumption practices. Further narrowing the focus, I explore baby practices and nappy practices. I then move the scope to review literature in the sustainability transitions field to gain insights into household practices and identify any research in this field on baby practices and nappy practices.

2.3 A review of sustainable consumption literature

The review in this section begins with an examination of parenting practices and domestic sustainable consumption. These fields provide a broad understanding of how household behaviours and choices impact environmental sustainability. This foundational knowledge is essential for contextualizing the specific issue of nappy practices. Literature purely focused on child development or general household management was not included unless it directly related to sustainability practices. The goal was to maintain a clear focus on household consumption behaviours that have environmental implications.

2.3.1 Parenting practices

Parents as the main purchaser of nappies play a key role in which nappy practice become normative. There is a large body of evidence that supports the notion that the transition to parenthood is one of the most positive and significant that people can experience (Griffin 1993, Feeney 2001). There is additional research that reveals negative elements of the transition including unwanted life-long changes in roles, an increase in the amount of conflict with life partners and a reduction in intimacy (Belsky and Pensky 1988, Griffin 1993). In aggregate these effects increase the level of stress that new mothers experience. New mothers offer a wholly unique set of circumstances as the purchaser of nappies compared to other consumer choices. The literature offers the notion of “Moments of Change” (Burningham et al. 2014) to describe those times over the course of ones’ life that have the potential to fundamentally shift someone’s behaviour. Research by Laney et al. (2015) suggests that for new mothers a phenomenon of “losing oneself” momentarily or more permanently in the process of integrating an infant into one’s life is evident. Other research reveals a shift in the identity of women as they transition to motherhood (Oberman 1996, Nicolson 1999, Steinberg 2005, Saisto et al. 2008, Bailey 2016). Other research highlights the changes in emotions and relationships that occur as a woman

becomes a mother (Nyström and Öhrling 2006, Fägerskiöld 2008, Johnson et al. 2014). This significant transition is accompanied by a change in consumption to equip new parents with a new range of objects to support them in the new role. With this comes an associated environmental impact.

The UK Government's "Moments of Change: Opportunities for influencing behaviour" (DEFRA 2011) report offers one of the few attempts at understanding how the transition to motherhood affects a person's consumption choices from an environmental point of view.

The research identifies five key behaviour types for new mothers that may cause an environmental impact namely: travel; purchasing baby equipment; nappy choices; food-related behaviour; and self-care behaviour (DEFRA 2011). Nappy choice stands out as having the most possibility to positively impact the environment as it is a plastic consumable product requiring repeat purchases totalling approximately 5,000 over the first three years of a baby's life (Warner et al. 2017, Klein 2018). Baby nappies are the only category mentioned in the UK's NHS literature for expectant parents as an opportunity to make a product choice that is better for the environment. The Women's Environmental Network is one of the UK's largest organisations focused on women's issues and the environment. Their parenting campaigns target the use of reusable nappies as a product choice by parents that can have a positive environmental impact (WEN 2013). Nappies hold significant potential as a new environmentally preferred choice if reusable nappies were chosen. DEFRA's "Moments of Change" report however highlights the conclusion of their own 2005 baby nappy Life Cycle Analysis (Aumônier and Collins 2005) which at the time concluded that reusable nappies did not offer superior environmental benefits compared to disposable nappies. The UK Government reinforces the use of disposable nappies as the social norm despite highlighting to new mothers that they could make an alternative choice. The limited research available on motherhood including the example of the UK Government's "Moments of Change" research use a theoretical framework that places the individual at the centre. This perspective assumes that the individual has agency and that they make rational choices independent of other influences. It is grounded in the Theory of Planned Behaviour (Ajzen 1991) which has dominated the field of human behaviour and behavioural economics for the past 30 years (Sniehotta et al. 2014). More recently, a growing amount of literature challenges the assumptions that underpin this theory (Sniehotta et al. 2014, Armitage 2015,

Ogden 2015). The Theory of Planned Behaviour will be further examined later in this Chapter. In the following section, I review the current literature on sustainable domestic practices as the use of nappies fits within this category. I identify if nappy consumption has been addressed and the theoretical lenses used to understand sustainable domestic practices.

2.4 Theoretical framings

2.4.1 Sustainable domestic practices

An initial investigation into research on sustainable domestic practices found the preponderance of research focused solely on the user adopting the Theory of Planned Behaviour (TPB) (Ajzen 1991) which dominates the field (Sniehotta et al. 2014, Tornikoski and Maalaoui 2019). Ajzen's work has generated over 60,000 citations to date. This framework assumes that an individual's behavioural intentions are influenced by three factors: attitude, subjective norms and perceived behavioural control. The theory concludes that an individual's behavioural intentions are the ultimate determinant of social behaviour. It has been applied to household recycling (Bamberg and Moser 2007) and household energy conservation (Abrahamse 2005).

The theory's focus on attitudes, social pressures, and perceived control over behaviour appeared relevant to understanding why parents continue to choose disposable nappies despite growing environmental concerns. Pro-environmental behaviour can be defined as actions that reduce the negative human impacts on the environment (Stern 2007). Applying TPB to sustainability transitions, an individual's behaviour could be altered toward a pro-environmental alternative by influencing their attitudes and beliefs. TPB has been widely applied in research to attempt to predict what intentions will turn into actions, and the extent to which an individual has control over those intentions. For example, Febrianti and Permana (2021) applied TPB to study consumer purchasing intent for a specific brand of disposable baby nappy, as it relates to environmental concern. The results of the study were inconclusive. This may have been because the scope of the research was limited or that the brand in question offered limited environmental benefits as it is made with the same raw materials as a regular nappy. The study also named perceived behavioural control as the strongest driver of purchase intent. Perceived behavioural control is the perception of the difficulty of enacting a behaviour. The study suggested that more

purchases of the diaper would be possible if more focus was given to price, quality and product function. This conclusion supports common market research that brands rely on to increase sales.

The premise that lies at the heart of TPB, namely that the consumer's attitude drives behaviour is challenged by the Attitude-Action Gap (Bowerman and Markowitz 2012) relative to pro-environmental behaviour. Also known as the KAP Gap (knowledge-attitudes-practice) and the Belief-Behaviour Gap, the Attitude-Action Gap describes a phenomenon that when users are surveyed about their attitudes to making pro-environmental choices, they will respond positively. However, that attitude fails to convert into action when actually making a pro-environmental choice. The literature reveals examples in environmentally-friendly vehicle purchases (Mairesse et al. 2012), consumer technology products (Young et al. 2010) and fashion (Mcneill et al. 2015, Wiederhold et al. 2018). Key conclusions as to why the gap exists range from a lack of time and space for users to follow a "green" lifestyle, the requirement for incentives to make the pro-environmental choice competitive and education via labelling (Young et al. 2010). Other identified factors include availability, knowledge, transparency, image, inertia and consumption habits (Wiederhold et al. 2018).

The Low-Cost Hypothesis (Diekmann and Preisendörfer 2003, Keuschnigg and Kratz 2018) offers another theory that can in some cases support the phenomenon described in the Attitude-Action Gap and further question the veracity of TPB. The Low-Cost Hypothesis suggests that as the behavioural costs increase, the strength of the effects of the concern a consumer has on environmental behaviour falls. In this context cost includes not just monetary expense but also convenience and alignment with personal norms. This describes the phenomenon of an individual actor who makes a pro-environmental choice only in circumstances where the cost is low to that actor and there is little inconvenience. Schwartz (1977) proposed that pro-environmental behaviour is only possible when the behavioural cost to the individual is low. This is driven by ones' own personal norms which are actions one chooses to take or not take based on a moral obligation. A norm is activated when a person sees that their action has caused a negative effect and they are able to correct that (Schwartz 1977). If the personal cost of a behaviour change to one that offers better environmental outcomes is low, the behaviour change is more likely to happen. That can be measured by looking at personal norms. Research into car-

reduction policies in seven European countries (Keizer et al. 2019) revealed that the hypothesis holds but not in very low cost scenarios.

In relation to nappies, the Low-Cost Hypothesis suggests that a parent will only make the pro-environmental choice if the cost to them is low. Given that 95% of parents in most developed economies use disposable nappies (Klein 2018), the perceived high cost of reusable nappies likely limits this market hence the observed dominance of disposable nappies with 95% market share. This is confirmed by initial UK-based research investigating attitudes to reusable and disposable nappies by parents (Pendry et al. 2012). Focus groups and follow-up interviews of users of both kinds of nappies were conducted. Disposable nappy users reported that they knew of the negative environmental impacts of disposable nappies but rationalised their choice by identifying other pro-environmental behaviours that offset the damage caused by disposable nappies. The consumer in this instance identifies that the personal cost to using reusable nappies is too high despite acknowledging the negative environmental effects of the product. They also report that they can choose other pro-environmental behaviours to offset those known negative effects which one might conclude are less personally costly to them.

The study by Pendry et al. (2012) also questions the level of agency assumed by consumers and the level of influence manufacturers have in influencing consumers. The market leading disposable nappy brand, Pampers spends USD\$8.3 billion per year (Business Chief 2016) in marketing its products. In doing so it can create the impression of the “equivocal” nature of the negative environmental consequences of their products while reinforcing the “popular, efficient, healthy and good value” elements of their product. In the absence of reusable nappy brands with similarly large marketing budgets, these users were required to proactively seek out alternatives to disposable nappies due to their own personal concerns around nappy waste. The approach taken in the research by Pendry et al. (2012) however focused solely on attitudes of nappy choices and did not explore the higher order question of whether the user has agency. The potential limitations applying TPB to understand pro-environmental consumer behaviour change have also been articulated by sociology scholars. Hobson (2016) cites the UK Government’s attempt to shift policy focus from sustained economic growth to sustainable consumption as questionable. This is because it positions the “rational” consumer at the forefront of its approach

and assumed that that actor, solely through his or her own choices, would make sustainable consumption decisions. Shove (2010) highlights the absence of context within which an actor makes a choice. This in turn limits the TPB framework's ability to accurately describe both current consumer behaviour and possibilities for changes in consumer behaviour. Shove (2010) reveals the preponderance of TPB-based research in policy making in the UK and the limited effect they have had on behaviour change.

The broad critique of TPB offered by previous authors highlights the limits of this framework in understanding consumer behaviour and behaviour change relevant to nappies (Diekmann and Preisendörfer 2003, Connolly and Prothero 2008, Shove 2010, Hargreaves 2011, Bowerman and Markowitz 2012, Spotswood 2014, Hobson 2016). Concerns have included the inability of TPB to make sense of the gap between a user's attitude and behaviour relative to pro-environmental behaviours, the need for a multi-disciplinary approach to understand behaviour change, the absence of the context within which a user decides and the assumption that the user solely through his or her decisions could make a pro-environmental choice. Given that, applying TPB to understand consumer behaviour and behaviour change for this research project will limit the quality of the results.

2.4.2 Practice Theories and Social Practice Theory

Practice theories are a broad category of social theories that focus on the routines, activities, and practices of individuals and groups. These theories emphasize that human behaviour and social life are shaped not just by individual intentions or societal structures but by the everyday practices people engage in.

Social Practice Theory (SPT) is a specific approach within the broader framework of practice theories. It emerged from the work of several scholars, notably Elizabeth Shove, Mika Pantzar, Alan Warde and others. SPT focuses on how social practices are formed, maintained, and transformed, emphasising the interconnectedness of practices, materials, and meanings.

Shove et al. (2012) has extensively studied a range of sustainable household practices including home heating and cooling and how these practices evolve over time. This researcher has done

similar research on the evolution of laundering, cleaning and bathing (Shove 2003). By applying Social Practice Theory (SPT) Shove has been able to show the influence of technology, cultural norms and environmental concerns in the changing nature of household practices. Mylan applied the framework to sustainable food consumption. Results of this research showed how dietary choices and food waste can be managed more sustainably. Warde (2005) observed that consumption occurs as a moment in practice performances. Mylan and Southerton (2018) in their investigation of household laundry practices challenged the view that more sustainable practices can be encouraged by using new technology and educating users. Their findings showed that the existing stocks of knowledge were more than sufficient to influence practices. They also highlighted the significant role women play in household laundering practices which likely mirrors the nappy practice. Sahakian and Wilhite (2014) in reference to three case studies of household food provisioning were able to reveal unique insights about the dynamics that moved the practice in a more sustainable direction. Given the volume of relevant research in the literature that used SPT, a more detailed investigation into this theoretical framework was made.

The origins of SPT can be found in the work of Bourdieu (1984), Giddens (1984) and Schatzki (1996). Giddens's (1984) structuration theory sets out that the agency of the individual and the social structures within which they exist influence each other. More recent work that built on these early foundations include analysis by Reckwitz (2002), Røpke (2009), Sahakian and Wilhite (2014), Shove (2003), Spaargaren (2011) and Warde (2005). These frameworks move the focus of study from the individual as an actor with agency, choice and self-interest, acting rationally or "Homo-economicus" as Welch et al. (2017) suggest, to a position that encompasses the broader and more complex terrain that surrounds consumption.

It attempts to do so with consideration for the dynamic nature of consumption and an individual's on-going changing role in the act of consumption (Mylan et al. 2016). Shove (2012) speaks of practices that "emerge, evolve and disappear" (p.4). Rather than a consumer making a choice based solely on their own personal preferences, a Social Practice Theory perspective imagines a consumer walking through their everyday lives habitually consuming a complex set of material goods and services. Their consumption choices are influenced by their own motivations along with technologies and infrastructure around them and collective cultural

norms that defines what is acceptable and (Mylan et al. 2016, Welch et al. 2017). The theory also suggests that mundane, daily consumption practices are often interconnected with one another and ever evolving. In this sense consumption can be seen as social rather than individual (p. 4). In aggregate, this creates a difficult environment to attempt to introduce interventions to change a consumption behaviour in order to reduce its environmental impact (Mylan et al. 2016). It involves much more than attempting to change an individual's attitudes and beliefs as the Theory of Planned behaviour suggests.

Shove et al. (2012) defines a practice as a meaningful, temporally and spatially bound nexus of three key elements: know-how, social meanings and materials. The individual's behaviour in SPT is no longer seen as the result of attitudes and beliefs, rather it is a part of a discernible "practice as performance". Different theorists have discussed and defined the elements in different ways to help further explain the factors that make up a practice. Reckwitz (2002) suggests that a practice is made up of several interconnected categories, including forms of bodily activities, forms of mental activities, things, understanding, know-how, states of emotion and motivational knowledge (p251). Shove (2012) summarised these six categories into three elements, "materials", "competencies" and "meanings". To illustrate this way of understanding consumption Shove discusses the consumption of energy. When framed in practice theory, Shove (2012) suggests that an individual's consumption of energy is much more than an individual act guided by individual attitudes, rather it is woven into the fabric of our everyday lives contributing to routine habits including how we commute, how we stay warm at home and how we cook. A practice is then made up of a practitioner who successfully combines these elements to carry out an activity. Taking a practice perspective allows the researcher to regard the performance of practices and the context within which they are performed as an interconnected entity to understand behaviour. To then understand behaviour change it is the observation of the "practice as an entity" that is the unit of enquiry (Reckwitz 2002, Warde 2005). "Practice as an entity" emphasises the stability and social construction of practices. "Practice as performance" focuses on the dynamic and situated nature of practices, emphasising that they are enacted and performed in specific contexts (Nicolini 2012, Shove et al. 2012). This perspective highlights the fluidity, variability, and contextuality of practices as they unfold in

everyday life. Together, these perspectives enrich the understanding of how practices function in social life and how they can change over time.

Bourdieu (1984)'s notion of *Habitus* is one that organises practices which are themselves being structured by those practices creating an endlessly dynamic relationship. *Habitus* also acknowledges the role of history in the constant evolution of a practice and includes an individual's biographical and past experience in any given practice. In this sense, *Habitus* can be seen in the intensely routine nature of the infant hygiene management practice and the relative stability of the practice over 60 years. The practice is carried out five to seven times per day continuously over, on average 3 years. For each child, the practice is repeated approximately 5,000 times over that 3-year period. Each subsequent child is also the subject of this practice. The practice then ends forever. In the many practices of our daily lives, changing nappies has unique features that are worthy of further investigation.

In SPT, the terms "habit" and "routine" are conceptualised to understand how practices are performed and sustained in everyday life. Habit refers to automatic behaviours or actions that individuals engage in with little conscious thought, often developed through repetition and familiarity. In this sense, habits are seen as ingrained patterns that can influence broader practices, as they shape individuals' decisions and interactions with the material and social environment (Warde 2005). On the other hand, routine encompasses a broader set of activities that may involve conscious decision-making and planning, often structured around specific contexts or situations. Routines are more flexible than habits, allowing for adjustments and variations based on external conditions or individual preferences (Shove et al. 2012). Together, habits and routines contribute to the stability and continuity of social practices, highlighting the interplay between individual agency and the structural influences of culture and society in the performance of everyday activities. This duality underscores the need to consider both the habitual and the more intentional aspects of behaviour when analysing the dynamics of practices in SPT.

How habits change is addressed by Sahakian and Wilhite (2014). They identify the distributed nature of agency across three pillars that make up a practice. These are the *Material World*,

which is made up of infrastructure and technology, the *Social World* made up of social norms, values and institutions and the *Body* which includes cognitive processes and physical dispositions (p.28).

Table 3. Summary of the three pillars that make up a practice by Sahakian and Wilhite (2014)

| Material World | Social World | Body |
|---|---|--|
| Infrastructure Technology Resources Finances | Social and cultural norms Institutions | Cognitive processes Physical dispositions Skills Habits Know-how |

They posit that the propensity for a change in habit is determined by the strength of the relationship of the habit to these three pillars. To create change you need to engage with the all three pillars. The interventions set out earlier in this chapter can be viewed as examples of isolated attempts to influence one of the three pillars. For example, the major manufacturer's attempts to (1) reduce the size of the existing product, and (2) recycle the existing product for example, only address the *Material World* and ignore the *Social World* and the *Body*. Awareness campaigns address the *Body* attempting to influence an individual's knowledge but ignore the *Material* and *Social Worlds*. Sahakian and Wilhite (2014)'s framework can help to explain why interventions to date have not been successful.

SPT has been applied to attempt to understand how novel business models may be successfully deployed. Therefore it is applicable to the proposed project that is also interested in a novel business model. Mylan (2015) also applied a Social Practice Theory approach to study a Sustainable Product Service System (SPSS). An SPSS is an example of a CE business model which combines a product, a service and infrastructure that meets a customer's needs with a lower environmental impact than traditional business models. Three key insights emerge from Mylan's study that are relevant to this project. The first is that SPSS should be regarded as

transforming rather than meeting a consumer's needs. This supports the view of Shove and Pantzar (2005) and Sahakian and Wilhite (2014) who see that practices are dynamic and are reflexive within the environment they operate in. Secondly, an SPSS will not gain traction easily if the new practice is not aligned with already existing practices. And lastly, SPSS innovations have a much higher chance of successful dissemination if the practice in question is not tightly coupled to any surrounding practices. Mylan (2015)'s analysis provides a thought-provoking approach to understanding the probability of a successful Circular Economy-inspired transition in the practice of changing nappies.

Boons et al. (2020) took a Practice Theory approach to understand potential changes in consumption globally, due to COVID-19. They highlight the juxtaposition of a significant reduction in greenhouse gas generating air flight with a resurgence in single-use plastic consumption. They attempted to identify sustained changes in hygiene practices after COVID-19's predecessors, SARS in 2002 and MERS in 2012 in Shanghai and Beijing. Their findings showed that mothers in affected areas changed their hygiene consumption practices for their children from reusable products to disposable products and did so for the long term (p.7). There is an opportunity to build on this COVID-19-era work using Social Practice Theory to generate novel thinking about how sustainability transitions come about and are maintained over time.

There is a substantial volume of research on a range of household practices and efforts to move them in a sustainable direction. The application of SPT has seen the emergence of unique insights that has advanced the field. As another unsustainable household practice, disposable nappies have yet to be the subject of such a study using SPT. Applying SPT to this research project presents a good opportunity to potentially create new insights and address a research gap.

2.4.3 Sustainability transitions literature

I found most of the literature on sustainable domestic practices was limited to research conducted within the home with no connection to broader industry perspectives and what their influence might be on persistent practice. This led me to adjust my literature review lens to explore research focused on systems-level change as it relates to domestic practices. I excluded broader environmental policy literature or sustainability studies not specifically addressing transition

dynamics. The emphasis was on literature that could illuminate the process of transitioning from one dominant practice to a more sustainable alternative.

This is where I encountered the field of sustainability transitions. The research of Rip and Kemp (1998) in exploring ways transitions come about across multiple sectors (technology, policy, markets, user practices, infrastructure, cultural meaning and scientific knowledge) involving multiple actors (companies, policy makers, consumers, society and researchers). Their Multi-Level Perspective (MLP) framework was further expanded and applied by Geels (2002), who utilised it to analyse transitions in various sectors, including transportation and energy. Geels (2011) describes the approach as interactions between niche innovations at the micro level, technological regimes at the meso level and sitting above these levels, the landscape at the macro level. The socio-technical regimes at the meso level represent the current status quo across policy, infrastructure, institutions and corporations. This has been described by Geels (2004) as the “deep structure” that offers stability to the system. Change is incremental in nature and path dependent at this level. They can however be vulnerable to influences of the socio-technical landscape at the macro level and niche-innovations at the micro level. The socio-technical landscape represents exogenous background factors including prevailing economic conditions, the price of commodities and global events. A recent example of such an event is the COVID -19 pandemic. According to (Geels 2004), the micro-level niche-innovations represent radically new offerings developed by R&D labs, incubators and start-up entrepreneurs and can come in the form of small-scale pilots and experiments. Their hope is that their technological innovation and business model innovation is incorporated into or replaces the existing technological regime. But the durability of the meso level is significant with a multitude of lock-in mechanisms which reinforce the status quo (Geels 2011). Figure 3 below, sets out how these three levels interact as socio-technical transitions evolve.

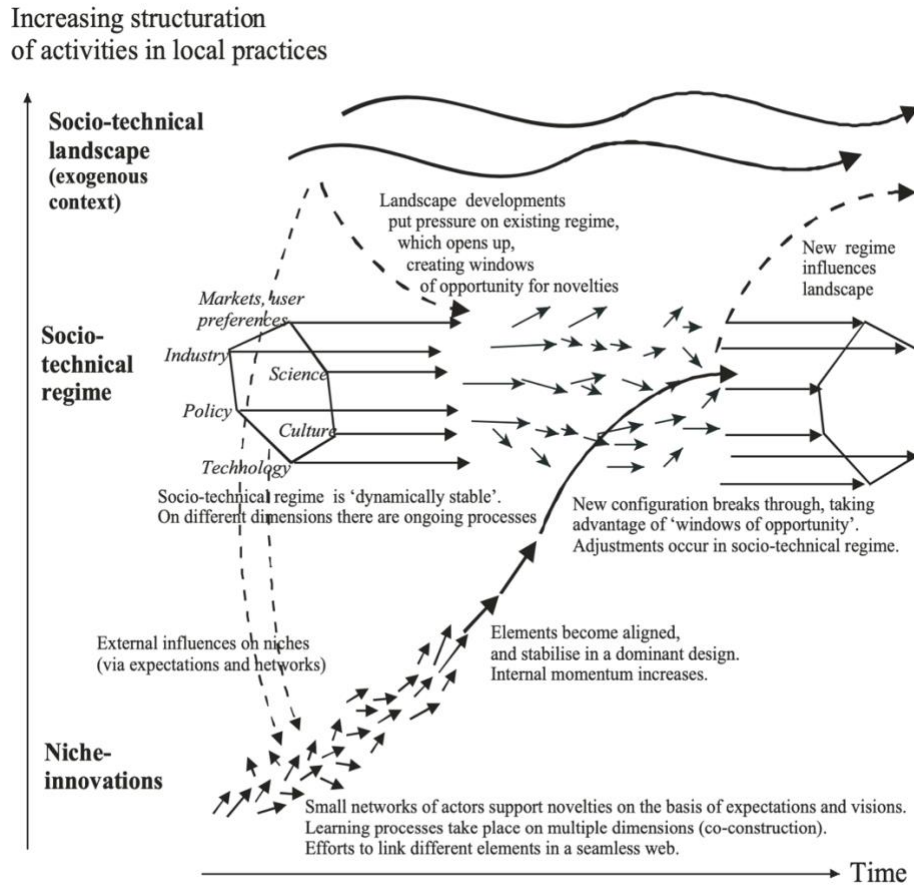


Figure 2. Transitions using the Multi-Level Perspective adapted from Geels (2002).

Kemp et al. (1998) added more elements including the notion of strategic niche management and pathways to accelerate more environmentally sustainable technologies into the regime level. Smith et al. (2010) applied MLP to sustainable development and developed additional insights on creating protective spaces for sustainable niche technologies (Smith and Raven 2012). Collectively this research has been useful in understanding sustainability transitions for grand sustainability challenges - large-scale, complex, and interconnected issues that pose significant threats to the long-term health, stability, and prosperity of human societies and the natural environment.

Research into the struggles that more sustainable, niche plant-based milk providers faced against the regime in the dairy category is a rare but valuable example of MLP being applied to a consumer product (Mylan et al. 2019). The research applied the “windows of opportunity” a

framework that sits within MLP and developed by Geels (2002), Nill and Kemp (2009) and Smith et al. (2010). It describes moments in time when external pressures align with internal developments within niches and regimes, creating a conducive environment for significant change. The addition of this framework to MLP addresses criticisms of MLP that it lacks a temporal element. While the contribution of Mylan et al. (2019) was more theoretical than empirical, applying the windows of opportunity framework to this research provides the possibility to more fully respond to the research questions.

2.4.4 Applying MLP to the nappy industry

The application of the MLP to the consumption of baby nappies could help explain how the three relevant actors in this research project, namely governments, major manufacturers and consumers who sit in the meso level create lock-in effects that make sustainability transitions difficult. Awareness of the environmental problems that disposable nappies cause specifically and plastic waste more broadly has grown. This is an example of an exogenous factor represented as a part of the socio-technical landscape. While this could create a forcing mechanism for change in the socio-technical regime, to date that has not been observed. The ‘lock-in effects’ as described by Geels (2004) that maintain the status quo in this particular product category are significant and include the sunk cost of existing infrastructure and distribution and the use of powerful lobbies to influence policy (discussed earlier in this chapter). Other lock-in effects include the monopoly the major manufacturers have over the development and ownership of the intellectual property needed to operate in the market (Quinn 2015, Quinn 2018). Nappy manufacturers own over 5,000 patents that protect the innovations they have developed over different elements of a disposable nappy (USPTO 2021). The major nappy manufacturers are active in prosecuting competitors who infringe their patents (Quinn 2015). MLP could help explain how these effects in combination have been successful in maintaining the dominance of disposable nappies since their inception 60 years ago. This is in spite of the growing awareness of the environmental damage that disposable nappies cause.

Attempts by major manufacturers to reduce the size of their products so they take up less room in landfills has had limited impact on the waste stream due to significant market growth (Srivastava

et al. 2015, Waterkeeper 2018, Trisia et al. 2021). Redesigning the product in this manner assumes that all nappies end up in landfill. This is not always the case. The problem is exacerbated owing to the lack of waste management infrastructure in most developing economies (Gunamantha and Sarto 2012). The major manufacturer's most recent attempts at recycling are still in pilot stage (Nonwovens Industry 2017). Given that recycling is limited to developed economies (Khoo et al. 2019), the yield on the recovered material is low (Fater SpA 2017) and there are questions about the sustainability of the process itself (Klein 2018), the prospect of this approach affecting the required socio-technical transition seems unlikely. As discussed earlier in this chapter, interventions by governments and NGOs may have resulted in new product innovations however they did not succeed in achieving significant market share.

As the MLP proposes, the incumbents adopt change in incremental ways and are path dependent. Niche compostable nappy manufacturers offering a service that encompass system-level change may hold more promise to put pressure on the socio-technical regime and contribute to a socio-technical transition. Understanding the broad range of factors including but not limited to the role of the consumer in the maintenance of the socio-technical regime is equally important to addressing the research questions. The MLP has yet to be applied to lower order sustainability challenges, which typically address more contained, specific and manageable issues at a local level. This could include community level recycling initiatives for example to offer alternatives large-scale waste management (Fisher et al. 2021). Given MLP's ability to describe regime-level dynamics including lock-in effects that keep socio-technical systems stable, it is well suited to be applied to this research project where an understanding of a persistent practice and socio-technical system is needed. In addition, the successful application of the "windows of opportunity" framework within the MLP in previous research in a field that faced similar socio-technical level rigidities as nappies, supports this approach.

2.4.5 The Dual Lens: MLP and SPT

There is a growing body of research that combines MLP and SPT to deepen our understanding of transitions towards sustainable practices and systems (Keller et al. 2022). As discussed above, MLP provides a framework for analysing long-term transitions in socio-technical systems, focusing on interactions between niche innovations, socio-technical regimes, and broader socio-

cultural landscapes (Geels 2002). On the other hand, SPT emphasises the role of everyday practices in shaping societal norms and behaviours (Shove et al. 2012). Geels et al. (2015) explored this integrated approach and proposed the notion of Sustainable Systems and Practices (SSP) to represent this new conceptual framework aimed at emphasising the orientation of this emerging agenda.

Some theoretical tensions exist between MLP and SPT due to differences in focus, conceptualisation of change, and methodological approaches. MLP emphasises structural factors and the interactions between niche innovations, regimes, and landscapes as drivers of sustainability transitions, often suggesting a linear progression of change (Geels 2002, Geels 2011). In contrast, SPT highlights individual practices, agency, and the fluidity of social interactions, viewing change as a complex and contingent process (Shove et al. 2012). Additionally, MLP focuses on hierarchical structures and interactions between three different vertical levels, while SPT explores a single, horizontal level (Keller et al. 2022). In addition, MLP analyses dynamics at a system level while SPT focuses on micro-level practices, leading to divergent interpretations of what constitutes a "driver" of change. Furthermore, while both frameworks acknowledge the importance of materiality, MLP sees it as part of the regime, whereas SPT emphasises the entanglement of materials with social practices (Halkier and Jensen 2011, Markard et al. 2012). Notwithstanding these tensions, by integrating MLP with SPT, scholars aim to bridge the gap between macro-level systemic changes and micro-level individual behaviours. This combination helps in exploring how niche innovations (like sustainable technologies or practices) influence and are influenced by everyday routines and societal structures. It enables a more holistic understanding of sustainability transitions by considering both the structural dynamics of socio-technical systems and the agency embedded in everyday practices.

Two studies that adopted this integrated approach was the work of Ford et al. (2017) that addressed the move to rooftop solar power in New Zealand and Seyfang and Gilbert-Squires (2019) who offered insights into the dynamics of transitions to more sustainable banking practices in the UK. Unique insights derived from interactions between the household level practice and socio-technical systems within which they operated were revealed. This “zoom in,

zoom out” dual lens approach was adopted to achieve this using SPT to understand the practice at the household level and MLP to gain insights at the socio-technical level. Intersection points between the two realms were then identified which through targeted interventions could be unlocked to accelerate transitions to more sustainable practices. While MLP and SPT independently offer the potential for unique insights to respond to the research questions in this research study, adding this dual lens framework as a third theory offers the possibility of additional insights, differentiated from those derived from MLP and SPT individually.

2.5 Chapter Summary

In this chapter I provided a review of relevant background literature on nappies, their environmental impacts and attempted interventions to date. This was done in part to ground my own understanding in the academic literature and move away from pre-existing industry knowledge. I then presented a more traditional literature review commenting on the state of the relevant research in order to identify gaps that my research can address. Within the sustainable consumption literature, a number of significant knowledge gaps emerged around our understanding of incumbent nappy practices and the possibility of more sustainable nappy practices emerging. Firstly, there is an absence of research at either the practice or socio-technical level of nappies. Secondly, there are limited insights into new parents and their approach to the various new consumption practices that emerge once their baby arrives including nappies. Thirdly, interactions between the stakeholders that sit around the nappy industry are poorly understood and lastly, there is little understanding of how new innovations in the nappy category can gain traction and become mainstream. A number of theoretical frameworks that were shown to prove useful in this review in better understanding sustainability transitions across domestic practices and socio-technical systems emerged. These were SPT, MLP and the dual lens that encompasses both.

The primary research questions and sub-research questions are as follows:

Primary research question 1:

What are the dynamics that influence the persistence of disposable nappies as a normative practice?

Sub-question 1.1:

In the nappy regime, what are the power dynamics across the incumbent stakeholders ?

Sub-question 1.2:

What is the relationship between domestic scale, everyday nappy practices carried out by individuals and stakeholders in the nappy regime to produce a persistent nappy practice

Primary research question 2:

Are there ways that a compostable nappy service can overcome adoption constraints?

Sub-question 2.1:

What are the challenges and opportunities encountered by parents using a compostable nappy service?

Based on this review and in order to most effectively respond to these research questions, a number of choices were made. To respond to the first primary research question and the two associated sub-questions, I will apply MLP and the “windows of opportunity” framework to identify niche-regime dynamics in the socio-technical system of nappies. To respond to the second primary question and associated sub-question, I will apply SPT and the dual SPT - MLP lens. The research design that follows in Chapter 3 accommodates this blend of theoretical frameworks. This approach allows for a comprehensive analysis of the nappy practice at the household level and the socio-technical system of nappies, considering both niche innovations and broader regime transitions. In doing so, significant yet specific knowledge gaps are addressed related to sustainability transitions in the nappy domain, which will contribute new insights in the fields of sustainable consumption and socio-technical transition theory.

Chapter 3. Methodology

3.1 Chapter Introduction

In this chapter, I will elaborate on the methodology and methods utilised to address the research questions. Given that this thesis is structured by publication, efforts have been made to minimise repetition. This has been achieved by concentrating on the specifics and rationale behind the design, recruitment, data collection, and analysis of each research phase, which were not feasible to include within the individual research papers.

3.2 Research Approach

The overarching objectives of this research as set out in Chapter 2 are twofold. Firstly, to explore the persistence of dominant and environmentally unsustainable nappy practices. Secondly, to investigate the potential of more environmentally sustainable nappy practices to challenge these dominant practices.

As described in the previous chapter, I justified the use of two theoretical frameworks and an integration of the two. These are the Multi-Level Perspective (MLP), Social Practice Theory (SPT) and a third, integrative approach that leverages the strengths of both theories to provide a more comprehensive analysis of socio-technical transitions and practices. Each theory maintains its conceptual integrity while being applied in tandem to offer a richer understanding of complex phenomena. These theories have then informed the research design set out in this chapter. These are summarised in Table 1 below and their methods described in more depth in the subsequent sections.

Table 1. Summary of research phases, methods and applied theories

| Research Phases | Methods | Theory |
|--|---|-------------------------|
| Phase 1: A Multi-Level Perspective of the nappy industry | Semi-structured interviews with key nappy regime stakeholders | Multi-Level Perspective |

| | | |
|---|--|--|
| Phase 2: A compostable nappy service field trial | A field trial of a compostable nappy service, involving 20 parents over a one-week period. Data collection methods included: In-home, semi structured interviews Re-enactments of nappy practices User diaries | Social Practice Theory |
| Phase 3: Intersections between the nappy regime and practices | Analysis of data of phases 1 and 2. | Multi-Level Perspective and Social Practice Theory |

In designing this research, I have adhered to ethical research protocols by acknowledging the real and perceived risks of my existing relationship with the compostable nappy company included in this research. As this is a thesis by compilation and includes three papers that match the three research phases, I have endeavoured to avoid duplication and repetition in this chapter. To that end, in the methodology section below, I start with general details of the methodological approach for this research project before describing the specific elements of each research phase in the sections below that.

3.3 Methodological overview

This section offers a detailed overview of the methodology for this research study, focusing on the overall structure and guiding logic behind the method selection. Given the focus on the dynamics influencing the persistence of disposable nappies and the potential for compostable nappy services, the methodology needed to address complex socio-technical systems and social practices. The methodological approach for this research study is designed to address the two central research questions: (1) What are the dynamics that influence the persistence of disposable nappies as a normative practice? and (2) Are there ways that a compostable nappy service can overcome adoption constraints? To achieve this, the study adopts the MLP and SPT independently and then integrates them which together provides a robust framework for analysing socio-technical transitions and everyday practices.

The research methodology is grounded in a realist ontology and a constructivist epistemology. The realist ontology, as adopted by the MLP theoretical framework, assumes an objective reality composed of multiple interacting levels: niches, regimes, and landscapes (Geels 2002). This ontology acknowledges the existence of stable structures and dynamic processes that shape socio-technical systems. Conversely, the constructivist epistemology, as embraced by both MLP and SPT, recognises that our understanding of these systems is constructed through social interactions and contextual interpretations (Shove et al. 2012). This dual foundation allows for a comprehensive analysis of both the structural and agency-related aspects of socio-technical change.

The methodological structuring of this research is informed by the principles of triangulation, which involves using multiple methods to study a single phenomenon. Triangulation enhances the validity, reliability and credibility of the research findings by providing a more nuanced and holistic understanding of the research questions (Denzin and Lincoln 2011).

In Chapter 2, I set out the rationale for selecting MLP, SPT and the dual lens approach (pp 58 – 67) for this research project. Below I provide a summary of their features and then a description of the individual methods I used below that.

3.3.1 MLP

The MLP framework is applied to understanding how socio-technical systems evolve through socio-cultural interactions and interpretations (Geels 2002). The landscape level represents the macro-level context, encompassing broad societal, economic, and technological trends that are relatively stable and change slowly over time. The regime level constitutes the meso-level and consists of dominant practices, rules, and institutions that stabilise existing socio-technical configurations (Geels and Schot 2007). At the niche level, radical innovations emerge, which have the potential to disrupt the regime if they manage to break through. MLP posits that socio-technical systems are composed of interrelated elements, including technology, user practices, regulatory structures, and cultural significance. These elements interact across different levels, influencing the stability and change of the system. This multi-level structure acknowledges that

socio-technical transitions are complex and involve the interplay of various forces across different scales. Semi-structured interviews have been effectively employed within the MLP framework to explore the dynamics of sustainability transitions. These interviews provide a flexible yet focused approach to gather in-depth qualitative data on the perceptions, experiences, and strategies of various stakeholders involved in transitions (Geels 2006). These interviews enable researchers to probe deeper into specific themes while allowing interviewees the freedom to express their views, thus providing rich, contextual data that enhances the understanding of complex transition processes.

3.3.2 SPT

SPT primarily uses qualitative research methods to explore the detailed and situated nature of practices. Ethnographic and participatory approaches are common in SPT, allowing researchers to immerse themselves in the practices being studied and gain in-depth insights into their dynamics. These methods facilitate a nuanced understanding of how practices are enacted, maintained, and changed. Reflexivity is also a key component of SPT research, with researchers reflecting on their role and influence in the research process and acknowledging that their interactions with participants can shape the knowledge produced.

3.3.3 Semi-structured interviews

Semi-structured interviews with parents in the field trial, and key stakeholders such as nappy manufacturers, childcare centres and waste management companies provide in-depth insights into the factors that sustain the use of disposable nappies. These methods allow for the exploration of individual perspectives around nappy usage. Previous research by Creswell (2013) has demonstrated the efficacy of interviews in capturing detailed and nuanced data, making them ideal for this study's objectives. Bryman (2016) highlights the importance of stakeholder perspectives in evaluating the feasibility and sustainability of new initiatives.

3.3.4 Ethnographic observations

Ethnographic observations in in-home settings help to capture the everyday practices and material arrangements associated with nappy use. Ethnography can provide a detailed understanding of how disposable nappies are integrated into daily routines and the meanings attached to their use (Hammersley and Atkinson 2019). By observing real-world interactions and behaviours, this method uncovers the contextual factors that influence nappy practices. Re-enactments of each participant's current nappy practice and new, compostable nappy practice were observed. These were photographed along with the infrastructure surrounding each participant's nappy practice. This included waste receptacles, nappy changing stations, and washing and drying facilities.

3.3.5 Photographs

Photographs of re-enactments of nappy practices are also employed to document the daily experiences and challenges faced by parents in trialling a new nappy practice. Pink (2013) highlights the value of visual methods in ethnographic research, noting their ability to convey the complexities of lived experiences. Halkier and Jensen (2011) used re-enactments within SPT to deliver unique insights. Their work explored how re-enactments can help understand the dynamics of everyday practices by allowing participants to demonstrate and discuss their actions, thereby providing a deeper understanding of the meanings, competences, and materials involved in those practices.

3.3.6 User diaries

Personal accounts provide a vivid portrayal of the practice, revealing insights that may not surface through interviews or observations alone. User diaries offer valuable insights in SPT by providing detailed, first-hand accounts of daily activities and routines, which are crucial for understanding the nuanced ways in which practices are enacted and sustained. Through regular entries, diaries capture the context, variations, and sequences of practices, revealing patterns and changes over time that may not be evident through other methods. This approach allows researchers to access the subjective experiences and reflections of individuals, shedding light on the motivations, meanings, and social interactions that shape practices. Additionally, user diaries

can highlight the influence of material and social contexts on practice performance, offering a comprehensive view of how practices are embedded in everyday life (Hargreaves 2011, Shove et al. 2012).

The use of multiple methods allows for a nuanced understanding of the research questions, enhancing the credibility and trustworthiness of the interpretations and consistency of the findings. This detailed overview of the methodological approach justifies the use of specific methods and explains how each contributes to addressing the research questions.

3.4 Ontological and epistemological positions

3.4.1 Personal positionality

Acknowledging one's positionality is integral to understanding how personal experiences, identities, and social contexts influence the research process. This positionality statement outlines my background, beliefs, and biases as they relate to my research. The entirety of my background bears influences on my research. I am a 54-year-old second-generation, male, Anglo-Saxon Australian, raised in a higher socio-economic setting in Sydney, Australia. My educational background over the past 30 years has included undergraduate degrees in Japanese and Economics and a Master's degree in Japanese Sociolinguistics. My professional experience has stretched from stockbroking in Japan, Japanese interpreting in Sydney, teaching in high schools, and launching a Venture Capital-backed company in the eco-friendly baby nappy business in the United States. I am the current Chair of Circular Australia, the country's peak Circular Economy body. While bias is a risk in any research, I am particularly aware of the significant risk that my professional background could have in influencing my research activities. There is documented evidence of bias in academic research within the consumer field, where higher degree research is sometimes used to draw conclusions for commercial gain (Lesser et al. 2007, Stewart and Niero 2018, Rao 2022).

I recognise that my personal and professional experiences have shaped my perspectives and may introduce biases into my research. My role at Circular Australia and long background in the eco-friendly nappy business, might predispose me to favour particular solutions for alternative systems. My role as a parent and my gender may also be a source of bias as it relates to this

research topic. Being aware of these potential biases, I have been committed to maintaining objectivity and reflexivity throughout my research process. I continuously engage in self-reflection and seek feedback from peers and supervisors to mitigate the influence of my biases and ensure the integrity of my findings.

My perspectives align with constructivist ontology and epistemology which aligns with the adopted theoretical frames. This perspective suggests that reality is socially constructed and shaped by human experiences, interactions, and interpretations. I view reality as being influenced by how individuals and societies perceive and respond to environmental challenges. This aligns with the idea that our understanding of sustainability and consumption practices is not fixed but evolves through social processes and interactions. It acknowledges that these concepts are not universally defined but are shaped by cultural, social, and historical contexts. This aligns with my goal of pioneering circular economy approaches, which require understanding how societal norms and behaviours influence environmental outcomes.

My epistemological position is constructivist. Constructivism emphasises that knowledge about social phenomena is actively constructed by individuals and communities within specific social and cultural contexts. As a qualitative researcher investigating sustainable consumption, I prioritise exploring how individuals and communities actively construct their understandings and practices related to consumption behaviours and environmental sustainability. This approach values qualitative research methods such as interviews, ethnography, and discourse analysis to delve into the diverse ways in which individuals interpret and negotiate their roles in sustainable consumption practices. By immersing myself in their lived experiences and perceptions, I seek to observe the intricate ways in which social interactions, cultural norms, and personal experiences shape their perspectives on sustainability. Constructivist epistemology underscores the importance of understanding the dynamic and context-dependent nature of knowledge construction. It encourages reflexivity in research, where I critically engage with how my own perspectives and interactions with participants influence the interpretations and meanings that emerge from the research process. This methodological approach can not only enrich our understanding of sustainable consumption but also highlights the complexity and diversity of

perspectives within this field of study. My ontological and epistemological positions align with the theories I have selected to respond to my research questions.

3.4.2 Theoretical frameworks

The ontological and epistemological positions of MLP and SPT are well suited to address the research questions of this project. Below I set out these positions for both frameworks along with their complementarity with each other that they provide for this research.

3.4.2.1 MLP

The ontological position of the MLP is grounded in a constructivist ontology by emphasising the social construction of socio-technical transitions, the role of actors and institutions in shaping these transitions, and the contextual and historical dimensions of technological change.

Epistemologically, MLP adopts a constructivist approach, recognising that our understanding of socio-technical systems is constructed through interactions and interpretations within these systems. MLP encourages the use of insights from sociology, political science, economics, and history to understand the dynamics of system transitions. This interdisciplinary approach allows for a comprehensive analysis of the processes and mechanisms through which transitions occur, rather than merely describing static states. MLP relies heavily on empirical research to analyse historical and contemporary case studies of socio-technical transitions. By examining these case studies, researchers can uncover the dynamics that drive changes within and across the landscape, regime, and niche levels. This process-oriented analysis emphasises the importance of understanding how transitions unfold over time and the factors that facilitate or hinder these changes.

3.4.2.2 SPT

SPT adopts a constructivist ontology primarily through its focus on understanding social reality as constructed through everyday practices and interactions. SPT focuses on the practices themselves as the primary units of analysis rather than individuals or societal structures.

Practices are seen as configurations of activities, meanings, competencies, and material artefacts

(Shove et al. 2012). These configurations are not reducible to individual actions but are patterns that emerge from the interactions among these elements. SPT posits that social practices are the fundamental entities that constitute social reality. SPT views practices as evolving entities that co-construct and are co-constructed by social and material systems. The persistence or change of practices is understood through their reproduction over time and their interactions with other practices. This perspective highlights the dynamic nature of social practices and their capacity to adapt and transform in response to various influences. SPT embraces a constructivist ontology by emphasising that social reality is actively constructed through the performance, interpretation, and reproduction of everyday practices within social contexts. This perspective provides a framework for understanding how individuals, communities, and societies shape and are shaped by the practices they engage in, highlighting the relational and contextual aspects of social life. Epistemologically, SPT employs a relational approach. Knowledge is derived from understanding the relationships and dynamics within and between practices. This perspective emphasises the situated nature of knowledge, recognising that practices are context-dependent and vary across different settings.

3.4.3 Research Risks

An assessment of the risks of this research were deemed low by the university's ethics committee in approving this research. Notwithstanding that, some risks were identified and noted, particularly related to the field trial in the second research phase. These included the risk of making parents feel self-conscious when asked about their parenting choices. Introducing the novel compostable nappy also had risks associated with potential product failure. There could be associated negative emotions of either feeling forced to continue to use the product or ceasing to use the product and having concerns that in doing so, this would jeopardise the efficacy of the study. These risks were addressed in the first conversations with each participant with an explanation as to how to navigate such scenarios. The following three sections outline the research phases that comprise this study.

3.5 Phase 1: A Multi-Level Perspective of the nappy industry

3.5.1 Research Design

The goal of this first research phase was to understand from stakeholders associated with the nappy industry why the disposable nappy practice is dominant. The design of the study was developed to meet this goal and focused on interviews with stakeholders associated with the nappy industry.

3.5.2 Methods

I conducted semi-structured interviews with key stakeholders from both the niche and regime levels within the nappy industry. This methodology is one of the oldest and most commonly used in sociology (Minichiello 1995, Kvale and Brinkmann 2009, Yin 2009). It offers a sufficient amount of predetermined structure while giving scope for broader topics to be included. During these interviews, three niche actors detailed a small-scale pilot of an innovative compostable nappy project in rural NSW. This pilot provided a compelling, albeit limited, case study to explore niche-regime dynamics on a broader scale using the “windows of opportunity” framework (Tongur and Engwall 2017) within MLP, discussed in Chapter 2. The use of MLP by Mylan et al. (2019) to show the dynamics of niche, plant based milk threatening the milk regime supported the decision to use the theory for this research. Morris et al. (2014)’s research showing a more sustainable regime of meat provisioning also provided evidence that MLP was an effective framework to address my research questions.

3.5.3 Participant recruitment

Stakeholders were identified by mapping each actor across the supply chain, from nappy product manufacturing to waste management. At the niche level, stakeholders included a compostable nappy company, niche waste management firms, and local governments addressing plastic nappy waste through innovative solutions. At the regime level, stakeholders included major disposable nappy brands, national supermarkets, childcare centres, waste management companies, and waste management regulators at local and state levels.

Interview candidates were approached for interviews by cold calling organisations in most circumstances. In one case I had an existing relationship with the niche compostable nappy company due to my commercial background in the industry. In each of the papers, I detail my existing relationship with this company, identify the real and perceived risks and declared that

relationship. I was unable to secure an interview with a regime-level nappy manufacturer due to perceived commercial conflicts. This was unfortunate but somewhat unavoidable. Consequently, primary data from these manufacturers was not included. Instead, secondary data from consumer research and industry association reports was used (EDANA 2005, Nonwovens Industry 2017, EDANA 2018). Table 2 below summarises the stakeholder interviewees.

Table 2. Summary of Stakeholder interviewees

| | |
|-------------|---|
| Niche Level | 1. Director – niche compostable nappy & service innovator |
| | 2. Manager - commercial composting company |
| | 3. Waste strategist – rural-based council |

| | |
|--------------|---|
| Regime Level | 1. Executive - national supermarket |
| | 2. Procurement Manager - for-profit childcare centre |
| | 3. Early Childhood Education Researcher - not-for-profit childcare centre |
| | 4. Waste Educator – Sydney council |
| | 5. Recycling Educator – Sydney council |
| | 6. Project Officer – state-based waste regulatory authority |
| | 7. Policy Officer – state government department |

The initial written communication sent to potential participants, briefly outlining the objective of the research and interview can be found in the appendices.

Interview questions were developed for each stakeholder. They were designed to gain insights, moving initially from a broad perspective on the topic of nappies down to the specifics. They are set out below in Table 3.

Table 3. Stakeholder interview question guide

| Childcare Providers | Current arrangements | Introducing a possible new innovation |
|---------------------|--|--|
| | What is the cost of your childcare service? | Have you ever considered offering alternative nappies? |
| | Are nappies provided by parents or the centre? | Why? Do you have examples? |
| | How many nappies are used per centre per child and in total? | Did you proceed. If so, why? If no, why? |

| | | |
|--|---|--|
| | <p>What is the purchasing decision making process?</p> <p>Are reusable nappies considered ?</p> <p>What are the largest sources of solid waste?</p> <p>What is the cost of waste management for each centre?</p> <p>Are environmental impacts of the nappies you choose to use a factor in purchasing decisions for the company? Do you have examples?</p> <p>Is sustainability a factor for team members and / or parents?</p> | |
|--|---|--|

| Nappy Manufacturers | Current arrangements | Introducing a possible new innovation |
|----------------------------|---|--|
| | <p>Product</p> <p>What are the major factors in choosing to manufacture a particular product?</p> <p>What is the role of patents in your product innovation strategy?</p> <p>Do Polypropylene prices fluctuate significantly?</p> <p>Are environmental considerations factored into product design? Do you have examples?</p> <p>What are the drivers around your new product innovation strategy?</p> <p>Manufacturing</p> <p>What is the cost to purchase, set up and operate a nappy manufacturing line?</p> | <p>Product</p> <p>Have you ever considered using alternative materials to make your products?</p> <p>Why? Do you have examples?</p> <p>Did you proceed. If so, why? If no, why?</p> |

| | | |
|--|--|--|
| | <p>Are the manufacturing lines operating 24/7?</p> <p>How many nappies per minute are manufactured?</p> <p>Advocacy</p> <p>Is your company a member of an industry association? If so, why?</p> <p>What is the role of the association?</p> <p>What are the benefits to your organisation of being a member of such associations?</p> | |
|--|--|--|

| Retailer | Current arrangements | Introducing a possible new innovation |
|-----------------|--|--|
| | <p>Product</p> <p>What is the role of nappies in your stores as it relates to customers?</p> <p>What brands do you carry?</p> <ul style="list-style-type: none"> - Disposable - Reusable - Eco-disposable <p>Criteria in carrying nappies?</p> <ul style="list-style-type: none"> - Price - Performance - Velocity <p>Do you charge brands for shelf space?</p> <p>Do ESG considerations factor into decision making at the company? Do you have examples?</p> <p>Customer</p> | <p>Product</p> <p>Have you ever considered using alternative materials to make your products?</p> <p>Why? Do you have examples?</p> <p>Did you proceed. If so, why? If no, why?</p> |

| | | |
|--|---|--|
| | What features are important to your nappy purchasing customers? | |
|--|---|--|

| Waste management providers | Current arrangements | Introducing a possible new innovation |
|-----------------------------------|--|--|
| | <p>Product</p> <p>Describe how disposable nappy waste is currently managed</p> <p>What are the licensing requirements to manage this waste stream?</p> <p>What is the cost for your customers (Councils and private customers) to dispose of waste in this way?</p> <p>Is there any capacity limitations to disposing of this waste stream in this manner</p> | <p>How would a 100% commercially compostable nappy be managed in your facilities ?</p> <p>What would the licensing requirements be to manage this waste stream?</p> <p>What would the cost be for your customers (Councils and private customers) to dispose of waste in this way?</p> <p>Would there be any capacity limitations to disposing of this waste stream in this manner</p> <p>How would the introduction of FOGO by councils potentially impact your provision of waste management ?</p> |

| Regulators | Current arrangements | Introducing a possible new innovation |
|-------------------|--|--|
| | <p>Federal Government</p> <p>Describe how disposable nappy waste is managed and regulated at a national level?</p> <p>Is this waste stream regarded as problematic?</p> <p>State Government</p> <p>Describe how disposable nappy waste is managed and regulated?</p> | <p>Federal Government</p> <p>To what extent has the Circular Economy influence national waste management policy?</p> <p>Could a federally mandated FOGO policy ever be considered?</p> <p>Describe the compostable nappy pilot and the waste code exemption process</p> |

| | | |
|--|---|--|
| | <p>Why has this regulator in the past described nappies as a problem waste ?</p> <p>Council</p> <p>Describe how disposable nappy waste is managed and regulated in this council</p> <p>Describe the rationale for and introduction of FOGO in this council. Has it been successful?</p> <p>Do ESG considerations factor into decision making at the EPA? Do you have examples?</p> | <p>Details of process, results, barriers and enablers</p> <p>Council</p> <p>Has there been any consideration for expanding FOGO to include other organic feedstocks?</p> <p>If so, can you provide details?</p> |
|--|---|--|

3.5.4 Data collection and analysis

Interviews of approximately 60 minutes in duration were conducted either in person or via Zoom depending on the circumstances of the interviewee. These were recorded and transcribed using digital transcription software (Otter.ai). I conducted a manual check for accuracy and clarity in finalising the transcript for each interview. All interviews were analysed using NVivo software. A coding rubric was developed to capture recurring themes. These categories helped identify themes which formed the basis of the findings.

3.5.5 Reflections

I recorded a reflection after each interview. Due to the after-effects of Covid-19, several interviews took place over Zoom in cases where companies were permitting work from home arrangements. This impeded my ability to create rapport in some cases which may have limited the richness of the data. The lack of participation by a major nappy manufacturer was also a disappointment. I was highly aware of concerns about potential for bias during the interview with the niche compostable nappy company. On reflection, I am not certain I could have safeguarded the project any further in trying to manage this potential conflict.

3.6 Phase 2: A compostable nappy service field trial

3.6.1 Research Design

The purpose of this research was to understand the barriers and enablers of a novel compostable nappy service to gain acceptance as an alternative to disposable nappies. As discussed in chapter 2, a unique feature of this nappy is that it is offered as a product and a deliver, collect and compost service. The design of this field trial was solely sociological, looking at the user and the new practice. The logistics and composting of the product fell out of the scope of this trial and has been addressed in separate research (Bega Valley Shire Council 2021, Australian Broadcasting Commission 2022).

3.6.2 Methods

To understand the dynamics of the durability of the current dominant disposable nappy practices and the possibilities for a compostable nappy and service to take hold, I selected the field trial as the methodological approach. Field trials have been employed in previous research using SPT to explore how practices develop in real-world contexts (Nicolini et al. 2003, Shove and Pantzar 2005, Spaargaren and Van Vliet 2007, Sahakian et al. 2021). A 7-day trial period was selected as it allows enough time for participants to integrate the new practice into their routines without being overly intrusive. This duration equates to approximately 40 nappy-changing opportunities, providing sufficient data to achieve saturation (Blaikie and Priest 2019). The nappy itself is made up of a compostable chassis and a reusable, washable cloth wrap (See Figure 2 below). Each participant was supplied at no cost with 40 compostable nappies which included one washable, reusable wrap, a package of compostable baby wipes and a package of compostable nappy bags for disposal. These items are shown in Figure 1 below.



Figure 1. The compostable nappy, wrap, wipes and nappy bags

Participants were instructed to use the compostable sacks for each nappy change and to simulate the separate collection of the product as would be required if the collection service was operational. When nappy changes happened away from home, participants were asked to bring used nappies home. In practical terms, the compostable nappies were disposed of in each participant's usual waste receptacle.

3.6.3 Participant recruitment

I selected 20 as the adequate number of participants for this research after investigating the literature. Mason (2010) suggests that when groups are homogenous and responses tend to be similar, data saturation can be achieved at approximately 12 respondents. More data collection will unlikely result in a greater diversification of results. However, Vasileiou et al. (2018)'s review of 15 years of sample sizes used in sociology, psychology and medicine showed a tendency for sample sizes to be too small which threatens their validity. Taking these factors into consideration and predicting that I may lose several participating parents give the busyness of young parents, I chose the slightly larger number of 20 participants.

I selected the Waverley Local Government Area in New South Wales to conduct the field study as it is representative of a community in a city. I also live in this area. By locating it in the area I live in, I was able to mitigate the risk of travel restrictions that were still lingering after the

Covid-19 pandemic had subsided. As a sociological study requiring in-person, in-home observations and interviews, mitigating this risk was important to maintain the quality of the results. However, by choosing the area within which I live, other risks emerged, such as possible conflicts of interest if any known parties become involved in the research. Fortunately, this scenario did not eventuate.

Two recruitment challenges emerged, which caused delays and presented a rethinking of the recruitment process. Firstly, unlike other data collection methods such as online surveys, this study required a high level of participant commitment, including two one-hour in-home visits that had to be scheduled around children's nap times, work, and other demands of new parents. Secondly, despite the many mothers' groups in Sydney providing ample enrolment opportunities, securing commitments proved challenging. Mothers were often reluctant to interrupt their limited social time with other new mothers to talk about a research project with a middle aged, male stranger. In some cases, a "reverse" snowball effect occurred, where one mother's decision not to participate led others in the group to follow suit. Approaches to childcare centres also met with limited success due to privacy concerns. Ultimately, after consulting with my supervisors, I enlisted my wife, a mother herself, as a recruiter, and she successfully enrolled 20 mothers.

As was anticipated when recruiting from a small geographic area, diversity was minimal. All 20 participants were from English-speaking backgrounds and were from middle to high socio-economic status. The age range of their babies was 3 to 16 months. One family employed an Au Pair to assist the household. Sixteen of the participants were new mothers, while the remaining four had a baby in nappies and one older child. This small number of participants with more than one child reflected the challenges in recruiting mothers juggling multiple commitments. While 95% of the population in the Global North use disposable nappies (Klein, 2018), the research aimed to recruit 10 disposable nappy users and 10 reusable nappy users to provide a broad range of data on existing practices. Ultimately, of the 20 participants, 12 (60%) were disposable nappy users, and 8 (40%) were reusable nappy users.

3.6.4 Data collection and analysis

I employed four data collection methods. They included in-home semi-structured interviews, re-enactments of nappy practices, a user diary and photographs of the re-enactments and physical

nappy-related infrastructures of each participant's home. Table 4 below shows a summary of data collection methods.

Table 4. Summary of data collection methods

| | Timing | Data collection method | Information gathered |
|---|--------------------|---|---|
| 1 | Pre-field trial | In-home, semi structured introductory interview | Existing nappy practices |
| 2 | Pre-field trial | Re-enactments of current nappy practice | Existing nappy practices |
| 3 | During field trial | User diary | Compostable nappy practices |
| 4 | Post-field trial | Re-enactments of compostable nappy practice | Compostable nappy practices |
| 5 | Post-field trial | In-home, semi structured concluding interview | Reflections of field trial practices and existing nappy practices |

During the pre-field trial in-home interviews, I observed re-enactments of existing nappy practices. Participants were asked to put on, take off, and dispose of or prepare to wash nappies, allowing me to observe the competencies involved in their current practices. The material infrastructures surrounding these practices, such as changing tables, waste receptacles, and clotheslines, were also noted. Participants were asked how they were introduced to their current nappy practices and what factors motivated their choices.

Following this, the compostable nappy was introduced. Participants were asked to maintain user diaries, adapted from Sofoulis (2006), to document their experiences. The diaries captured the frequency of nappy changes each day, who changed the nappies, where the changes occurred, and reflections on the experience, including the efficacy of the product (See Figure 2 below).

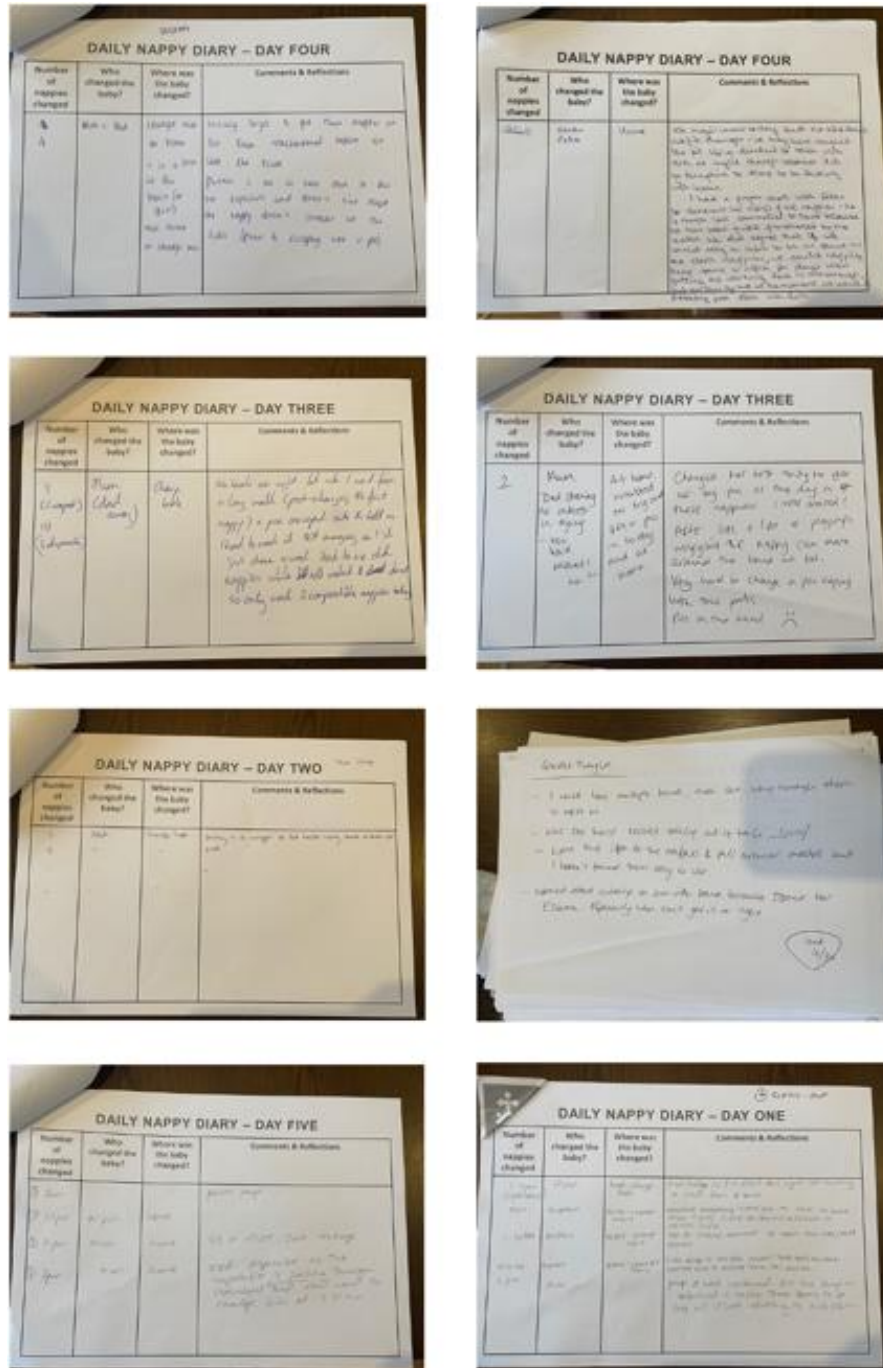


Figure 2. A sampling of user diaries

The field trial concluded with a second in-home, semi-structured interview and re-enactments of the new nappy practices, which were also photographed (See Figure 3 below). The diaries offered a temporal perspective, while the in-home interviews contributed a spatial dimension. Interview recordings were transcribed using transcription software and verified for accuracy.

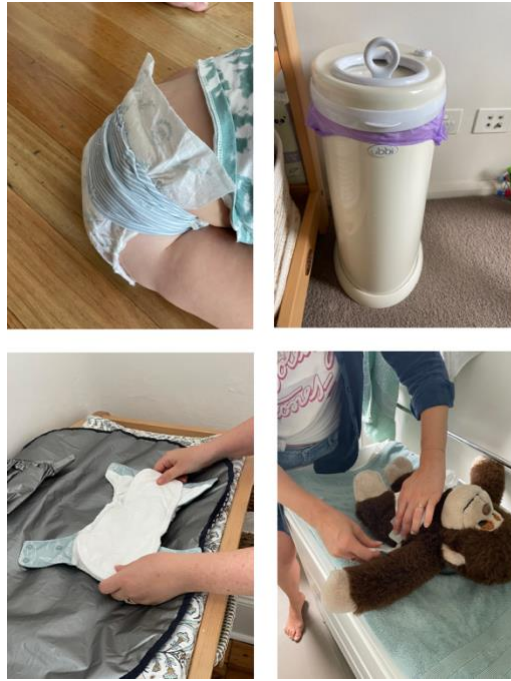


Figure 3. A sampling of photographs capturing nappy practices

The user diaries and interviews were coded using NVivo software. Codes were developed to capture recurring themes using SPT's three elements of competence, material and meaning (Shove 2003).

3.6.5 Reflections

Despite the initial recruitment troubles, I was able to create a positive rapport with the research participants. The home visits were an impactful way to truly sense the competing practices new parents face. In almost all cases upon entering a participant's home, there was an apology for the perceived messy state of their living rooms. This in and of itself reflected the world of new parents which would not have been captured using other, more remote methods. I was pleased that all 20 participants completed the trial despite many having poor experiences with the new compostable nappy service. This multiple method approach while demanding for the participants proved to be a valuable way to discover insights into nappy practices.

3.7 Phase 3: Intersections between the nappy regime and practices

3.7.1 Research Design

In attempting to address the research questions in this thesis, the first research phase had a focus on niche - regime dynamics at the nappy industry level while the second was on nappy practices at the household level. This third phase attempts to draw conclusions from each of the first phases using a different analytical lens. It does so by investigating how regime level lock-in effects interact with practice dynamics at the household level to keep the incumbent disposable nappy practice in place. From that position, potential interventions could be developed to allow for more sustainable nappy practices to emerge.

3.7.2 Methods

For this research phase, this “zoom in, zoom out” approach, pioneered by Nicolini (2014) primarily involved re-analysing the data produced from the first two research phases. A growing body of research has highlighted the value of co-applying the MLP and SPT to better understand sustainability transitions, addressing major challenges such as energy, mobility, and food systems. Notable contributions include work by Hargreaves et al. (2013), Geels et al. (2015) and Keller et al. (2022). Both theories are concerned with sustainability and transitions, focusing on holistic systems change and the interplay between stability and emerging transitions. They advocate for a multi-actor approach, featuring the co-evolution of heterogeneous elements, and reject prioritizing either agency or structure, instead emphasizing recursive processes in social change. This approach does not merge the two theoretical lenses; rather, each is applied independently to identify intersection points between practices and regimes. These points of intersection serve as opportunities for interventions to accelerate shifts toward sustainability. This method highlights key areas of conflict and connection between systems and practices, providing valuable insights for driving sustainable change. Combining MLP and SPT in sustainability transition research offers a comprehensive framework for understanding societal shifts towards sustainability. MLP concentrates on the dynamics within socio-technical systems, while SPT emphasizes social practices as the primary unit of analysis. Together, they provide a holistic view of transitions by examining the interactions between macro-level factors, such as policies, and micro-level factors, such as individual behaviours.

3.7.3 Data analysis

The datasets and findings from the first two research phases were re-analysed. At a practice level, barriers to the adoption of the novel compostable nappy service were highlighted. At the regime level, lock in effects between actors such as retailers and manufacturers were noted. This integration aids in identifying intervention points to drive sustainable change, addressing the complexity of sustainability transitions by combining structural and cultural analyses. Furthermore, it has practical implications for policy-making and interventions, facilitating effective strategies that promote sustainable behaviours and transitions. Overall, this combined approach offers a robust framework for navigating transitions towards sustainability.

3.7.4 Reflections

This third research phase was less involved from a practical research design and delivery point of view but more engaging as the data was reviewed and new relationships between the practice and the regime were identified. This relatively new method generates an additional set of findings in response to the research questions. As a researcher who has come into academia from industry, it is this last research phase that perhaps holds the most potential for turning research into policy and actions.

3.8 Chapter Summary

In this chapter I have discussed the research design and methods used to respond to the research questions. As a thesis by publication, I have attempted to avoid repetition. I have done so by focusing on the details and rationale of the design, recruitment, data collection and analysis of each research phase that were not able to be incorporated in the individual research papers. The next three chapters described the three research phases referenced in this chapter. The three associated research papers are reproduced in each of these chapters. Conclusions are then presented in Chapter 7.

Chapter 4. A Multi-Level Perspective of the nappy industry

This chapter sets out the first of the three research phases discussed in Chapter 3. It takes the form of a research paper co-authored with my supervisors, entitled “Windows of opportunity: The power dynamics in the disposable nappy regime and opportunities for niche innovations”. It was published in “Cleaner and Responsible Consumption”, Volume 12 in March 2024 (Graham-Nye et al. 2024). The contents of the research paper is reproduced in this chapter.

This first research phase takes a Multi-Level Perspective of the nappy industry. It does so by studying niche-regime dynamics in sustainability transitions in the disposable nappy industry. As set out in Chapter 1, disposable nappies generate a disproportionate amount of plastic waste relative to the per capita usage of the product. In the 60 years since disposable nappies were introduced into the market, niche innovators attempting to offer more sustainable solutions have been unable to challenge the dominant market position of disposable nappies. Little attention has been paid to the dynamics of this industry despite the growing plastic waste crisis and the emergence of new niche innovations.

In this study, we apply the Multi-Level Perspective (MLP) to the disposable nappy category for the first time. We adopt the “windows of opportunity” framework that sits within MLP to understand niche-regime dynamics in the nappy industry. The findings of this study revealed several significant barriers that niche nappy innovators need to overcome to destabilise regime-level actors and become mainstream. Achieving price parity and matching performance and convenience are the most significant factors. A new policy intervention in the Australian state of New South Wales banning the inclusion of compostable biofilms in household Food Organics Garden Organics (FOGO) waste collections also poses an immediate regulatory barrier.

Windows of opportunity: the power dynamics in the disposable nappy regime and opportunities for niche innovations.

4.1 Introduction

This paper explores the prospect of sustainability transitions in the disposable baby nappy industry. Since their introduction in 1961, up to 95% of parents in the Global North use disposable baby nappies (Klein 2018). As a result, this nappy product choice has become the norm for multiple generations of parents. The most recently available consumer market research shows that annual production of disposable baby nappies reached 167 billion units in 2017 (Olivo 2017). The production and consumption of plastic disposable baby nappies has caused substantial damage to the environment since their introduction 60 years ago (United Nations Environment Programme 2021). There are two major environmental impacts caused by disposable baby nappies: the upstream use of oil to manufacture the product, and downstream disposal in landfills. Landfills receive significant amounts of organic matter which generates greenhouse gas (GHG) emissions. Used nappies also pollute waterways in countries where there are limited formal waste management systems (Khoo et al. 2019). The United Nations Environment Programme described the product as one of the largest contributors to plastic waste globally (United Nations Environment Programme 2021). The announcement in March 2022 by the United Nations Environment Assembly of a global, legally binding plastic treaty to end plastic pollution indicates the scale of the plastic waste problem and the desire to address this source of pollution (United Nations Environment Programme 2022). Relative to the well-documented environmental damage caused by single-use plastic shopping bags (Weinstein 2010, Wagner 2017, Global Health Metrics 2018), disposable baby nappies represent a far larger source of pollution on a per user basis. However, the environmental impacts of disposable nappies and the possibility of alternatives have yet to gain a commensurate level of attention in academia and wider society.

There are four alternatives to disposable nappies. They are reusable nappies, eco-friendly nappies, hybrid nappies and compostable nappies. Reusable nappies were the first nappy product choice for parents since their inception in the US in 1887 (United States Patent Office 1887) up

until the introduction of disposable nappies in 1961 (Ratnapandian and Warner 1996). Reusable nappies are made of washable materials that are purchased once and used and washed repeatedly during the years a baby uses nappies. There is evidence to suggest that reusable nappies offer less negative environmental impacts than disposable nappies (Garrett et al. 2008, Klein 2018, United Nations Environment Programme 2021). This is chiefly due to their ability to be washed and reused over the life of a baby or multiple babies. The negative effects of water and energy usage for reusable nappies are outweighed by the extraction of oil to make the plastic in disposable nappies and their disposal in landfills where they may take up to 500 years to degrade (Sanderson 2008, Wang et al. 2016, Khoo et al. 2019). However reusable nappies have been unable to challenge the dominant market position of disposable nappies. Today, they represent just 0.7% of the value of the disposable nappy market (Market Growth Reports 2023).

Over the past two decades eco-friendly nappies have been developed that use some compostable materials along with incumbent plastic films. However, assuming the entire nappy is disposed of in landfill, the environmental benefits are unlikely to be significantly different than regular disposable nappies. Eco-friendly nappies have been unable to gain significant market share due to their price premium. More recently, hybrid nappies have been developed that include an outer washable pant, and an absorbent, industrially compostable liner² (Walker 2006). Hybrid nappies have been commercialised and have faced the same difficulties that reusable and eco-friendly nappies have experienced in gaining mainstream appeal. Compostable nappies using a reusable, washable fastening mechanism (Klein 2018) have also been developed but are yet to be fully commercialised. Unlike the other alternatives, compostable nappies are offered along with a full service including the delivery, collection and composting by the manufacturer or a third party. This full service is also known as a “Product Service System” in academic literature and is a business model that integrates a product and service providing a complete solution to meet customer’s needs and create value (Pieroni et al. 2019). The concept has increasingly appeared in

² Industrial composting is defined as "the process of converting organic waste from industrial sources into a valuable soil amendment through the breakdown of organic matter using aerobic decomposition." It typically involves the use of specialized equipment to manage and control the process, such as enclosed composting systems, aerated static piles, and in-vessel systems. Industrial composting of organic materials helps to reduce the amount of waste sent to landfills, improve soil fertility, and reduce the need for synthetic fertilizers. Additionally, it can reduce emissions of environmentally harmful gases and provide a valuable source of compost for farms and other agricultural operations. Source: Bae, E., & Han, S. (2018). Industrial composting of organic waste: A review. *Renewable and Sustainable Energy Reviews*, 97, 803-817.

Circular Economy literature as a way to provide products in a more sustainable way. In Australia, the compostability of this product has been endorsed by Australia's peak composting-industry body, Compost Australia (Wadewitz 2009). The compostable nappy product-service system is the subject of this study. Given their early stage of development, there has been little research conducted to better understand the dynamics between the dominant disposable nappy and this new alternative product and service format. This study aims to understand how a compostable nappy with a reusable fastener and service could challenge the dominant market position of disposable nappies.

The Multi-Level Perspective (MLP) (Kemp et al. 1998, Geels 2004, Geels 2011) has gained prominence as a useful theoretical lens to understand the dynamics of sustainability transitions. Sustainability transitions are large and complex and occur at a global scale which requires systemic change. This includes changes across multiple sectors (technology, policy, markets, user practices, infrastructure, cultural meaning and scientific knowledge) involving multiple actors (companies, policy makers, consumers, society and researchers). MLP describes interactions between niche innovations at the micro-level, technological regimes at the meso-level, and sitting above these levels, the landscape at the macro-level. The socio-technical regimes at the meso-level represent the current status quo across policy, infrastructure, institutions and corporations. Niche innovations may develop and destabilise the regime, becoming mainstream themselves. The landscape may also destabilise the regime, creating opportunities for niche actors to join the regime (Geels 2004). Geels (2002), Nill and Kemp (2009) and Smith et al. (2010) further developed MLP by identifying "windows of opportunity" opening and subsequently closing for niche sustainability innovations to destabilise the regime and become mainstream. This "windows" approach is growing in popularity and has been applied by researchers to understand niche innovation across a wide range of subject areas. They include infrastructure, online retail and transportation (Normann 2015, Tongur and Engwall 2017, Dannenberg et al. 2020, Becker et al. 2022, Szasz et al. 2022). This approach provides a compelling retrospective of moments in time when a niche innovation may have been able to destabilise the regime but was ultimately unsuccessful. Understanding the dynamics of these historical opportunities for sustainability transitions may provide insights for future opportunities for sustainability transitions to take hold. In the context of nappies, challenging the dominant

market position of disposable nappies by alternative products can be characterised as a sustainability transition. This study applies MLP to nappies for the first time.

In this research, 12 semi-structured interviews were conducted with stakeholders who sit at the regime and niche levels of the nappy industry. Analysis of these interviews was then conducted through the lens of MLP with a specific view to identifying examples of windows of opportunity. This paper makes four contributions to the field surrounding the dynamics of sustainability transitions. It is the first application of MLP to the nappy industry. It also contributes to an emergent body of literature applying MLP to a product category rather than a system. In addition, it uses the “windows” lens to understand niche-regime dynamics within the nappy industry. Lastly, it reflects on the lessons of the past to suggest how future windows of opportunity can be “wedged open” to accelerate sustainability transitions in the nappy industry.

The lead researcher has 20 years of commercial experience in the environmentally friendly nappy industry and has lived experience of developing and marketing products for the sustainable nappy sector. He acknowledges that this background will shape the lens through which he engages with this topic. In addition, he is aware that his identities including gender, age and family experience may influence his approach and interactions as part of this research. To address the potential for bias, he has engaged in critical reflection with co-authors and advisors who have different identities in terms of professional experience, disciplinary background, age and gender.

The structure of this paper is as follows: following this introduction in Section 4.1, Section 4.2 introduces the windows framework and describes how it applies to the nappy industry; Section 4.3 describes the methodology; Section 4.4 sets out the results and offers an analysis; Section 4.5 provides a discussion; and Section 4.6 offers concluding remarks.

4.2 Analytical Framework

MLP is a framework for understanding sustainability transitions acknowledging the complexity and multiple dimensions of a socio-technical system. It was developed initially by Rip and Kemp

(1998) and further refined by Geels (2002) in an attempt to understand how socio-technical transitions occur considering three levels of analysis within a socio-technical system. Geels (2011) describes the approach as interactions between niche innovations at the micro level, technological regimes at the meso level and landscape factors at the macro level. The socio-technical regimes at the meso level represent the current status quo across policy, infrastructure, institutions and corporations. This has been described by Geels (2004) as the “deep structure” that offers stability to the system. Change is incremental in nature and path dependent at this level. They can however be vulnerable to influences of the socio-technical landscape at the macro level and niche-innovations at the micro level. Micro-level niche-innovations represent radical new offerings developed by R&D labs, incubators and start-up entrepreneurs and can come in the form of small-scale pilots and experiments (Geels 2004, Smith and Raven 2012). In this model, sustainable niche-innovations seek to have their innovations incorporated into or replace the existing technological regime. Smith and Raven (2012) labelled this incorporation of a niche innovation into the regime as an example of a “Fit and Conform” configuration while the niche innovation that entirely replaces a regime technology is an example of a “Stretch and Transform” innovation. Mylan et al. (2019) added a third category, namely a hybrid approach that has elements of both “Fit and Conform” and “Stretch and Transform”. The socio-technical landscape represents exogenous background factors including prevailing economic conditions, the price of commodities and global events. A recent example of such a factor is the Covid-19 pandemic. The durability of the meso level is significant with a multitude of lock-in mechanisms which reinforce the status quo and render many niche innovations ineffective in becoming mainstream (Geels 2011).

Applications of MLP have to date been predominantly centred around systems-level transitions including energy, food provisioning, finance and transport (Mylan et al. 2016, Tongur and Engwall 2017, Geddes and Schmidt 2020, Lucas-Healey et al. 2022, Medina-Molinaa et al. 2022). There are relatively few examples of the application of MLP at a product category level (Becker et al. 2022, Sunio and Mateo-Babiano 2022). Two exceptions include Morris et al. (2014) and Mylan et al. (2019). Morris et al. (2014) applied MLP to explore a more sustainable regime of meat provisioning. They did so by looking at Less Meat Initiatives (LMIs) as socially innovative niche projects. LMI’s include campaigns such as Meat-Free Mondays and Meatless

Mondays in the US and UK. This research showed the impact of a social innovation on the consumption of a mass-consumed, entrenched product not dissimilar to disposable nappies. Their work concluded that while LMI's had replicated and scaled up across the world, they have not destabilised regime-level meat consumption. The authors argued that this is because the initiative was too radical to become mainstream. In addition, while state actors, organisations and the media continued to promote a diet high in meat, the impact of LMIs was limited. LMIs are effective in raising awareness about a diet less dominated by meat. Mylan et al. (2019) using MLP took a historical view of the challenges faced by niche plant-based milk (PBM) innovators as they attempted to enter the liquid dairy milk regime. These are milks made from soy, nuts, legumes, seeds and grains. Their research showed a bi-directional dynamic between regime-level liquid dairy manufacturers and niche-level PBM producers. Rather than the well documented, one-way push upwards by the niche player pressuring the regime to incorporate their offerings, this research found the regime itself developing their own products or acquiring niche players. Building on previous studies, in this work we apply MLP to the specific product category of baby nappies. We do so in an effort to show new insights that can assist practitioners, researchers and policy makers address the growing disposable nappy waste problem.

Geels (2002), Nill and Kemp (2009) and Smith et al. (2010) developed the “windows-of-opportunity” framework to further explain niche-regime dynamics. While MLP describes a structure within which three socio-technical levels interact, the windows of opportunity approach adds a temporal element to further elaborate MLP. The framework describes a period of time where an opportunity emerges for niche innovations to destabilise the lock-in effects of the regime and become mainstream. Examples of such windows opening include government interventions supporting niche innovations and landscape level factors such as pandemics and financial crises. Since first raised by Geels (2002), a growing number of researchers have applied the windows approach to understand the prospects of sustainability transitions. Nill and Kemp (2009) built on Geels' work by defining windows of opportunity as a phase of instability for the dominant, regime-level technology. Tongur and Engwall (2017) applied the windows framework to explore the barriers and enablers to infrastructure investments to support sustainability transitions. They added to the work of Nill and Kemp (2009) by defining four window-of-opportunity phases that enable niche innovations to become mainstream. These are the “pre-

window-of-opportunity” state, the “opening” state, the “closure” state and “post-window-of-opportunity closing” state, described in detail below.

4.2.1 Four phases of the windows-of-opportunity

It is the “windows-of-opportunity” framework that we focus on in this study. In the “pre-window-of-opportunity state”, regime-level technologies are stabilised by lock-in effects. These include the deep relationship between major brands of products and supermarkets that create barriers for niche innovators. Niche innovations are in incubation stage and unable to gain a foothold due to the lock-in effects at the regime level and limited pressure on the regime to change from landscape factors (Tongur and Engwall 2017).

In the “opening state”, the existing, regime-level technology is destabilised by external, landscape-level pressures. Such pressures include an increasing global awareness of climate change and incidences of pandemics such as the Spanish Flu, HIV / AIDS and Covid-19. Regime actors can become vulnerable to both emerging niche technologies gaining competitiveness, along with their own internal issues such as the unsustainability of their own technology.

According to Tongur and Engwall (2017) in this state, newly emerged problems and solutions seek each other out and partnerships are formed between niche innovators and regime-level actors. Innovations are assessed and either modified to fit the existing regime or the innovation stretches the regime and transforms it to become the new socio-technical regime.

Covid-19 provided a recent example of an external, landscape factor threatening regime-level technologies globally with varying degrees of success and on-going durability. The pandemic prompted a volume of research in the past two years that applied the windows framework to understand niche – regime dynamics during this significant landscape-level shock. Dannenberg et al. (2020) describe the temporary impact of the pandemic on online grocery sales in Germany. Becker et al. (2022) found that pop-up bicycling infrastructure established in Berlin during the pandemic is likely to remain in place, catalysing a regime shift from cars to bicycles due to the positive impacts that the infrastructure provides. Szasz et al. (2022) reviewed the impacts of Covid-19 on online retail in 23 countries. While the shock of the pandemic opened the “window-of-opportunity” for significant growth in online retail sales vis a vis regime level traditional retail stores, this was in the context of 10 years of slow and steady growth of online sales. In addition, multiple sub-regimes including shifts in policy (stricter government restrictions) and consumer

behaviour (changes driven by reduced mobility) were identified as requirements to keep the window open (Szasz et al. 2022)

Sunio and Mateo-Babiano (2022) focused their research on transportation in Metro Manila. Prior to the pandemic, cycling was not a common mode of transport in the city due to safety concerns. Covid-19 opened a “window-of-opportunity” for the government to create a more sustainable transport system. They introduced policies that were supportive of cycling including business model development for operators, safety measures for cyclists along with the financing and implementation of bus routes and infrastructure supporting active mobility that continues today. These examples support the view of Normann (2015) whose research on policy development related to the introduction and subsequent demise of wind farms in Norway. He suggested that windows of opportunity open not only when the dominant technology is under pressure but also through government interventions as they respond to external pressure. Kingdon (2013) also touched on the role of politics in niche-regime dynamics. Kingdon suggested that niche innovations have a far greater chance of becoming mainstream if the political stream is supportive of it. He adds that windows do not themselves deliver change, rather it is in combination with a specific niche-level solution that can effectively address a problem. Covid-19 provided a rich vein of research using the windows framework which when viewed through the four phases lens, and specifically the opening state phase offers valuable clues as to how sustainability transitions come about and how they can be sustained.

The "closure state" is achieved when the niche innovation has more effectively addressed the problem than the incumbent solution and replaces it. Lastly, in the “post window-of-opportunity closing state”, the socio-technical system has been reconfigured with the niche technology at the centre of the solution. The approach and insights from the existing research provides a fruitful foundation for this research paper. In this paper Tongur and Engwall (2017)’s four phases of the windows framework is adopted.

4.3 Methodology

For this study, we used two methodologies. We initially conducted semi-structured interviews with key stakeholders at both the niche and regime level in the nappy industry. During the interviews with the three niche actors, a small-scale pilot of a niche nappy innovation in rural NSW was described. This presented us with a case study that we could use to understand niche-regime dynamics more broadly.

4.3.1 Stakeholder identification

Stakeholders were identified by mapping each actor across the supply chain from the manufacturing of the product to the end-of-life management of its waste (Table 1).

Table 1. Summary of Stakeholder Identification Process using the Multi-Level Perspective

| | |
|--------------|--|
| Niche Level | 1. Compostable nappy & service innovator |
| | 2. Niche waste management companies |
| | 3. Forward-thinking councils |
| Regime Level | 1. Disposable nappy brands |
| | 2. National supermarkets |
| | 3. Childcare centres |
| | 4. Waste management companies |
| | 5. Waste management regulators |

At the niche level, the stakeholder mapping identified the compostable nappy company, niche waste management companies (industrial composters) and councils (local government) willing to address plastic nappy waste in innovative ways.

At the regime level, this included major disposable baby nappy brands, national supermarkets, childcare centres, waste management companies and waste management regulators at local and state government levels. Major disposable nappy brands are the providers of the product that 95% of Australian parents use (Klein 2018). National supermarkets are the key retailer and the choice of products they choose to stock influence what nappies parents use. Childcare centres

were included as 47% of Australian children aged 0 - 5 attend childcare centres (Department of Education 2021). As a result, childcare centres are a significant purchaser and consumer of baby nappies. Waste management companies are a key element of the nappy regime as they are charged with collecting and managing nappy waste. Waste regulators at the local and state level are responsible for regulating waste streams generated by households. This includes issuing licenses for landfill and compost operators to accept and process waste safely. It also includes the introduction of new waste management laws that directly impact how compostable products are managed at end of life.

The stakeholder mapping identified interviewees who we then approached to be interviewed. While the primary author's commercial experience provided relevant industry knowledge for this research, major global nappy manufacturers who were approached for interviews were unwilling to be interviewed owing to the perceived potential commercial conflicts. Thus, this research does not include primary data providing the perspectives of major disposable nappy manufacturers. We have instead relied on secondary data through consumer research and industry association reports to address the gap in data (EDANA 2005, Nonwovens Industry 2017, EDANA 2018). Table 2 below summarises the stakeholder interviewees.

Table 2. Summary of Stakeholder interviewees

| | |
|-------------|---|
| Niche Level | 1. Director – niche compostable nappy & service innovator |
| | 2. Manager - commercial composting company |
| | 3. Waste strategist – rural-based council |

| | |
|--------------|---|
| Regime Level | 1. Executive - national supermarket |
| | 2. Procurement Manager - for-profit childcare centre |
| | 3. Early Childhood Education Researcher - not-for-profit childcare centre |
| | 4. Waste Educator – Sydney council |
| | 5. Recycling Educator – Sydney council |
| | 6. Project Officer – state-based waste regulatory authority |
| | 7. Policy Officer – state government department |

4.3.2 Niche Level Case Study

The niche innovation used in the case study was a nascent compostable nappy and service. The compostable product is delivered, collected and composted by the manufacturer or a third party to ensure no waste goes to landfill. For this innovation to displace the disposable nappy regime, a system change is required including regulatory reform to allow for the composting of human waste along with the establishment of commercial composting infrastructure and reverse logistics services. These elements add cost to an already relatively expensive product due to the more expensive compostable materials used in its design. Baby nappies are a highly price-sensitive category which impedes the commercial viability of such innovations. Because of these challenges, sustainability innovators focused on systems change have limited access to capital further restricting their ability to scale and threaten the regime. The compostable nappy and service provides a unique research subject. This is because it is pre-commercial in stage and faces several complex factors in order to threaten the regime.

Interviews with the three niche-level stakeholders revealed details of their collaboration in a small pilot using the niche compostable nappy in a rural community in New South Wales. This case study provided a valuable source of data which revealed the elements necessary to open the “window-of-opportunity” to disrupt the stability of the nappy regime. The Waste Strategist at the rural-based council provided background information about the pilot. The council’s landfill was approaching capacity at a faster rate than initially expected. They also noted that a high proportion of organic waste was being disposed in the landfill. Faced with the prospect of raising a levy from the community to build a new landfill, the council chose to develop a commercial composting facility. This offered additional economic and environmental benefits which also contributed to the “window-of-opportunity” being opened. Economic benefits included extending the life of the current landfill which increased the return on the original investment of the existing landfill. The cost of establishing and operating a composting facility is less than a landfill according to the Waste Strategist at the council. In addition, while not significant, the compost generates some income as it can be sold back into the local community. The environmental benefits of commercial composting include a reduction in greenhouse gases associated with organics entering landfill and the resultant compost which benefits soil health

(Liu et al. 2022). To encourage the community to divert their organic waste to composting, the council also provided a weekly, separate kerbside food organic and garden organic collection service (FOGO). This would divert organic waste away from landfill reducing greenhouse gas emissions by the landfill. It would also produce compost which could be used to support soil health in the community. To encourage separation of organic waste from residual waste and maximise the amount of organics diversion, the council reduced their existing weekly landfill-bound waste collection to every second week. This caused parents to complain that they were having significant amounts of dirty nappies accumulating in their bins between collections. Collaborating with the community, the council devised a one-month pilot of a niche, compostable nappy to address the problem.

4.3.3 Regime level Semi-Structured Interviews

The lead researcher conducted semi-structured interviews with stakeholders in person or over zoom depending on the subject's preference and availability. Recordings were transcribed and analysed using the NVivo software program. Each interview was coded to identify themes which were then analysed through the four phases of the windows of opportunity lens posited by Tongur and Engwall (2017). This approach enables the research to deliver the four research contributions, namely the unique application of MLP to nappies along with the application to a specific product category, understanding this specific niche-regime dynamic using the windows framework and identifying lessons from this research to understand how future windows of opportunity can remain open to accelerate sustainability transitions in the nappy industry.

4.4 Results and Analysis

The results and analysis section is presented following the four states of the “windows-of-opportunity” framework (Tongur and Engwall 2017) numbered (4.4.1) to (4.4.4) summarised in Table 3 below and expanded in the following section. For greater readability, the narrative and analysis are presented together.

Table 3. Summary of results using Tongur and Engwall (2017)'s Windows-of-Opportunity framework.

| (4.4.1) Pre-window-of-opportunity state | (4.4.2) Opening state | (4.4.3) Closure state | (4.4.4) Post-window-of-opportunity closing state |
|--|---|--|---|
| <p>Stable Regime...</p> <p>Long-term regime stability is evident, driven by consumer demand for the incumbent disposable nappy product enabled by two main stakeholders: supermarkets and childcare centres.</p> <p>Three factors that ensure nappy regime stability:</p> <ol style="list-style-type: none"> 1. Low price 2. High performance 3. Convenience | <p>...the window opens...</p> <p>Regime stability is threatened by a niche nappy innovation driven by two factors:</p> <ol style="list-style-type: none"> 1. Demand for new, cost - effective waste management resulted in the introduction of industrial composting. 2. Introduction of weekly Food Organic Garden Organic (FOGO) waste collection to maximise organic waste diversion to | <p>...the window closes...</p> <p>The opportunity for the niche innovation to threaten the regime closes due to two:</p> <ol style="list-style-type: none"> 1. The commercial composting facility reached capacity. 2. The regulator bans the biofilms that the niche nappy innovator uses to make the product as a feedstock in FOGO collection. | <p>...regime stability returns.</p> <p>Incumbent disposable nappy usage returns.</p> |

| | | | |
|--|---|--|--|
| | compost facility lead parents to demand compostable nappies. | | |
|--|---|--|--|

4.4.1 Pre-window-of-opportunity state

4.4.1.1 Intense competition for young parents by supermarkets support regime stability

The case study and interviews highlighted the relative power dynamics across regime-level actors. It shows the limited possibilities of this particular niche nappy innovation becoming mainstream. In the “pre-window-of-opportunity” state, stability in the nappy regime is driven by the intense competitiveness between supermarkets to appeal to young parents. The Executive of a national supermarket who was interviewed for this research reported that where parents buy their nappies is typically where they do their entire weekly grocery shop. If a parent’s preferred nappy brand or size is unavailable, they will go elsewhere to buy not only their preferred brand of nappies but their entire weekly grocery shop. This phenomenon has significant financial repercussions for supermarkets, requiring them to prioritise satisfying the needs of young parents. According to the Executive, this dynamic is relatively unique to nappies. It makes the supermarket’s decisions around which nappies to stock and at what price far more important than many other product categories. Supermarkets are the main distributor of nappies to parents in Australia according to the Executive. As such, supermarkets play a key role in maintaining the stability of the regime based on the decisions they make about which nappies to sell. He added that convenience, performance and price drive a parent’s purchasing decision. There is limited differentiation between the major brands of nappies with each offering similar levels of convenience and performance. This leaves price as the remaining factor in a parent’s decision about where they buy their nappies. This then leads supermarkets to price nappies aggressively to appeal to young parents.

The Executive also mentioned that nappies take up a significant amount of shelf space. An indicator of financial success for supermarkets is how “productive” the shelf is. A productive shelf in this case means a product which is bought regularly and therefore needs replenishing frequently. This indicates consistent sales for the supermarket and is something that they strive for. This suggests that for the stability of the nappy category to be threatened, a niche innovation would need to gain distribution in supermarkets by matching the convenience, performance, and price of current nappies to generate similar levels of productivity at the shelf. According to the Executive, a supermarket would not be willing to risk losing young parents if the new, niche innovation was unable to match the incumbent nappy’s productivity at the shelf.

An additional source of stability in the regime are childcare centres and their choice of nappies. According to the Department of Education, 47% of Australian children aged 0 – 5 attend childcare (Department of Education 2021). Some childcare centres provide nappies for parents while others ask parents to provide nappies. The Procurement Manager for a for-profit childcare centre chain, serving 20,000 families purchases disposable nappies for all childcare centres. Reportedly, reusable nappies are not an option as they require more regular changes and there are health considerations storing soiled nappies onsite to be collected by parents each day. The Procurement Manager also reported that waste management systems at childcare centres are designed to efficiently manage soiled disposable nappies. Waste management companies are contracted to collect and dispose of this waste in landfills. A researcher at the largest not-for profit childcare chain in Australia with 65,000 children in their care, reported that the choice and provision of nappies is left up to each parent. The interviewee said that it was very much the parents and their preference for disposable nappies that needed to be respected:

“you'd be out of business very quickly, when it comes to caring for children, if you didn't put the parents front and centre in terms of what they want.”

Parent preference for disposable nappies along with childcare centres and the waste management companies that service them create lock-in effects that contribute to the stability of the nappy regime.

4.4.2 Opening State

4.4.2.1 Case Study: unique circumstances open the window and keep it open

Specific events or circumstances can provide triggers to opening windows of opportunity (Normann 2015, Tongur and Engwall 2017, Dannenberg et al. 2020, Becker et al. 2022, Szasz et al. 2022). Demand for cost-effective waste management opened the window-of-opportunity for the niche nappy innovator in a small, rural town in New South Wales. The Waste Strategist at the rural-based council described a unique combination of actors and circumstances that kept the window open for a period of time. These included a pro-active council looking for solutions, a rural setting, a tight-knit community, the provision of a niche nappy provided at no cost to parents and the role of the waste regulator. The council was particularly proactive in solving the nappy waste issue with the community:

“It's not Council's normal business to go down this pathway either, but it was just about saying ‘we're here, our community, we're going to try and actually fix this because someone has to resolve it’...”

The rural setting offered the physical space for an expansion of an existing industrial composting facility which isn't typically available in urban areas. The Waste Strategist explained that the tight-knit community had been brought together previously through bushfires and floods. It meant that they were willing to come together to solve the nappy waste problem that emerged from the introduction of FOGO. The niche nappy innovator also played a key role in keeping the window-of-opportunity open. They were willing to provide nappies at no cost to 50 families for the one-month pilot. They were also able to leverage the success of their existing partnership with another council's FOGO program to attract the interest of this council. The product has

been included in another city's FOGO collection for several years. After collecting the used product each week, the council composted the product, certified the material to Australian Standard AS4454 and sold it for \$75/m³. The nappy manufacturer reported that the appeal of this approach is that it leveraged the council's existing FOGO collection and composting facilities at no incremental cost to the company or the parents. For the council, it provides a constant feedstock for its compost production that would otherwise be entering its landfill. For the rural-based council pilot, the nappies were delivered to participating households at no cost to the parents. Parents would deposit used nappies in their FOGO bin for weekly collection. The goal of the pilot was to gather user feedback on the product and test its compostability in the council's composting facility. The Waste Strategist reported that the user feedback was positive and purchase intent was strong assuming the price premium wasn't more than 10-15% of disposable nappies.

In order for used compostable nappies to be accepted into an industrial composting facility, testing of the compost is required and an assessment made by the waste regulator. Waste management facilities are regulated by the state authorities and their willingness to engage in the trial was of critical importance. The composting of human waste is not legal in industrial composting facilities in Australia. For the council to conduct the pilot they needed to know that if successful, they would be able to accept this compostable nappy waste as an on-going waste stream in their composting facility. This process involves independent laboratory testing of the compost to ensure it is free of pathogens and safe to apply to soils as a compost. The council were successful in their application process which permitted them to transition the pilot into an on-going service for its residents. For the niche innovator it meant an expansion of its business and validation of its product for other councils to potentially adopt. An additional factor that kept the 'window-of-opportunity' open came in August of 2022 when the NSW government announced the mandatory introduction of FOGO across the state to reduce landfill-bound food and organic waste by 50%. For the niche nappy innovator, this decision held the promise of more councils looking for proven compostable nappy solutions to address the same negative feedback the council in this study had experienced with parents as they grappled with the odorous waste generated by soiled nappies. This policy intervention effectively kept the window-of-opportunity open for an extended period. It allowed the niche nappy innovator to gain additional traction.

The pilot achieved its goals and was regarded as a success by the council and the niche nappy manufacturer.

4.4.3 Closure State

4.4.3.1 Compost capacity and new regulations close the window

According to the Waste Strategist, the council's FOGO program exceeded expectations, and they have been able to divert 10% of their landfill-bound waste to compost. As a result their composting facility reached capacity and they were not able to offer the compostable nappy solution until a new facility is built. This effectively closed the window-of-opportunity for the niche nappy innovator. In addition, in September 2022, the waste regulator announced that the only waste streams allowed in FOGO was food waste and garden waste (Proust 2022). This prevented the inclusion of the niche nappy despite the successful independent test results of the product in industrial composting facilities. This was driven by contamination concerns by the regulator. As the Director of the niche nappy manufacturer stated, the pilot has:

“given us the opportunity to demonstrate to the EPA that this is a practical, simple and economical way of recycling compostable nappies. And they do recognise, they have admitted that that this is the right way to go. However, they're not ready to support that across the board because they need the education to go with it”.

Unlike Tongur and Engwall (2017)'s case study that applied the "window-of-opportunity" framework, the niche innovation in this case was unable to destabilise the regime. In Tongur and Engwall (2017)'s case, the niche freeway infrastructure project was thwarted by regime-level responses from powerful stakeholders. In this case, it was in fact a lack of composting facility capacity initially and ultimately a ban on all non-food and non-garden waste materials in FOGO that closed the window. It is important to note the inherent limitations of the pilot, namely its small scale, the free product provided to parents and the exclusion of supermarket and childcare centres.

4.4.4 Post-window-of-opportunity closing state

With the pilot concluded due to industrial compost capacity limitations and new regulations, the “post-window-of-opportunity closing state” was entered. Parents returned to using disposable nappies with used product being collected in the fortnightly collection and landfilled as had been the case prior to the pilot.

4.4.5 Additional barriers: price, performance and convenience

Beyond the limited scope of the case study above, the niche nappy innovator faces additional barriers more broadly to destabilise regime-level actors. Achieving price parity and matching performance and convenience of disposable nappies are the most significant of these factors. According to the Executive at the national supermarket, a new nappy offering will only get mass appeal if they are offered at a competitive price and with the same convenience and efficacy as current disposable nappies. For niche sustainability innovators, achieving price parity and matched convenience with incumbent products is a very difficult task. One example of this is reusable nappies. The Executive of the national retailer mentioned that the high price of reusable nappies, a niche product with just 5% market share (Klein 2018) has prevented the retailer from offering them nationally at the supermarket:

“Reusable nappies isn't (sic) something historically we've sold. Typically, they've got a much higher price point and it's a fairly niche market, and so wouldn't be suitable ranging everywhere.”

Plant-based milk faced similar challenges in the early stages of their development before lower cost was achieved through technological advances (Mylan et al. 2019). The niche nappy innovator is attempting to develop a compostable nappy using materials that need to compete on price and performance with plastic. As a by-product of oil production, plastic is consistently one of the lowest priced raw materials available. This is a significant challenge.

The Procurement Officer at the for-profit childcare chain – while expressing an intent to offer more environmentally sustainable nappies for their families – cost, convenience and efficacy were of primary importance. This along with concerns about how to integrate a dedicated composting collection for the nappies meant that they were unlikely to consider this innovation. In the interview with the urban-based council waste educator who pioneered FOGO, there was immediate resistance to the introduction of any non-food or non-garden organic material in their program. This was prior to the waste regulator's ban on such material being included in FOGO. The key reason was the risk of contamination. The council's current rate of contamination is less than 2% and any introduction of a compostable product poses contamination risk if a similar product made from non-compostable materials enters FOGO. Excessive contamination rates trigger penalties to be paid by the council to the waste management company. This points to the need for consumer education if compostable products are to be successfully introduced into FOGO.

The findings set out above show that the disposable nappy regime is a stable one. This is due to powerful stakeholders including supermarkets and childcare centres who promote disposable nappies to support the success of their own businesses. Supermarkets mediate between the manufacturer and the consumer and require any new entrant to match the price, performance and convenience levels of the incumbent disposable nappy. This is also the case for those childcare centres who provide nappies for the babies in their care. A third stakeholder, waste management companies offer additional regime stability as their service is designed to efficiently collect and manage used nappies in landfills. The window of opportunity only opened for the niche nappy innovator as a result of two preceding concerns. The first was to address landfill capacity constraints which led to the development of an industrial composting facility. The second was the introduction of FOGO which then led to parents asking the council for a solution to their disposable nappy waste issues. The window stayed open due to the commitment of multiple stakeholders searching for a solution. The window closed initially due to capacity constraints at the industrial composting facility and ultimately with a state-wide ban on the inclusion of compostable biofilms in FOGO programs (Proust 2022). Compostable biofilms are an important ingredient in the niche nappy innovator's nappy. Figure 1 below summarises these dynamics.

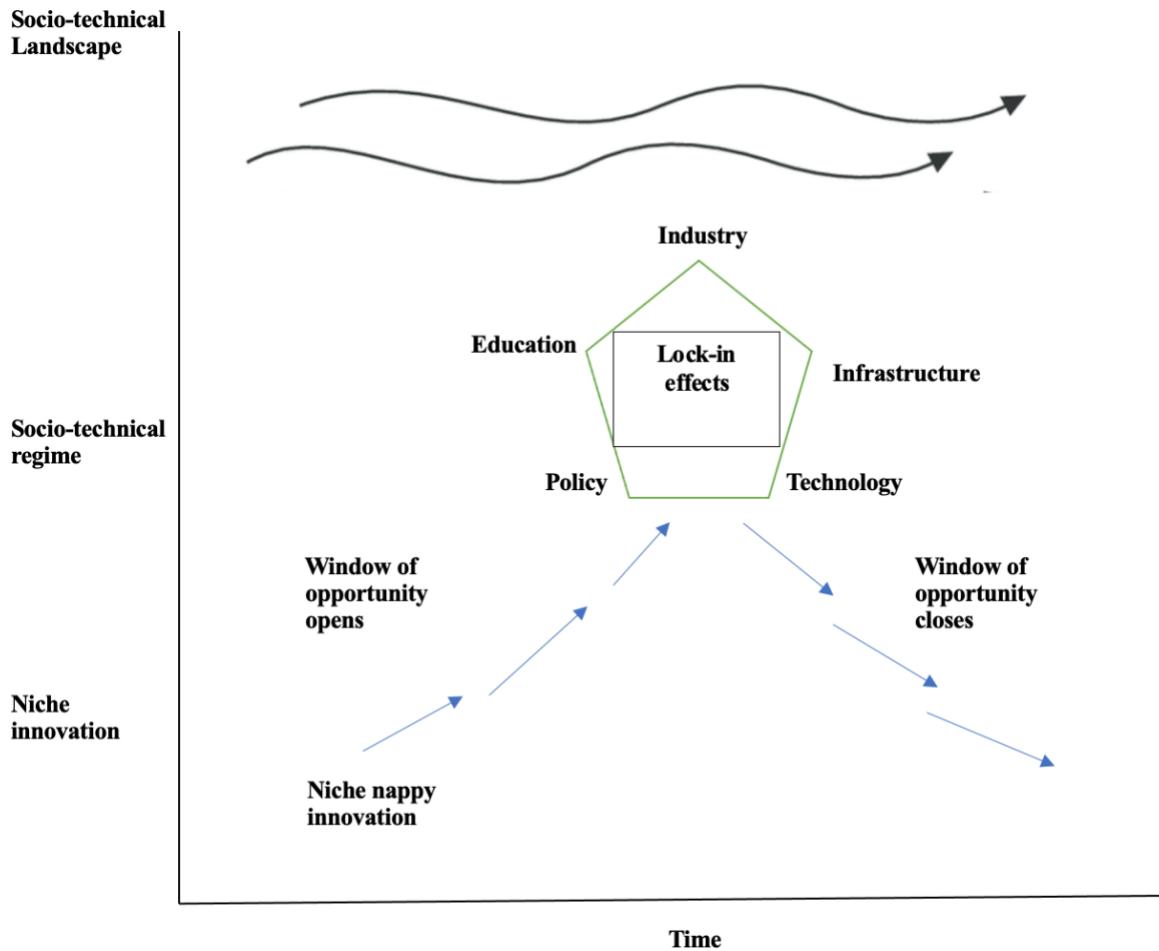


Figure 1: Adapted from Geels (2002)

4.5 Discussion

4.5.1 A stable regime in the nappy industry

This research showed a stable regime in the nappy industry. The regime includes the large supermarkets serving as the key distributor of the product, childcare centres which are used by almost half of all babies and waste management companies. Mylan et al. (2019)'s application of MLP to the liquid dairy milk industry also revealed a stable regime, at least initially. That regime includes farmers, supermarkets, coffee shop chains, state-sponsored nutritional agencies and agricultural lobbies. Unlike the relatively new niche nappy studied here, plant-based milks

(PBM) have the advantage of 50 years of development. With a growing awareness of the health and environmental issues with liquid dairy milk, PBMs have ultimately destabilised the regime and entered the mainstream market. It started as a niche, featuring small, independent manufacturers serving the few who had ethical concerns about liquid dairy milk, or medical issues associated with consuming dairy milk. In the mid 2000's consumer interest in PBM's grew thanks to technology that lowered cost and an improved flavour that more closely resembled liquid dairy milk. It was price and performance that drove the popularity of PBM and enabled it to destabilise the regime. It now has a global market share of 12% (Mylan et al. 2019). The regime, sensing the genuine consumer demand that could provide them additional revenue streams, engaged and embraced the niche by either acquiring independent brands or developing their own brands. A crucial step in the mainstreaming process was the supermarket's decision to place PBM's in the refrigerated dairy cabinet, next to liquid dairy milk. The niche nappy innovation used in this research has not had the benefit of 50 years of product development that may have reduced price and increased performance to match incumbent disposable nappies. There has also been a relatively low level of awareness about the environmental concerns of disposable nappies that may have caused parents to demand alternatives. For this research we were unable to interview either of the two large global nappy manufacturers, however the powerful influence of supermarkets and childcare centres was evident in our primary data. Neither are willing to offer niche compostable nappies given the price, performance and convenience discrepancies with incumbent disposable nappies. As a result, the niche nappy innovation remains a niche, unable to attract mainstream distribution.

Greater awareness of the environmental issues that disposable nappies cause may serve as a precursor to what Mylan et al. (2019) referred to as "Rage and Reform". For PBMs this phenomenon saw the regime destabilised following a growing trend for healthy and more environmentally friendly alternatives over decades, a sufficient amount of demand from consumers forced the regime to reform and include PBMs in their offerings.

PBMs benefitted from offering two different user motivations to pressure regime change, one health, the other environmental. This by definition increases the number of people seeking change. A change in nappies however isn't influenced by the health factors that have driven the

mainstreaming of PBM's. This leaves just environmental concerns as a main factor. Nappies are a necessity for parents in a period of particular exhaustion for them as they adjust to the first 3 years of their child's life (Gillis and Roskam 2019). While a proportion of parents may be aware of the environmental issues of disposable nappies, an insufficient number are demanding alternatives to threaten the regime. There was no evidence of a "rage" against the nappy regime by parents to effect reform at the regime level (Mylan et al. 2019). As a result the niche nappy innovator was unable to threaten the regime. Unlike PBM, there is limited evidence of any health concerns caused by disposable nappies, rendering a second driver for alternatives unavailable to niche nappy innovators. In the pilot study featured in this research, we found that disposable nappy waste was a third order concern after the council had addressed their landfill issues and introduced FOGO. It may take a longer period of time for awareness to grow about the disposable nappy waste issue to prompt parents to demand alternatives as was the case with PBMs.

A multi-stakeholder approach may hold the key for niche nappy innovators to threaten the regime. This approach emerged as a common, supportive feature for both PBM and compostable nappies as they attempted to threaten the regime. For PBMs, this included niche manufacturers, consumers, supermarkets and coffee shop chains. NGOs also played a role in changing the cultural significance of dairy milk consumption by criticising dairy milk producers about their product claims (Mylan et al. 2019). In the case of the niche nappy innovator in the pilot, a similar phenomenon occurred on a much smaller scale. A council, a community and a waste regulator came together to solve a series of problems, one of which was disposable nappy waste. A possible future enabler for niche nappy innovators is a multi-stakeholder approach.

Morris et al. (2014) applied MLP to understand how less meat initiatives (LMIs) may or may not threaten the meat regime. LMIs are an example of a social innovation to reduce meat consumption rather than a product innovation that this paper focuses on. Examples of LMIs included campaigns such as Meat-Free Mondays and Meatless Mondays in the US and UK. The researchers found that while LMIs did increase awareness about the issue, a move to eating less meat was too radical to threaten the regime and become mainstream. Regime-level actors, namely media organisations and interventions by governments including subsidies, proactively

promoted diets with a high meat component. This contradicted the efforts of LMIs. These actions by regime-level actors in the meat industry proved to be too strong to be threatened by LMIs. A similar phenomenon can be observed by the regime in the nappy industry. When the environmental concerns about disposable nappies first emerged in the early 1990's, the US government considered a tax on disposable nappies. This would have encouraged the use of reusable nappies which had been a niche offering for the preceding 40 years. In response, disposable nappy manufacturers launched a campaign to convince users and lawmakers that disposable nappies were compostable in 90 days and posed no environmental damage (Kinney 1990). This campaign was supplemented by industry-paid research by Arthur D. Little (Rockney et al. 1991). The advertisement (Figure 2) was deemed to be deceptive by the Fair Trade Commission (Baker 1998). Over the proceeding ten years the 400 reusable nappy companies operating in the US were reduced to just 50 (Baker 1998). While many factors may have caused such a decline the regime's response to the proposed ban was a likely factor. The disposable nappy market share grew to 85% during this period (Rockney et al. 1991) and by 2020 it has reached up to 95% in most developed economies (Olivo 2005). Like reusable nappies before them, the compostable niche nappy innovation faces significant resistance from the regime.



Figure 2. A 1991 Procter & Gamble advertisement in the New York Times in response to a proposed tax on disposable nappies.

4.5.2 The role of Government in levelling the playing field for niche nappy innovators

Government intervention can play a key role in keeping the window of opportunity open to allow niche nappy innovators to gain a foothold. The window-of-opportunity framework was applied in a series of papers during the Covid-19 pandemic (Dannenberg et al. 2020, Becker et al. 2022,

Sunio and Mateo-Babiano 2022, Szasz et al. 2022). Covid-19 served as a large, landscape-level shock that triggered the opening of a multitude of windows of opportunity. This included transport in Metro Manila, bicycling in Berlin and e-tailing in Germany. In the case of Metro Manila and Berlin, the size of the shock was sufficient enough to destabilise the regime for niche bicycling to become mainstream.

In contrast, in this research for the nappy regime, the shock was barely perceptible given the nappy waste problem was a second-degree concern from parents after FOGO was introduced in a small, rural community. Similarities exist between the case studies used in prior windows of opportunity research and this paper. It is clear that government intervention is effective at forcing the window open and allowing niche innovations to enter the regime. This can be seen in the Metro Manila and Berlin bicycling cases. Similarly, the government's state-wide mandate for all councils to offer FOGO by 2030 is having a similar effect in promoting industrial composting as an end-of-life solution. A reconsideration of the ban on compostable biofilms as an acceptable waste stream in FOGO by the waste regulator might again open the window-of-opportunity for the niche nappy innovator and provide a potential pathway to mainstream adoption. There are limitations to the effectiveness of government interventions. In 2022, the UK Government introduced a Plastic Packaging Tax at a rate of £210.82/tonne on plastic packaging with less than 30% recycled plastic (PWC 2022). While a similar policy for non-packaging plastic could be considered, the suggestion of a tax on the plastic in nappies made by the then UK Minister for Environment, Michael Gove was quickly denied, after it was depicted as a tax on parenting (Blewett 2021).

4.6 Conclusion

This paper makes four contributions to sustainability transitions literature. It applied MLP to a specific product rather than a system and did so in the nappy category for the first time. It tested and confirmed the “windows of opportunity” framework developed by Tongur and Engwall (2017) and suggest how future windows of opportunity can remain open to accelerate sustainability transitions in the nappy industry. This study found a series of factors prevented the niche nappy innovation from threatening the regime. These included the strength of regime

actors, the compostable nappy technology's inability to compete with the incumbent on performance, convenience and price and low levels of awareness around waste management issues. To address these issues, government interventions are necessary. This paper identified several insights about how windows of opportunity can occur, what factors keep the window open and what causes the window to close in the context of baby nappies. Possible future research could include applying the windows framework to a dedicated, larger scale pilot of niche nappy innovations. Another possibility would be applying the framework to other consumer product categories that create proportionately large amounts of waste and where innovation has been unable to threaten the regime.

Chapter 5. A compostable nappy service field trial

Chapter 5 moves on from the first phase of research, which took a macro view of the nappy regime and shifts the research lens to phase 2, to take a micro view of the nappy practice at a household level. This chapter is a reproduction of a paper, again co-authored with my supervisors entitled “Challenging the durability of disposable nappy practices with a novel compostable nappy and service”. This was submitted for publication to “Consumption and Society” on January 31, 2024. Feedback was received, amendments made, and the manuscript was resubmitted on June 5, 2024.

This paper takes a social practice perspective of infant sanitation and investigates the stability of disposable nappy use practices and the potential for more sustainable infant sanitation practices to enter the mainstream. This research builds on the work of Shove (2003), Jack (2013), Sahakian and Wilhite (2014) and Shove (2023) by further exploring the application of social practice theory to understand mundane, daily consumption practices and identifying levers of change to encourage more environmentally sustainable practices. Disposable nappies represent a significant waste burden, yet their use continues to dominate infant sanitation practices. Other more sustainable product offerings have remained as niche practices. Little attention has been paid to the broader view of nappy consumption. There has been limited research to date examining how and why disposable nappy practices have persisted and how these practices may be destabilised. Social Practice Theory provides a useful framework to understand the dynamics of practices at a household level. A qualitative study centred around a field trial of a novel compostable nappy was conducted in Sydney, Australia. The findings of this study revealed two key insights. Firstly, that the competing, daily practices that new parents negotiate create a mental load that shapes the nappy practice by prioritising convenience to alleviate this pressure. Secondly, the data showed that the induction of the disposable nappy practice occurred early in the process and across multiple sources which established it as the norm. This included recommendations from friends who already had children, hospitals, government funded take-home maternity bag programs, and childcare centres. The study then assesses the possibility of a compostable nappy practice which produces better environmental outcomes than the current

dominant practice. The paper concludes with suggestions for possible interventions which could encourage the emergence of new compostable nappy practices.

Challenging the durability of disposable nappy practices with a novel compostable nappy and service.

5.1 Introduction

This paper analyses the durability of disposable nappy practices and the prospects of new, more sustainable practices emerging. Since their introduction in 1961, up to 95% of parents in the Global North³ use disposable baby nappies for infant sanitation (Klein 2018). Annual production of disposable baby nappies reached 157 billion units in 2023 (World Economic Forum 2023) generating USD\$57 billion in revenue, highlighting the significant scale of the consumption (Statista 2024). There are three major environmental impacts caused by disposable baby nappies. Firstly, the use of oil to manufacture the product, secondly the disposal in landfills; and thirdly the plastic elements that persist in the environment after disposal. Landfills receive significant amounts of organic matter which generates greenhouse gas (GHG) emissions. Used nappies also pollute waterways in countries where there are limited formal waste management systems (Khoo et al. 2019). Twenty seven percent of the household waste stream of the 21 island nations of the South Pacific is made up of the 800,000,000 disposable baby nappies the region uses each year (European Union et al. 2022). The United Nations Environment Programme described the product as one of the largest contributors to plastic waste globally (United Nations Environment Programme 2021). The announcement in March 2022 by the United Nations Environment Programme of a global, legally binding plastic treaty to end plastic pollution indicates the scale

³ The term "Global North" refers to a group of countries or regions that are typically characterized by higher income levels, greater industrialization, and relatively stronger political and economic influence on the global stage. These countries are often considered to be part of the more economically advanced and developed world. The Global North is commonly contrasted with the "Global South," which includes less economically developed and less politically influential countries.

of the plastic waste problem and the desire to address this source of pollution (United Nations Environment Programme 2022). Relative to the well-documented environmental damage caused by single-use plastic shopping bags (Weinstein 2010, Wagner 2017, Global Health Metrics 2018), disposable baby nappies represent a far larger source of pollution on a per user basis. However, the environmental impacts of disposable nappies and the possibility of alternatives have yet to gain a commensurate level of attention in academia and wider society.

Multiple attempts at recycling used disposable nappies date back 30 years and have yielded limited success. The most recent example is a pilot conducted by the Welsh Government who recycled nappies for use in road base (Welsh Government 2022). Concerns about the scalability of the project have however emerged (Maunder 2022). Moreover, this approach may be more accurately described as ‘downcycling’ rather than recycling because the recovered materials are being used for a low value application and offer limited environmental benefits. There is also a risk that the plastic may leach into the environment. Proctor & Gamble in partnership with Fater SpA, an Italian based engineering company has been piloting a similar approach for the past five years (Khoo et al. 2019). The yield produced by the process is relatively small. 22.5% of the inputs are recovered as cellulose fibres while 7.5% are recovered as plastic which will ultimately be landfilled (Fater SpA 2017). Given that only 9% of all plastics have ever been successfully recycled (Geyer et al. 2017) it is difficult to imagine that a multi-layered plastic product infused with human faeces could be successfully recycled in a way that is cost effective. Other interventions including proposed taxes and bans of disposable nappies dating back to 1991 in the US (Allred 2009, Olivo 2019) and subsidies for more environmentally friendly reusable nappies in the early 2000’s in the UK (Warner et al. 2015) have also not proven effective.

Nappy industry reports typically set out four alternatives to conventional disposable nappies (Fortune Business Insights 2023, Statista 2024). They are reusable nappies, eco-friendly disposable nappies, hybrid nappies and compostable nappies. Reusable nappies were the first nappy product choice for parents since their inception in the United States in 1887 (United States Patent Office 1887) up until the introduction of disposable nappies in the US in 1961 (Ratnapandian and Warner 1996). Reusable nappies are made of washable materials that are purchased once and used and washed repeatedly during the years a baby uses nappies. There is

evidence to suggest that reusable nappies offer less negative environmental impacts than disposable nappies (Garrett et al. 2008, Klein 2018, United Nations Environment Programme 2021). This is chiefly due to their ability to be washed and reused over the life of a baby or multiple babies. The negative effects of water and energy usage for reusable nappies are outweighed by the extraction of oil to make the plastic in disposable nappies and their disposal in landfills where they may take up to 500 years to degrade (Sanderson 2008, Wang et al. 2016, Khoo et al. 2019). However reusable nappies have been unable to challenge the dominant market position of disposable nappies. Today, they represent just 0.7% of the value of the global disposable nappy market (Market Growth Reports 2023).

Over the past two decades eco-friendly disposable nappies have been developed that use some compostable materials along with plastic films. Industrial composting facilities are generally unavailable for processing nappies, meaning that even though they may contain compostable materials, these products still end up in landfills. Given that, the environmental benefits of a partially compostable nappies are unlikely to be significantly different than regular disposable nappies. More recently, hybrid nappies have been developed that include an outer washable pant, and an absorbent, industrially compostable liner⁴ (Walker 2006). Hybrid nappies have been commercialised and have faced the same difficulties that reusable and eco-friendly nappies have experienced in gaining mainstream appeal. Compostable nappies using a reusable, washable fastening mechanism (Klein 2018) have also been developed but are yet to be fully commercialised. Unlike the other product-only alternatives listed above, these particular compostable nappies are integrated into a service. The service allows for the product to be collected once used, safely composted, the compost certified and then sold. This end-of-life pathway avoids the negative environmental consequences of plastic disposable nappies. The service is also known as a “Product Service System”: a business model that integrates a product and service providing a complete solution to meet customer’s needs and create value (Pieroni et al. 2019). The concept has increasingly appeared in Circular Economy literature as a way to

⁴ Industrial composting is defined as "the process of converting organic waste from industrial sources into a valuable soil amendment through the breakdown of organic matter using aerobic decomposition." It typically involves the use of specialised equipment to manage and control the process, such as enclosed composting systems, aerated static piles, and in-vessel systems. Source: Bae, E., & Han, S. (2018). Industrial composting of organic waste: A review. *Renewable and Sustainable Energy Reviews*, 97, 803-817.

provide the functions of products in a more sustainable way. The compostability of this product and the economic value of the resultant compost has been established in Australia (Bega Valley Shire Council 2021, Kuver Designs 2021, Australian Broadcasting Commission 2022). In the case of Hobart City Council, the compost is being sold for \$75 / m³, demonstrating that what was once a landfill-bound product can be regenerated into a valuable resource. There is however limited research on the product experience and user acceptance. There has also been little research conducted to understand in what ways this new product service offering could challenge the dominant disposable nappy practice. Given these gaps, the capacity of a compostable nappy and service to displace disposable nappy practices is the subject of this study. To do this, the study aims to understand existing disposable nappy practices within a given context and determine where there may be opportunities for a novel compostable nappy and service practice to gain traction.

Nappies are used as part of everyday parenting practices that new parents generally learn upon the birth of their first baby. Social Practice Theory (SPT) was developed as an approach to understanding the ways in which social practices, such as daily routines, rituals, and activities, shape and are shaped by society and culture. SPT is a sociological framework with origins in the work of Bourdieu (1984), Giddens (1984) and Schatzki (1996). Giddens's (1984) structuration theory sets out that the agency of the individual and the social structures within which they exist influence each other. With further development by Warde (2005), Shove et al. (2012), Sahakian and Wilhite (2014), Mylan and Southerton (2018), SPT suggests that behaviours are not isolated actions, but rather embedded in larger social contexts and systems of meaning. Shove et al. (2012) emphasises that practices emerge, endure, change and disappear when the elements that make up a practice are created, sustained or broken. A variety of debates have emerged within the SPT field. These range from the ontology of practice (Schatzki 2002, Shove et al 2012) to agency and structure (Reckwitz 2002, Warde 2005) and the practical implications and policy interventions of the theory in changing behaviour and promoting sustainability (Shove 2010, Shove and Spurling 2013). This research is situated within and extends SPT research seeking to understand how interventions can be made in unsustainable practices. . The durability of the disposable nappy practice emerged in the (Gutis 1987, Rockney et al. 1991). SPT offers a new

perspective on nappy practices to inform more effective interventions to address the environmentally unsustainable nature of the practice.

In this research study, a field trial of a compostable nappy and service was conducted with 20 families in Sydney, Australia. An SPT lens was used to gain new insights to understand nappy practices. This paper makes two contributions to the practice field and illustrates how interventions can shift daily, mundane consumption practices in a more sustainable direction. Firstly, this study represents the first application of SPT to understand infant sanitation practices, which have significant adverse environment impacts, described further below. Secondly, it offers new understandings about how infant sanitation practices may or may not change.

The lead researcher has 20 years of commercial experience in the environmentally friendly nappy industry and has lived experience of developing and marketing products for the sustainable nappy sector. He acknowledges that this background will shape the lens through which he engages with this topic. In addition, he is aware that his identities including gender, age and family experience may influence his approach and interactions as part of this research. To address the potential for bias, he has engaged in critical reflection with co-authors and advisors who have different identities in terms of professional experience, disciplinary background, age and gender.

The structure of this paper is as follows; Section 5.2 introduces the conceptual framework; Section 5.3 describes the methodology; Section 5.4 sets out an analysis of the results and Section 5.5 provides concluding comments.

5.2 Conceptual Framework

We have chosen to use an SPT lens in this study as it has, in previous research, provided valuable insights into the nuances behind daily, mundane practices. The origins of SPT can be found in the work of Bourdieu (1984), Giddens (1984) and Schatzki (1996). More recent work that built on these early foundations include analysis by Reckwitz (2002), Shove (2003), Warde (2005), Røpke (2009), Spaargaren (2011), Sahakian and Wilhite (2014). These frameworks

move the focus of study from the individual as an actor with agency, choice and self-interest, acting rationally or “Homo-economicus” as Welch et al. (2017) suggest, to a position that encompasses the broader and more complex terrain that surrounds consumption. It attempts to do so with consideration for the dynamic nature of consumption and an individual’s on-going changing role in the act of consumption (Mylan et al. 2016). Shove et al. (2012) defines a practice as a meaningful, temporally and spatially bound nexus of three key elements: competencies, meanings and materials. A practice emerges through specific dynamic interactions between these elements over time. While practices are ‘carried’ by individual practitioners, they become relevant for understanding phenomena such as resource consumption or waste when shared and adopted as collective conventions across a society. (Figure 1). Taking a practice perspective allows the researcher to regard the performance of practices and the context within which they are performed as an interconnected entity. A user’s consumption choices are influenced by their own beliefs and motivations, along with technologies and infrastructure around them and collective cultural norms that defines what is necessary and acceptable (Mylan et al. 2016, Welch et al. 2017). They are also influenced by ‘bodily’ knowledge and habits that do not involve cognitive engagement once learned, such as tying one’s shoelaces or driving a car. The theory also suggests that mundane, daily consumption practices are often interconnected with one another and ever evolving. In this sense consumption can be seen as social rather than individual and it is reinforced socially. In addition, as argued by Shove (2010), it involves much more than attempting to change an individual’s attitudes and beliefs, an approach that has gained significant popularity, pioneered by Ajzen (1991) in the Theory of Planned Behaviour. Practitioners are guided by what the body knows how to do already and the infrastructural environment they live in. Rather than a consumer making a choice based solely on their own personal preferences, an SPT perspective imagines a consumer walking through their everyday lives habitually consuming a complex set of material goods and services. In aggregate, the social nature of consumption practices can create a difficult environment to attempt to introduce interventions to change a consumption behaviour in order to reduce its environmental impact (Mylan et al. 2016).

This study builds on research that has applied SPT to identify interventions to shift mundane, domestic and environmentally unsustainable consumption practices toward more sustainable

ones. Examples of practice studies include laundering (Jack 2013) and the consumption of bottled water, food consumption and cooking (Sahakian and Wilhite 2014) . This study adopts Shove’s approach by scrutinising the totality of a nappy practice rather than just the practitioner or the product in isolation. The present research paper seeks to gain new understandings of the durability of disposable nappy practices and the possibilities of a compostable nappy and service that seeks to avoid the negative environmental impacts of plastic disposable nappies within a given context. Durability, as conceptualized by Shove et al. (2012), refers to the resilience or persistence of practices over time within specific socio-cultural contexts. Shove emphasizes that the durability of social practices is not solely determined by individual preferences or intentions but is also shaped by broader structural factors, cultural norms, and material arrangements. Practices become durable through routinization, institutionalization, and the establishment of infrastructural support systems that sustain their performance over time.

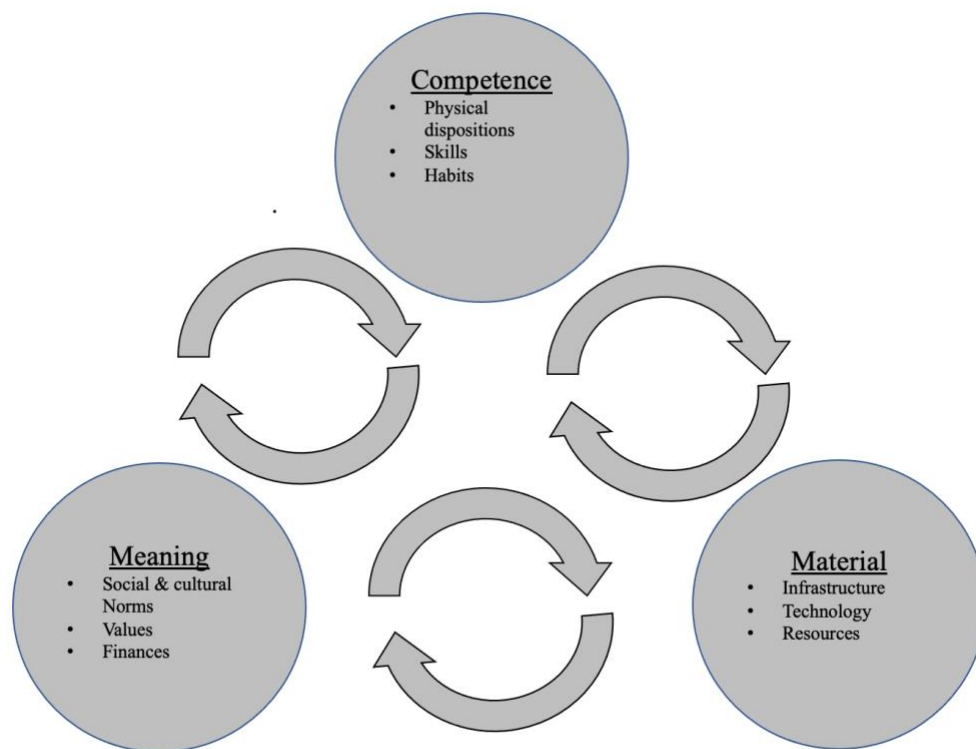


Figure 1. Elements of Social Practice Theory (Shove et al. 2012).

5.3 Methodology

We wanted to understand the sources of durability of current dominant disposable nappy practices and the possibilities for a compostable nappy and service. As discussed above, we chose to use SPT as it has proven in previous research to be well suited to this task specifically when applied to daily, mundane, household practices. Multiple data collection methods were used to gain a broad understanding of the nappy practices of participants. The data collection was divided into three components including pre-field trial in-home interviews, user diaries during the field trial and a post field trial in-home interview. During the pre-field trial in-home interviews, the lead researcher observed re-enactments of existing nappy practices. Participants were asked to put on, take off and dispose of or prepare to wash nappies so that the competencies of the existing practice could be observed. The various material infrastructures that surrounded the practice were also observed including items such as changing tables, waste receptacles and clothes lines. Participants were also asked about how they were introduced to their current nappy practice and what factors motivated them. The compostable nappy field trial was then presented to participants along with the user diary. The diary asked participants to record on a daily basis the number of nappies changed each day, who changed the nappies, where the nappies were changed and reflections on the process. In the post field trial interviews, participants were asked about their reactions to the look of the new product along with the new competencies required to use and dispose of the product. The following section offers details of the enrolment process, participant profiles, field trial design, data collection and analysis methods.

5.3.1 Participant Enrolment

Data was generated through a qualitative study conducted in Sydney, Australia with 20 families. The sample size was guided by Blaikie and Priest (2019) research on saturation levels in qualitative research. Saturation was achieved when the data revealed repetitive findings. The aim was to establish each family's baseline nappy practice via an initial one-hour, in-home visit and observation. A one-week field trial of a compostable nappy and service was then introduced, and results were recorded. Two groups of parents were enrolled. One group were self-identified as

disposable nappy users while the second were self-identified as reusable nappy users. Reusable nappy users were included as their practices may offer clues as to how a new practice could gain traction. Mothers were the focus of recruitment as they are the primary nappy changers in any given household (Statista 2012, Parker and Wang 2013, Fillo et al. 2015). Two recruitment difficulties emerged that restricted the variety of potential research subjects. Relative to other data collection methods (online surveys, for example), the data collection methods in this study demanded a high level of participant commitment. This included two, one-hour in-home visits which required scheduling around children's nap time, work and other demands that new parents face. Secondly, while the many mothers' groups that meet each week in Sydney provided ample enrolment opportunities, gaining commitments proved challenging. Interrupting their limited social time with other new mothers while tending to their baby's needs was often unwelcome. Mothers struggled to engage with a male, middle-aged lead researcher. A "reverse" snowball effect emerged in some cases where one mother would choose not to participate, and the remaining nine mothers would all follow suit. Childcare centres were also approached but limited traction was gained due to privacy concerns. Ultimately the lead researcher's wife, a mother, was enrolled as a research assistant. She was successful in enrolling 20 mothers for the field trial. The enrolment difficulties themselves speak to the challenges faced by mothers during this life course transition.

5.3.2 Participant Profile

Given the recruitment difficulties, there was a lack of desired diversity across the participant group. The 20 participants were all from English-speaking backgrounds, lived in Sydney and can be described as middle to high socio-economic status. The age range of their babies was 3 to 16 months of age. One family employed an Au Pair to assist the household. 16 of the 20 participants were new mothers while the remaining four mothers had a baby in nappies and one older child. This small number of participants with more than one child reflected the difficulties in recruiting mothers juggling the many commitments of raising more than one child. While 95% of any given population in the Global North use disposable nappies (Klein 2018), the intent of this research was to recruit 10 disposable nappy users and 10 reusable nappy users to provide a breadth of data on existing practices. Ultimately of the 20 participants, 12 (60%) were disposable nappy users while 8 (40%) were reusable nappy users. Given the recruitment challenges

presented here, a multitude of future research opportunities exist comparing nappy practices between families of more than one child, in urban and rural settings and across a broader range of socio-economic levels.

5.3.3 Compostable Nappy & Service Field Trial Design

Field trials have been used in previous research applying SPT to understand how practices evolve in real-world settings (Nicolini et al. 2003, Shove and Pantzar 2005, Spaargaren and Van Vliet 2007, Sahakian et al. 2021). A 7-day trial length was chosen as it provided a window of time for practitioners to incorporate the new practice into their lives without being too intrusive. 7 days approximates to 40 nappy changing opportunities, providing a sufficient amount of data to reach saturation (Blaikie and Priest 2019). Participants were provided with 40 compostable nappies, a package of compostable wipes and a package of compostable bags for disposal. While the new practice includes a compostable product and a delivery, collection and composting service, the focus of the field trial was on the user practice rather than the logistics of collection and technical aspects of composting. These latter two factors have been investigated and demonstrated to be viable in previous research (Bega Valley Shire Council 2021, Kuver Designs 2021). As a result, participants were instructed to use the compostable bags for each nappy change and to simulate the separate collection of the product as would be required if the collection service was operational. When nappy changes happened away from home, participants were asked to bring used nappies home. In practical terms, the compostable nappies were disposed of in each participant's usual waste receptacle.

5.3.4 Data Collection and Analysis Methods

To develop a detailed picture of each family's existing nappy practice prior to the trial, a range of data collection methods were used. These included an in-home semi-structured interview and re-enactments of each mother's current nappy practice that were photographed. The field trial was then introduced and user diaries, modified from Sofoulis (2006), were deployed for participants to record their experiences. This included the frequency of nappy changes each day, who changed the nappies, where the nappies were changed and reflections on the experience, including the efficacy of the product. The field trial concluded with a second in-home, semi-

structured interview and re-enactments of the new nappy practice, that were also photographed. This research was approved by the UTS Human Research Ethics committee (ETH 21-5978).

Table 1. Summary of data collection methods

| Data collection method | Information gathered |
|---|---|
| (1) In-home, semi-structured introductory interview | Existing nappy practices |
| (2) Re-enactment of current nappy practice | Existing nappy practices |
| (3) User diary | Field trial practices |
| (4) Re-enactment of compostable nappy practice | Field trial practices |
| (5) In-home, semi-structured concluding interview | Reflections of field trial practices and existing nappy practices |

This combination of data collection methods included a temporal element via the diaries and a spatial element during the in-home interviews. The in-home interviews allowed for observations of nappy changing areas, related apparatus and waste disposal infrastructure. Recordings of the interviews were transcribed using transcription software and checked for accuracy by the lead researcher. All data, including user diaries and interview observation notes were then coded using NVivo software.

5.4 Analysis

The analysis is divided into three sections. In the first section we describe the existing disposable and reusable nappy practices observed prior to the field trial commencing. It includes an explanation of the new, compostable nappy practice introduced to the trial participants. In the next section we apply the lens of SPT to analyse the data, revealing factors that make disposable nappy practices persistent. Two key insights were gleaned that help explain why certain nappy practice configurations persist within this cohort of mothers. In the final section, we identify barriers experienced by the participants trialling the new compostable nappy practice and suggest possible interventions that could address these barriers and destabilise the dominant disposable nappy practices.

2.3.6 Disposable, reusable and compostable nappy practices

While the descriptions below are centred around the product and related infrastructures, SPT highlights the fact that no product or infrastructure operates in isolation (Shove et al. 2012). Each are designed and connected with other products and infrastructures to make up a practice. Consequently, changing a practice involves much more than substituting one product for another. In addition, as Sahakian and Wilhite (2014) suggest, change comes about when more than one of SPT's three elements are changed. Below we set out each of the nappy practices observed prior to the field trial commencing along with the new, compostable nappy practice.

Disposable nappies, regardless of brand, are made from similar materials. They include a series of plastic layers, some to repel moisture, others to wick moisture away from the skin, elastic, super absorbent gel, wood fluff pulp and plastic tabs. Parents then choose a brand that works best for their baby. The observed at home practice was typically centred around physical infrastructure including a nappy changing station featuring a changing mat, a wipes dispenser, and drawers of nappies and baby clothes. In many cases a receptacle specifically designed to manage the smell of dirty disposable nappies was also present.



Figure 2. A dedicated disposable nappy receptacle and a nappy changing station.

Reusable nappies observed in this study were made of a variety of washable textiles and came in a wide range of product formats combining an outer external pant with absorbent layers. Examples of reusable nappy formats include All in Ones, One Size Fits All, One Size Fits Most,

Pocket Nappies, Pre-folds and Origami Folds. Associated materials needed for the practice include a change table, wipes (often also reusable), a pail to collect used nappies to be washed, wet bags when away from home, a washing machine and a dryer and / or line drying facilities.



Figure 3. A reusable nappy change station on a washing machine; a collection of reusable nappy inserts and line drying facilities.

The compostable nappy is made up of a chassis made of materials designed to be industrially composted. The plastic tabs used to secure a disposable nappy around a baby's waist have been replaced with a reusable, washable wrap. This is because at present, there are no alternative compostable materials available to replace their function. Unlike the disposable and reusable nappy practices, the compostable nappy practice includes the proposition that a collection and composting service is also offered. This is important as it guarantees a positive end-of-life environmental outcome for the product. The compost is then certified and sold. The compostability and certification of the material has been demonstrated through previous research (Ellen Macarthur Foundation 2020, Bega Valley Shire Council 2021, Australian Broadcasting Commission 2022).

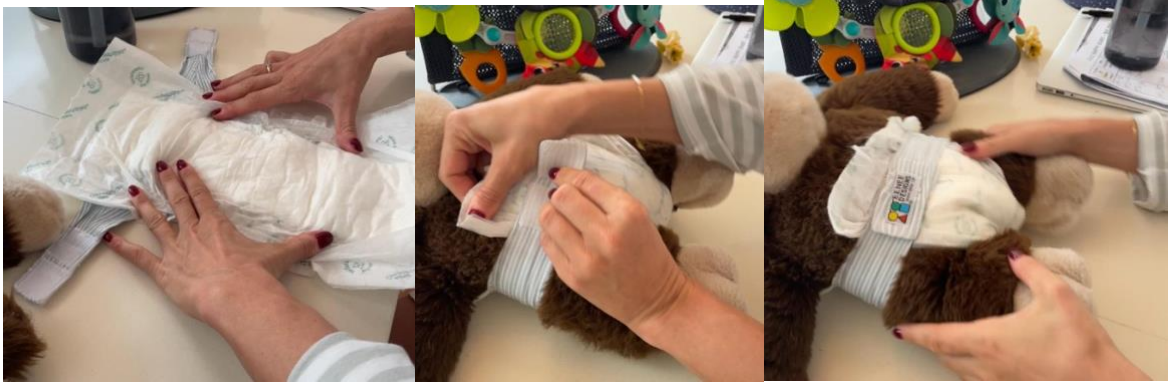


Figure 4. Fastening the compostable nappy

2.3.7 Variables that sustain the disposable nappy practice

This section discusses how convenience is reflected in both the physical competencies of the practitioner and the material elements of the practice. SPT describes elements of practices interacting with each other to create and maintain a practice. A review of the data was conducted including the user diaries, observational and interview notes and photographs of the re-enactments of the participant's existing nappy practices and comparing them to those taken as they negotiated the new nappy practices. Two groups of variables emerged that give insight into how disposable nappy practice configurations have come to dominate. One is the competition between the many new practices that mothers uniquely navigate in their role as a parent. Examples of such competing practices included preparing for day care, washing bottles, packing the nappy bag and the overall increase in laundry generated by the baby. In addition, other more substantial practices were also at play such as competition between work responsibilities, keeping the house clean, cooking, and looking after other children. This supports the work of Shove (2009) who argues that practices compete for the limited time and attention of practitioners, as individuals must prioritise certain activities over others. This competition among practices can lead to the emergence of new forms of collaboration, where different practices intersect and support one another. For example, synergies may arise between the use of nappies, how they are carried and subsequently disposed or laundered. These interactions illustrate how competition can foster collaborative relationships, ultimately shaping the dynamics of consumption and daily routines.

Disposable nappy practitioners reported that choosing the most convenient nappy was their most effective way of negotiating these competing practices. Competence and materials are inextricably linked to convenience because the materials used in the product offered parents an easy-to-use product, delivering convenience. Specifically the use of highly absorbent plastic materials allowed the product to last for extended periods of time, reducing the frequency of changes contributing to convenience. In addition, the use of plastic tabs that are adjustable to get a better fit ensured less leaks and were used to securely roll the nappy up in a ball for easy disposal also provided convenience. The second set of variables were specific to the practice itself. Participants reported that they were introduced to the practice early and from a variety of respected sources (friends who already had children, hospitals, government bodies and childcare centres). This solidified for them that disposable nappy practices were the norm. The multiple sources disseminating this information are categorised as materials in SPT while the broad exposure which imbues disposable nappies as the “norm” are categorised as meanings in the framework. In combination, the focus on (1) convenience and (2) the establishment of the disposable nappy practice as the norm contribute to the persistence of disposable nappy practices. Below we analyse the data that brought us to this conclusion.

5.4.3 Competing practices encourage convenience that contributes to the durability of the practice

While there are many ways that labour is divided within homes, given the recruitment challenge discussed in the previous section, our focus in this study is on mothers who do the majority of household labour. We acknowledge that there are many households that do not conform to this heteronormative division of labour. The various new, competing practices negotiated by new mothers moved many of them in this trial to seek the most convenient nappy practice. These “bundles of practices”, (Shove et al. 2012) highlight the interconnected and dynamic nature of social practices. Most participants used disposable nappies to alleviate the mental and physical load that they experience as new mothers. Participants expressed this phenomenon in a variety of

ways. Harriet⁵ was one of just two mothers in the trial who had returned to work and was juggling a multitude of parenting tasks in order to fulfill her return-to-work commitments. Harriet's reference to the "little things" downplays the scale of the daily negotiations needed to succeed as a mother and employee.

It's a massive, massive list of things. It's the thing that I'm struggling with most. I've only just gone back to work full time. Because it was fine having the mental load when I didn't have anything else competing. But now that I'm going back full time, I can't manage. And like, it's the little things like, I was in Melbourne for the day yesterday (for work). It involved getting up at 4.30am. And the night before, I'm kind of thinking through "how do I get dressed, so I don't wake anybody up?". "How do I make sure that everything he needs to go to day care is packed and ready?". So, I'm you know, washing bottles, packing his bag, like just all of those little things.

Pia reflected on a shift in an existing practice, laundry and how that contributes to her mental load as a new mum.

I think it's because it's the amount of mess as well. So yeah, like, I feel like one of the things that changes is how frequently you do laundry. I do it twice a day now, sometimes whereas before, I could stretch it out to once a week. But now, my partner is covered in vomit, she (my baby) goes through three outfits a day, so you're constantly doing more and more.

The recruitment of extra support to alleviate the new demands of motherhood is an additional burden itself that fell on Harriet:

But you know, two weeks ago I was recruiting our next Au Pair. That was about 30 hours of work.

⁵ Pseudonyms have been used to preserve all participant's anonymity

The load was often expressed relative to their thoughts on using reusable nappies. Isabella described it in the following way:

Reusable nappies looked complicated and then there was this insert and there's this other insert and I'm like, "Oh my god, it's just too complicated. I just don't have time for that". It's been a challenging experience being a parent. We didn't want to add to the difficulty.

Disposable nappies, as a one-piece product makes it easy to put on, take off and dispose of in all settings made it exceptionally convenient for all disposable nappy practitioners. As Amanda described it, disposable nappies are "brainless" to use. Convenience is reflected by the relatively low level of competence required to use the product:

I can do it (put on the nappy) in my sleep.

The ease of use of a disposable nappy combined with the repetitive nature of the practice solidified the durability of the practice for Sasha:

I think once you start, you are on autopilot using them.

Julia explicitly described the disposable nappy practice as the "convenient way", vis a vis reusable nappy practices:

I looked a little bit into cloth nappies and then was like, you know, I am going to do it the convenient way.

Convenience is also evident via the materials that disposable nappies use. The lead researcher observed with several participants that the re-attachable plastic tabs allow for easy putting on, taking off and disposal in a neat ball. In addition, as materials in the SPT framework encompass the necessary infrastructure for a practice to be configured, waste receptacles for disposable nappies are broadly available beyond the home, making the disposal of the product easy in all

locations. This contributes to the convenience of disposable nappies over reusable nappies which need to be taken home and washed after each use. Sasha described it this way:

Disposables in general, they're just so convenient, aren't they? You're outside and you just bung them in the bin. You're not carrying around three poo-ey reusable nappies in your bag along with packed lunches. So I guess it's just too easy. It's too easy to use them.

Another important feature of the product that contributes to its convenience is that it has to perform, especially overnight while the baby sleeps. As Julia described, the product has to be “bombproof”. Product failure saw participants switch to other disposable brands to find a better fit.

We ordered Brand A⁶, and he had a huge blowout, and we were like okay, we'll try another brand. And Brand B have been pretty good since.

To achieve this, the product needs to be easy to put on for all practitioners – parents, au pairs, relatives and other caregivers, to ensure a good fit and provide excellent product performance. This speaks to the competence element of SPT. The product is intuitive to put on, requiring almost no instructions. Only one participant, Felicity could recall where she learned how to put a disposable nappy on.

It was only in the antenatal group; she told us to put the wings out and that's what I remember. That was the one instruction to make sure they don't have an explosion. So I do that.

Other participants had no recollection of how they acquired the skills to use a disposable nappy.

⁶ Nappy brand names have been anonymised throughout this research paper

The use of plastics, wood fluff pulp and super absorbent gel delivers high absorbency that works overnight. The use of these materials connects performance to convenience, reinforcing Shove et al. (2012)'s notion that elements, in this case competence and material intimately interact to configure a practice. Earlier work by Shove (2003), highlighted the increasing role of convenience in replacing collective modes of co-ordination to address fragmented moments of time for mothers. This then breeds greater demand for additional conveniences and suggests there may be no turning back for such practices.

5.4.4 Early induction into disposable nappy practices contributes to their durability

Early induction into disposable nappy practices also contributes to their durability. Specifically, as a product provided at no cost in maternity wards of hospitals in NSW, included in take-home maternity bags by the NSW government, available in all major supermarkets, widely marketed by the manufactures, used by childcare centres and by the majority of parents, disposable nappy practitioners are reassured to follow the same practice as the majority of parents and institutions around them. The widespread availability and visibility of the product, suggests that the disposable nappy practice is seen as “normal” for many field trial participants. Through an SPT lens, the interaction of (1) materials: including widespread distribution across hospitals, retailers and childcare centres and (2) meanings: its status as the “normal” nappy, is another example of the co-constitutive nature of elements which reinforce the durability of the practice. The following data from the field trial supports this assertion.

The ubiquity of disposable nappies (in this case Brand A disposable nappies) started influencing Anna prior to becoming a mother.

I think maybe I just feel like Brand A is the first thing you kind of get drilled into you. Even when you don't think about kids, it's just like “what nappies?”, “Brand A”.

Similarly, Gina identified the role of brand marketing by large disposable nappy companies in establishing the product format as the norm.

I think disposable nappies are the status quo. It's clever marketing on Brand A's part.

In the same way, Lara reported that for her, the very first nappy she saw and subsequently used was a disposable nappy, provided by the hospital when her child was born.

In the hospital, they use Brand A so that's your first introduction to changing a nappy and its Brand A.

The NSW Government's provision of a take-home maternity bag of baby care items to all mothers giving birth in the public hospital system includes just one form of nappies, disposable nappies. The majority of participants in this study received this bag. Mary described her response to the bag this way:

You get the bag, the "Gladys Bag"⁷, which I thought was great, but then within the bag, there are Brand A nappies. And I think that just sets people up on that journey.

Along with hospital and government institutions, Lara suggested that her friends also played a role in her choice of disposable nappy practices.

I think you're hugely influenced by your friends with babies.

The interrelated elements set out above combine to configure a persistent disposable nappy practice which in aggregate establishes nappy practices norms or conventions. Identifying ways to bring more sustainable practices to bear is a complicated task. To do so successfully, as Shove

⁷ The take-home maternity bag is called the "Gladys Bag" after Gladys Berejiklian, the Premier of New South Wales who introduced them in 2019.

(2003) suggested is to focus on the formation and evolution of such shared norms. In the next section, we highlight the barriers participants experienced trialling a new compostable nappy practice and identify corresponding interventions to address each of them.

5.4.5 Barriers and possible interventions to encourage compostable nappy practices

As set out above, the observed disposable nappy practices of participants are made up of variables which in combination configure and solidify the practice. Using the compostable nappy challenged many participants, including concerns around the two parts of the product, product failure attribution, and the incremental cost of a dedicated collection service. For each barrier however, potential interventions are considered, and these are discussed below. The two-part product caused concerns for many participants. As a material, the presence of two parts rather than one breached the norms of what a nappy “should” look like and caused anxiety for participants. Hilary described it in this way:

When I first saw the nappies, I felt a bit unsure. Surely without the sticky tabs securing them, they would leak.

For most participants, the two-part system required new competencies to get a consistently good fit. Almost all participants found it “fiddly” to put on. With a poor fit came leaks and the need to wash the reusable component which was inconvenient vis a vis their current disposable nappy practice.

In addition, Pia revealed a particular conundrum for this and any new innovation. Because by definition the product being trialled is not the norm, the attribution of poor performance was placed on the product rather than the practitioner. This creates an additional barrier for such innovations.

Especially if I was doubting because I think the thing is, because it's not the status quo. I would always be doubting whether if there's like leakage. But if you're doing it when you're using the Brand A nappies that 99% of everyone

else uses and they're also having the odd blowout here and there you think, "Oh, well, it's just par for the course". Whereas if using a product that not everyone else is using and you're like, "Ah, it's a bit fiddly to put on. Am I doing that right? Is that the right product?"

Lastly, while there was broad acceptance that users would be willing to spend an approximately 10% premium on the product given the environmental benefits, there was minimal interest in paying for a dedicated collection service.

Previous research which focused on the mechanisms of change in daily mundane practices offer a variety of suggestions for interventions. Sahakian and Wilhite (2014) proposed that a potential mechanism of permanent change in practices can come about if two of the three elements in SPT are altered. Reflecting on changes in practices, unlike other studies, this research finds that the unique life stage opens up families to practice disruption and shifts. However, it also introduces more competing practices and time pressures for mothers. These insights highlight what might make nappy practices resistant to change or, conversely, open to intervention. They suggest that the timing and context of interventions are crucial, as periods of significant life changes can provide opportunities for altering entrenched behaviours. This extends prior thinking by emphasizing the importance of targeting intervention points during transitional life stages to effectively address unsustainable practices.

5.4.6 Interventions

We have identified three interventions that in combination support the findings of previous research while uniquely addressing the enduring nature of current, incumbent nappy practices. These interventions are offered sequentially and in order of importance based on the breadth of practice elements that each intervention can address. Sahakian and Wilhite (2014) highlighted the variability of agentive power across a given practice. Some actors hold more influence when it comes to changing practices. In the case of nappy practices, disposable nappy manufacturers hold a significant degree of power given that the product in the practice offers the performance and convenience that mothers seek. As such, the first intervention is the development of a one-

piece compostable product including compostable tabs at a similar cost to the current, plastic nappy. This would address multiple practice elements simultaneously. It would offer a product requiring the same competencies currently demanded using a material designed to be industrially composted. With limited change in user behaviour in the use stage, the innovation stands a better chance of disrupting the current practice than the two-piece product used in the field trial.

The second intervention attempts to address the cost barrier of a dedicated collection and composting service that practitioners face. It is this element that is crucial to regenerating the nappies into a usable compost. The introduction of a mandatory Extended Producer Responsibility (EPR) regulation on nappy manufacturers provides an effective mechanism. EPR is a waste management policy that shifts the responsibility for handling products after use from users to manufacturers. Under EPR, manufacturers become legally and financially accountable for the disposal, recycling, or treatment of their products once they reach the end of their useful life. This approach aims to incorporate the environmental and social costs of products, incentivising manufacturers to design more eco-friendly products and packaging, thereby promoting resource efficiency and waste reduction. Similar programs have been successfully implemented in Europe, addressing packaging waste in Germany and textile waste in France. From a practice perspective and drawing again on Sahakian and Wilhite (2014), a mandatory EPR could help reduce the power imbalance of manufacturers and stimulate the creation of new practice options for practitioners to consider.

The final intervention involves the early introduction of this practice across the relevant institutions. This would include an education campaign in ante-natal classes and in mothers' groups along with the provision of the nappies in hospital wards, any government-funded maternity take-home bags and childcare centres. This would begin to establish the practice as a new convention. It also leverages existing education sites as expectant and new mothers are already in information gathering mode. This foregoes the need for new dedicated programs to be created. This intervention also supports the notion of social learning to introduce a new community of practice highlighted by Sahakian and Wilhite (2014). These three interventions are by no means easy to implement. They vary significantly from user-focused solutions such as awareness campaigns and product-only innovations that are relatively simple to implement but

have not been effective. This research demonstrates that by taking a practice-based approach, measures can be identified to target change in unsustainable, daily practices and create new conventions.

Similarities can be drawn between the results of this research and previous work by Sahakian and Wilhite (2014). Most nappy users, like the practitioners in their three case studies do not feel compelled to change. The catalyst for change in Sahakian and Wilhite's research was the environmental and health data showing the detrimental effects of the existing practices on the planet and human health. While the evidence of the negative environmental impacts of disposable nappies is clear, it has yet prompted interventions to address the problem. This may be due to the unique life stage of new mothers. This stands in contrast to the practitioners in previous case studies which focused on laundry, personal hygiene, home heating, food preparation and physical activity to address obesity (Shove 2003, Sahakian and Wilhite 2014, Godin et al. 2020).

New mothers are faced with a multitude of new competing, high stakes practices (feeding, sleeping, bathing), while negotiating the unpredictable, on-demand nature of the nappy practice. It could be argued that this pushes this particular group of practitioners toward a convenient practice in ways that have to date not been well understood. This then suggests that the interventions needed to produce better environmental outcomes may also need to be somewhat unique vis a vis interventions suggested in previous research.

5.5 Conclusion

This study explored the durability of disposable nappy practices and the prospect of intervening to introduce a more sustainable compostable nappy and service option. Despite the negative environmental impact, the practice of using disposable nappies continues to dominate. Limited attention has been given to understanding the reasons behind the persistence of disposable nappy practices and how they can be disrupted. This paper found that the competing practices that new parents face drive many to the convenience and high performance of disposable nappies. In addition, disposable nappy practices are introduced to and reinforced amongst expecting and new

parents across multiple touchpoints including pre-natal classes, mass media marketing, supermarkets, hospitals and childcare centres, establishing them as the norm. By viewing this situation through an SPT lens, three interventions were found that could help reconfigure each of the elements of the dominant nappy practice and encourage practices that offer more environmentally sustainable outcomes. These ranged from the development of a one-piece compostable nappy to the introduction of mandatory EPR for nappy manufacturers and the early introduction and education of the new practice across key touchpoints.

This paper makes two key contributions to the practice literature, specifically related to inconspicuous, daily, unsustainable practices and levers of change. Firstly it is the first use of SPT in the context of nappy routines which is important given the disproportionately negative impact of plastic nappy waste on the environment. Secondly, it provides new insights into how these practices might change or remain the same. The research scope was limited due to recruitment difficulties. This made for a lack of ethnic and socio-economic diversity with a cohort that conformed to heteronormative divisions of labour. This opens the door for further research using a broader participant cohort and the potential use of Living Labs to gain an even richer understanding of the practice and possible interventions (Godin et al. 2020). There are also opportunities to apply this approach in different contexts, including the Global South. In countries, disposable nappy practices are nascent but growing rapidly much larger plastic waste crisis is emerging. Plastic waste mitigation is an urgent global topic of interest for consumers, researchers, policy makers and inter-governmental organisations such as the United Nations. As a significant contributor to this problem, we argue that real-world interventions can be introduced to address the large plastic nappy waste contribution to this problem.

Chapter 6. Intersections between the nappy regime and practices

With phases 1 and 2 taking a macro and micro view of the nappy regime and practice respectively in the previous two chapters, this chapter sets out phase 3, highlighting intersections between the regime and practices. A paper co-authored by myself, and my supervisors entitled “Normalising compostable nappy practices: A zoom out, zoom in approach to unlocking sustainability transitions in the nappy industry”, was developed and submitted to “Sustainability: Science, Practice and Policy” on 10 June 2024.

Given the significant environmental burden that nappy waste has on the planet, this paper investigates the possibilities of more sustainable nappy alternatives. Attempts to decrease their waste burden such as disposable nappy recycling have been ineffective. Other more sustainable, niche product offerings for example compostable nappies, have also been unable to gain a foothold. This chapter’s focus is on identifying the reasons for the durability of disposable nappy practices, and whether a compostable nappy service represents an opportunity to disrupt them. In order to identify opportunities for transition, we adopt a “zoom in, zoom out” approach, first suggested by Nicolini (2014). This uses Social Practice Theory to zoom in on the relevant micro-level practices and the Multi-Level Perspective to zoom out to get a view of the systemic factors at play. Note that the terms “micro” and “macro” used here are referring to the intersection of two frameworks and are not to be confused with these same terms used previously when discussing MLP. A qualitative study centred around a field trial of a novel compostable nappy and collection service was conducted in Sydney applying a SPT lens. Semi-structured interviews with regime and niche-level actors in Australia were conducted to reveal MLP dynamics. This dual lens approach reveals intersection points between the two lenses where constraints could be unlocked. Notwithstanding significant limitations with the trialled compostable nappy solution, a range of interventions are proposed that can help inform future innovations, policies and awareness campaigns to address this significant environmental issue.

Normalising compostable nappy practices: A zoom out, zoom in approach to unlocking sustainability transitions in the nappy industry

6.1 Introduction

Since their introduction in 1961, up to 95% of parents in the Global North⁷ have used disposable baby nappies (Klein 2018). Annual production of disposable baby nappies reached 157 billion units in 2023 (World Economic Forum 2023) generating USD\$57 billion in revenue (Statista 2024). Disposable baby nappies cause three major environmental impacts: oil use for plastic film manufacturing, landfill disposal, and persistent plastic elements in the environment. Landfills occupy land and generate greenhouse gases due to significant organic matter. In countries with limited waste management systems, used nappies also pollute waterways (Khoo et al. 2019). 27% of the household waste stream of the 15 island nations of the South Pacific is made up of the 800,000,000 disposable baby nappies the region uses each year. The United Nations Environment Programme described the product as one of the largest contributors to plastic waste globally (United Nations Environment Programme 2021). The announcement in March 2022 by the United Nations Environment Programme of a global, legally binding plastic treaty to end plastic pollution indicates the scale of the plastic waste problem and the desire to address this source of pollution (United Nations Environment Programme 2022). Relative to the well-documented environmental damage caused by single-use plastic shopping bags (Weinstein 2010, Wagner 2017, Global Health Metrics 2018), disposable baby nappies represent a far larger source of pollution on a per user basis. However, the environmental impacts of disposable nappies and the possibility of alternatives have yet to gain a commensurate level of attention in academia and wider society. Attempts to recycle used disposable nappies have been ongoing for three decades with limited success. The results can be more accurately described as downcycling, whereby a material is transformed into something of lower value (Maunder 2022).

⁷ The term "Global North" refers to a group of countries or regions that are typically characterized by higher income levels, greater industrialization, and relatively stronger political and economic influence on the global stage. These countries are often considered to be part of the more economically advanced and developed world. The Global North is commonly contrasted with the "Global South," which includes less economically developed and less politically influential countries.

Other strategies, such as proposed taxes and bans on disposable nappies in the US since 1991 and subsidies for more eco-friendly reusable nappies in the UK in the early 2000s have not supported alternative nappy technologies in becoming commercially viable (Allred 2009, Warner et al. 2015, Olivo 2019). Nappy industry reports typically set out four alternatives to conventional disposable nappies (Fortune Business Insights 2023, Statista 2024). These are summarised in Table 1 below.

Table 1. Four alternatives to disposable nappies

| Nappy Type | Adverse environmental impacts | Positive environmental impacts |
|--|---|--|
| Reusable nappies A nappy made up of washable, reusable materials | Water and energy usage in washing the product | As a reusable product, it offers the most environmentally beneficial nappy option (Garrett et al. 2008) the product does not use oil in upstream production and does not enter landfill after each use |
| “Eco-friendly” disposable nappies A disposable nappy using some compostable components with regular, non-compostable plastic films | Use of oil to make the regular plastic films Compostable components do not break down adequately if sent to landfill They contribute to landfill at the end of each use like disposable nappies | Fewer plastics are used which means less oil is needed in the upstream manufacturing stage. |

| | | |
|---|---|---|
| Hybrid nappies A reusable outer pant and a single use absorbent insert made of materials designed to be industrially compostable. | Water and energy usage in washing the outer pants | No plastics are used which means no oil is needed in the upstream manufacturing stage. |
| Compostable nappies A reusable wrap and a single use absorbent insert made of materials designed to be industrially compostable. | Water and energy usage in washing the reusable wrap | No plastics are used which means no oil is needed in the upstream manufacturing stage. The compost produced after use improves soil health and sequesters CO2 from the atmosphere. |

Reusable, "eco-friendly" disposable, and hybrid nappies have all struggled to gain widespread commercial acceptance. Reusable nappies, despite improved materials and subsidies, have faced these challenges for decades. (Berg 1993, Warner et al. 2017, Wood 2021). Adding a service that delivers, collects and washes the product to offer more convenience has also failed to mainstream the product (Australian Nappy Association 2021). Unlike the other nappy alternatives identified above, compostable nappies offer a solution that can regenerate their waste in existing technology, industrial compost to create a commodity that is in demand and has a market value (Wadewitz 2009, Australian Broadcasting Commission 2022). However, they have yet to achieve broad commercialisation and as such are worthy of investigation.

A "Product Service System" model integrating compostable nappies with a collection and composting service has emerged as a potential sustainable alternative (Klein 2018). This model, demonstrated in Australia, converts used compostable nappies into valuable compost, avoiding the environmental harm of plastic disposables. The product's compostability and the economic value of the compost have been established in Australia (Bega Valley Shire Council 2021, Kuver Designs 2021, Australian Broadcasting Commission 2022). Hobart City Council sells the compost for \$75/m³, showing that landfill-bound waste can be turned into a valuable resource. Limited research exists on the macro dynamics of the nappy industry and the user experience

with compostable alternatives, in contrast to extensive studies on reusable nappy usage and uptake. (Environment Agency 2005, Pendry 2012, Wilks 2013, Klein 2018) and their inability to threaten the dominant, disposable nappy practice. To address this research gap, the focus of this research is on a compostable nappy service.

We use a zoom-in, zoom-out approach, combining the Multi-Level Perspective (MLP) and Social Practice Theory (SPT) to understand nappy practices. MLP focuses on socio-technical system dynamics, while SPT examines social practices, providing a comprehensive framework for sustainability transitions. This integration helps identify intervention points for sustainable change by analyzing macro-level policies and micro-level behaviors. The combined approach has practical implications for policymaking and promoting sustainable behaviors. This paper addresses knowledge gaps by exploring potential interventions to drive sustainable infant sanitation practices using both MLP and SPT. We do so by identifying and evaluating intervention points identified in prior research by Graham-Nye et al. (2024) which applied MLP to the nappy industry and additional research, also by Graham-Nye et al., (submitted) using SPT in the context of nappy practices.

The principal researcher has two decades of experience in the eco-friendly nappy industry and firsthand involvement in sustainable nappy development. Aware of potential biases due to his background, he critically reflects with co-authors and advisors from diverse professional and demographic backgrounds to mitigate these biases.

This paper contributes to the practice and transition literature by applying the zoom-in, zoom-out approach to plastic waste from disposable nappies, offering a holistic view from micro to macro levels. It focuses on new mothers' competing practices and their impact on consumption habits, suggesting interventions to reduce resource use and support sustainability transitions. The findings also identify enablers for mainstreaming environmentally sustainable nappies. The research aims to accelerate sustainability transitions in the nappy industry using an MLP-SPT approach. The paper is structured as follows: Section 6.2 outlines the theoretical context, Section 6.3 details the methodology, Section 6.4 presents results, Section 6.5 offers a discussion, and Section 6.6 provides concluding comments.

6.2 Theoretical Context

This section summarises and compares MLP and SPT used in this research and discusses their combined value. MLP provides a framework for understanding socio-technical system changes, focusing on three levels: niche innovations, regime structures, and broader landscape contexts. In contrast, SPT examines socially shared bundles of activities and the conditions needed for sustainable outcomes by considering links between practice elements and relationships between practices. Co-applying MLP and SPT offers a comprehensive approach to understanding and fostering sustainability transitions. Shove et al. (2012) identified meanings, competencies, and materials as the key elements that dynamically interact to produce social practices. Meanings can include things like social norms that reinforce a certain practice. Competences include the skills to perform a practice. Materials are the physical objects and infrastructures used to enact a practice. MLP therefore gives insight into the broader context of a given system while SPT gives insight into the various aspects of human behaviour specifically around routine activities. In MLP, practices can operate at both the niche level where new innovations are incubated and as mainstream practices at the regime level.

A growing volume of research has identified the value in co-applying MLP and SPT to more fully understand sustainability transitions to address grand sustainability challenges such as energy, mobility and food systems. This includes work by Hargreaves et al. (2013), Geels et al. (2015) and Keller et al. (2022). Both theories share an interest in sustainability and transitions. They emphasise holistic systems change and the interplay between stability and emerging transitions, endorsing a multi-actor approach and focusing on recursive processes in social change. This approach applies both MLP and SPT to identify intersection points between practices and regimes, targeting these for sustainability interventions. By co-applying MLP and SPT, we highlight key conflicts and connections, offering perspectives for crafting sustainability initiatives. The co-application of MLP and SPT to understand transition dynamics has been suggested by Hargreaves et al. (2013), Geels et al. (2015), Keller et al. (2022) and Keller et al. (2022). Emerging as a promising field, with a sharp increase in its application since 2017 (Keller

et al. 2022), applying the two theoretical approaches can mutually enhance the depth of insight and understanding through productive dialogue.

To date, the application of this dual lens approach has mainly been limited to sectors like energy, transport, and food (Keller et al. 2022). Given the global plastic waste crisis (United Nations Environment Programme 2018) and the significant contribution of plastic nappies, this theoretical approach can offer unique insights into the issue and potential solutions. We first review our previously published paper on the nappy industry using an MLP lens (Graham-Nye et al. 2024). To explore the capacity of a compostable nappy service to replace disposable nappy practices, we conducted a field trial using an SPT lens. With this data, we identify critical intersections between the studies and suggest ways to leverage these as opportunities for a more sustainable nappy industry.

6.3 Methodology

In this section we present our methodology. We pursued two series of data collection activities to identify potential interventions to drive sustainable infant sanitation practices.

6.3.1 Investigating systemic influences on nappy practices

Semi-structured interviews with key stakeholders investigated niche-regime dynamics in the nappy industry. Stakeholder identification involved mapping actors across the supply chain. Three niche-level actors participated: the director of a compostable nappy company, a manager from a composting company, and a waste strategist from a rural council. Regime-level actors included executives from a supermarket chain, a childcare centre chain, a not-for-profit childcare centre, Sydney councils, a state waste regulatory authority, and a state government department. Interviews revealed valuable data, with three stakeholders highlighting a small pilot involving niche compostable nappy service innovation in rural NSW. This pilot, initiated by the rural council due to landfill capacity issues and a push for sustainable waste management, tested the compostable nappy service. Economic and environmental benefits of composting, including extended landfill life and reduced greenhouse gas emissions, were key factors. NVivo software analysed the data, identifying themes and insights into niche-regime dynamics. Limitations in

primary data from major disposable nappy manufacturers were addressed using secondary data. A summary of stakeholders is presented in Table 2.

Table 2. Summary of Stakeholders interviewed at the niche and regime level.

| | |
|-------------|---|
| Niche Level | 1. Director – niche compostable nappy & service innovator |
| | 2. Manager - commercial composting company |
| | 3. Waste strategist – rural-based council |

| | |
|--------------|---|
| Regime Level | 1. Executive - national supermarket |
| | 2. Procurement Manager - for-profit childcare centre |
| | 3. Early Childhood Education Researcher - not-for-profit childcare centre |
| | 4. Waste Educator – Sydney council |
| | 5. Recycling Educator – Sydney council |
| | 6. Project Officer – state-based waste regulatory authority |
| | 7. Policy Officer – state government department |

6.3.2 Investigating domestic practices

This qualitative study was conducted mainly in Waverley Council, Sydney, due to its many young families and proximity to the lead researcher’s home, especially relevant given post-COVID-19 travel concerns. Data was gathered from 20 families to explore nappy practices and assess a compostable nappy service through a one-week field trial. Participants included both disposable and reusable nappy users, providing a broad perspective. Although participants were primarily from English-speaking, middle to high socio-economic backgrounds, they offered valuable insights. Their babies ranged from 3 to 16 months old. Recruitment was initially challenging due to the busyness of new motherhood, but the distribution allowed for a comprehensive exploration of existing practices.

The 7-day field trial involved providing compostable nappies, wipes, and bags, focusing on social aspects rather than logistical and technical elements of composting previously explored by (Graham-Nye et al. 2024). Data collection methods included in-home interviews, re-enactments of nappy practices, and user diaries, capturing details such as nappy changes and reflections on

the compostable nappy's efficacy. NVivo software was used to code the data. Despite participant diversity limitations, the study provided valuable insights into nappy practices and the feasibility of compostable alternatives, highlighting the need for future research across different family compositions, settings, and socio-economic levels⁸.

6.3.3 Types of nappy practices

While the descriptions focus on the product and related infrastructures, SPT emphasizes that no product or infrastructure operates in isolation. Each relates to others to form a practice, meaning changing a practice involves more than substituting one product for another. Below, we outline nappy practices observed before the field trial and the new compostable nappy practice. Each practice is context-dependent, with parents often adopting a multi-practice approach based on factors like time of day, location, and activity.

Disposable nappy practices involve single-use products made from similar materials, including plastic layers, elastic, super absorbent gel, wood fluff pulp, and plastic tabs. Parents choose the brand that works best for their baby. At-home practice typically revolves around a nappy changing station with a changing mat, wipes dispenser, and drawers of nappies and baby clothes. A receptacle for managing the smell of dirty nappies is often present. See Figure 1 below.



Figure 1. A dedicated disposable nappy receptacle, a nappy changing station and a nappy storage area.

⁸ This research was approved by the UTS Human Research Ethics committee (ETH 21-5978).

The reusable nappy practice observed in this study used nappies that were made of a variety of washable textiles and came in a wide range of product formats combining an outer external pant with absorbent layers. Examples include All in Ones, One Size Fits All, One Size Fits Most, Pocket Nappies, Pre-folds and Origami Folds. Associated materials needed for the practice include a change table, wipes (often also reusable), a pail to collect used nappies to be washed, wet bags when away from home, a washing machine and a dryer and / or line drying facilities. These can be seen in Figure 2 below.



Figure 2. An origami fold, a collection of reusable nappy inserts and line drying facilities.

The compostable nappy practice features a nappy that is made of materials designed to be industrially composted. The plastic tabs used to secure a disposable nappy around a baby's waist have been replaced with a reusable, washable wrap. Figure 3 shows how the two parts work together to form the nappy. The washable wrap is necessary because at present, there are no alternative compostable materials available to replace their function. Unlike the disposable and reusable nappy practices, the compostable nappy practice includes the proposition that a collection and composting service is also offered. This is important as it guarantees a positive end-of-life environmental outcome for the product. The compost is then certified and sold. The compostability and certification of the material has been demonstrated through previous research (Ellen Macarthur Foundation 2020, Bega Valley Shire Council 2021, Australian Broadcasting Commission 2022).



Figure 3. Fastening the compostable nappy

6.4 Results

Although MLP and SPT each offer valuable insights, combining them shows crucial intersection points vital for understanding where innovation faces resistance at both regime and niche levels. Analysing the data through both lenses highlighted four shared factors that create constraints. These constraints arise from actors reinforcing stability at the regime level and factors that make disposable nappies the most convenient, reliable, cost-effective, and conventional choice. First, we use SPT to identify the four factors stabilizing disposable nappy practices. Then, we apply MLP to understand how stakeholders in the regime support the incumbent practice. In Section 5, we discuss potential interventions to facilitate the adoption of compostable nappies and services.

6.4.1 SPT

- **Convenience: Competing practices prioritise the most convenient choice of nappy**

We identified that despite diverse ways labour is divided within homes, particularly in non-heteronormative ones, our focus was on mothers who perform most household labour due to recruitment challenges. New mothers in the trial often chose the most convenient nappy practice because of the various new, competing practices they had to manage. These "bundles of practices" (Shove et al. 2012) highlight the interconnected and dynamic nature of social practices. Most participants sought convenience to ease their mental and physical load. For

example, Harriet, one of the two mothers who had returned to work, balanced numerous parenting tasks to meet her work commitments, underscoring the daily negotiations required to succeed as both a mother and employee.

It's a massive, massive list of things. It's the thing that I'm struggling with most. I've only just gone back to work full time. Because it was fine having the mental load when I didn't have anything else competing. But now that I'm going back full time, I can't manage. And like, it's the little things like, I was in Melbourne for the day yesterday. It involved getting up at 4.30am. And the night before, I'm kind of thinking through "how do I get dressed, so I don't wake anybody up?". "How do I make sure that everything he needs to go to day care is packed and ready?". So, I'm you know, washing bottles, packing his bag, like just all of those little things.

Pia reflected on a shift in an existing practice, laundry and how that contributes to her mental load as a new mum.

I think it's because it's the amount of mess as well. So yeah, like, I feel like one of the things that changes is how frequently you do laundry. I do it twice a day now, sometimes whereas before, I could stretch it out to once a week. But now, my partner is covered in vomit, she (my baby) goes through three outfits a day, so you're constantly doing more and more.

The recruitment of extra support to alleviate the new demands of motherhood is an additional burden itself that fell on Harriet:

But you know, two weeks ago I was recruiting our next Au Pair. That was about 30 hours of work.

The load was often expressed relative to their thoughts on using reusable nappies. Isabella explains:

Reusable nappies looked complicated. And then there was this insert.

and there's this other insert and I'm like, "Oh my god, it's just too complicated. I just don't have time for that". It's been a challenging experience being a parent. We didn't want to add to the difficulty.

Disposable nappy practices involve a one-piece product that's easy to put on, take off, and dispose of, making it exceptionally convenient. One participant described disposable nappies as "brainless" to use, highlighting the low level of competence required. Amanda also noted this ease of use.

I can do it (put on the nappy) in my sleep.

The ease of use of a disposable nappy combined with the repetitive nature of the practice solidified the durability of the practice for Sasha:

I think once you start, you are on autopilot using them.

Julia explicitly described the disposable nappy practice as the convenient way, vis a vis reusable nappy practices:

I looked a little bit into cloth nappies and then was like, you know, I am going to do it the convenient way.

Convenience in disposable nappies is evident in their materials. During home visits, the lead researcher observed how re-attachable plastic tabs allowed easy application, removal, and disposal in a neat ball. Waste receptacles for disposable nappies are widely available beyond the home, making disposal easy. This contrasts with reusable nappies, which must be taken home and washed after each use. Sasha described it as follows:

Disposables in general, they're just so convenient, aren't they? You're outside, you bung them in the bin, you're not carrying around three poo-ey reusable nappies in your bag along with packed lunches. So I guess it's just too easy. It's too easy to use them.

Conversely, adopting the compostable nappy challenged many participants. The two-part product caused concerns for several participants. As a material, the presence of two parts rather than one breached the norms of what a nappy “should” look like and caused anxiety for participants. Hilary described it in this way:

When I first saw the nappies, I felt a bit unsure. Surely without the sticky tabs securing them, they would leak.

For most participants, the novel compostable nappy practice required new competencies to get a consistently good fit. Almost all participants found it “fiddly” to put on. With a poor fit came leaks and the need to wash the reusable component which was inconvenient vis a vis their current disposable nappy practice.

- **Reliability: Product reliability eases the burden for parents**

Another important feature of any nappy practice is that it must perform reliably. This is especially so overnight while baby sleeps. Jane stated that the product must be “bombproof”. Within the disposable nappy practice, product failure saw some participants switch to other disposable brands to find a better fit. Julia commented:

We ordered Brand B⁹, and he had a huge blowout, and we were like okay, we'll try another brand. And Brand C have been pretty good since.

To achieve this, the product needs to be easy to put on for all practitioners – parents, au pairs and other caregivers, to ensure a good fit and provide excellent product performance. This speaks to the competence element of SPT. The one-piece disposable product is intuitive to put on, requiring almost no instructions. Only one participant could recall where she learned how to put a disposable nappy on. Felicity had no recollection of how she acquired the skills to use a disposable nappy beyond this one lesson:

⁹ Nappy brand names have been anonymised throughout this research paper

It was only in the antenatal group; she told us to put the wings out and that's what I remember. That was the one instruction to make sure they don't have an explosion. So, I do that.

In the disposable nappy practice, the use of plastics, wood fluff pulp and super absorbent gel delivers high absorbency that works overnight. The use of these materials connects performance to convenience, reinforcing Shove et al. (2012)'s notion that elements, in this case competence and material intimately interact to configure a practice.

Conversely participants in the compostable nappy practice trial struggled to achieve the reliability they were used to in their current practice. Rebecca commented in her User Diary:

“It took a few goes to get used to putting the nappy on – very wiggly child” and then “leaked at night-time and used old nappies”.

After continuing issues with the new practice, Julia noted in her User Diary on Day Five:

“Trial stopped as the nappy product isn't good enough”.

Cassie noted in her User Diary:

“Day One. Second nappy. Poo leakage. Changed him into a Brand A for his nap. Undecided if to continue with compostable nappies”.

Product reliability plays a key role in determining whether a new nappy practice will take hold.

- **Price: Low priced nappies contribute to a stable disposable nappy practice**

From a Practice perspective, price is a key factor for new parents facing increased household budget pressures. Amongst the field trial participants, there was broad willingness to spend up to a 10% premium on the compostable product itself given the environmental benefits:

Zara: Yeah, but like, we are buying some Brand A for when the cloth nappies happened to run out, or if it's raining a lot, or if we're traveling, so, yeah, if they're on par with the price of regular Brand A, then we would buy them.

Isabella: I would definitely pay the same (price for compostable nappies). Would I consider paying a little bit more? Probably yes, but not too much.

There was however minimal interest in paying for a dedicated collection service. Those that did express an interest did so on the basis it was a small charge rather than an amount that it would actually cost.

Rebecca: I'd pay I pay an extra cost for that. As long as it was, you know, not obscene.

The data showed evidence that price contributed to the stability of the disposable nappy regime and durability of the practice.

- **Norms: Early induction as the “normal” practice develops strong brand loyalty**

As set out in our prior research (Graham-Nye et al. 2024) from an SPT perspective, early induction into disposable nappy practices contributes to their durability. Specifically, as a product provided at no cost in maternity wards of hospitals in NSW, included in take-home maternity bags by the NSW government, available in all major supermarkets, widely marketed by the manufacturers, used by childcare centres and by most parents, disposable nappy practitioners are reassured to follow the same practice as most parents and institutions around them. This highlights the importance of the social and institutional context for consumption practices. The widespread availability and visibility of the product, suggests that the disposable nappy practice is seen as “normal” for many field trial participants. Through the SPT lens, the interaction of materials and meanings is another example of the co-constitutive nature of elements which reinforce the durability of the practice. Materials in this instance include the widespread distribution of the product across hospitals, retailers, childcare centres along with the broad availability of bins in public places.

Meanings can be seen in the status of disposable nappies as the “normal”, conventional nappy. Lara reported that for her, the very first nappy she saw and subsequently used was a disposable nappy, provided by the hospital when her child was born.

In the hospital, they use Brand A so that's your first introduction to changing a nappy and its Brand A.

In NSW, the location of the field trial, the NSW Government provides a take-home maternity bag of baby care items to all mothers giving birth in the public hospital system that includes just one form of nappies, disposable nappies. Most participants in this study received this bag. Mary stated:

You get the bag, the “Gladys Bag”¹⁰, which I thought was great, but then within the bag, there are Brand A. And I think that just sets people up on that journey.

In addition, Pia revealed a particular conundrum for this and any new innovation. Because by definition the product being trialled is not the norm, the attribution of poor performance was placed on the product rather than the practitioner. This creates an additional barrier for such innovations. Pia states:

Especially if I was doubting because I think the thing is, because it's not the status quo. I would always be doubting whether if there's like leakage. But if you're doing it when you're using the Brand A nappies that 99% of everyone else uses and they're also having the odd blowout here and there you think, “Oh, well, it's just par for the course”. Whereas if using a product that not everyone else is using and you're like, “Ah, it's a bit fiddly to put on. Am I doing that right? Is that the right product?”

¹⁰ The “Gladys Bag” refers to a free take home bag for new parents from hospitals, funded by the state government and named after Gladys Berejiklian, the Premier of the day.

Through the SPT lens, convenience, reliability, low price and disposable nappy practices as the norm, all contribute to the stability and durability of the practice. In the next section we assess the nappy regime through the MLP lens.

6.4.2 MLP

- **Regime actors strive to satisfy their customer's needs to achieve their corporate financial goals**

Through the MLP lens, and as detailed in previously published research by the authors, key regime actors (supermarkets and childcare centres) expressed a keen focus on satisfying the needs of parents to achieve their company's financial goals (Graham-Nye et al. 2024).

The national supermarket executive described it in this way:

“Nappies are incredibly important and that customer - a young family, is a very important customer. Typically, they (mothers) are the main shopper, and they have a big spend - a big “basket¹¹”. And typically, they're quite loyal on their shop but would shop around for nappies because nappies are a big purchase. And typically, young families are on a budget so that nappy customer will shop around. So it's important that we retain them.”

“The shop that the customer buys their nappies in is a part of a big purchase, it is normally their main shop. And so the basket will also shift. There's a real risk that we disappoint our customers. It is a product you need, and we may potentially lose customers and lose not just the nappy purchase, but also the entire basket as well”.

Regime actors reported that parents show high levels of loyalty to their preferred disposable nappy brand. For the national supermarket chain who participated in this research, this means making sure there is adequate stock of popular brands of disposable nappies across all sizes. The commercial implications of not having the right brand and size for the retailer is significant. The executive of the national supermarket explained it in this way:

¹¹ “Basket” is a term used in the retail sector to describe the number of products sold in a single purchase. Basket size is a key sales measure of success. The larger the basket, the more valuable that customer is to the retailer.

“Nappies are one of those things that aren't really substitutable. If your customers are quite loyal to a brand of nappy, children, infants when they get used to that nappy, parents become very loyal to that nappy brand. If we don't have that product in stock, they (parents) don't typically substitute...that customer will go somewhere else, because if you need nappies, you need nappies. So, typically, you will go somewhere else and that might be another one of our stores. Or it might be another retailer...so you have to be available. You have to be able to deliver on time and in full. Because if you lose that customer, you not only damage your brand and reputation, but you lose commercially a big basket”.

Similarly, parent's needs are of primary importance for Childcare centres. The Procurement Manager of a for-profit childcare centre chain explained that disposable nappies are the preferred choice of their customers, and for their own operations, as they offer their educators the same benefits as parents. These include a convenient, high performing product that is easy to use and dispose of using their existing waste management system.

“you'd be out of business very quickly, when it comes to caring for children, if you didn't put the parents front and centre in terms of what they want.”

- **Offering the lowest price reinforces the incumbent product**

As was seen in the analysis of the nappy practice in section 4.1.3 above, price plays a major role in how retailers think about the nappies they offer to satisfy their customers' needs. The national supermarket executive described it in this way:

“It is a very price sensitive category and value in this area is incredibly important. For example, we have a pricing policy with all of our own (store) brands and in nappies specifically that we don't expect to be more expensive than our main competitors And then with where we're competing versus discounters (discount supermarkets), nappies is one area where we would certainly not allow ourselves to be out of a pricing guard rail or index with them. So if we look at Brand C nappies, for the bulk packs, we sell them at \$11.50. The discounter sells the same product at \$11.49. We are line price with a discounter. And so for that customer where price is very important, we need to offer great value and that is a combination of quality and price.”

To threaten the stability of the disposable nappy category, a niche nappy innovation would need to match the price of existing disposable nappies (Graham-Nye et al. 2024). The Executive emphasised that supermarkets would be reluctant to risk losing young parents if a new innovation couldn't match the incumbent nappy's "return on shelf ¹²". In assessing any new, sustainable nappy offerings the executive set out three key attributes:

"So those sorts of initiatives, they've got to be good for the environment and for them to be good, they've got to be convenient, and they've got to be great value".

The executive goes on to acknowledge the scale of the problem and the inherent conundrum of satisfying consumers while offering sustainable solutions. Ultimately however, the primacy of the customer and the commercial goals of the company that the customer delivers are the priority, ensuring the status quo remains in place.

"It's a big problem to solve....because we can't keep putting plastic nappies in landfill...so we need to find a way to solve this problem. But for customers to buy it, we need to make it great value and fit for purpose".

- **Maintaining disposable nappies status' as the "norm"**

Norms emerged as a key theme in the SPT analysis in section 4.1.4 above. Norms are relevant because they shape individual behaviour by establishing what is considered acceptable within a community, thereby maintaining social order. They facilitate social cohesion by fostering trust and cooperation among group members. Understanding norms is crucial for driving behavioural change, as it helps identify and address the underlying expectations that sustain current practices. While the two major global nappy brands, Brand A and Brand B, were unwilling to participate in this research, these regime actors have a significant impact on the stability of the category. Data

¹² "Return on Shelf" is a measure of how productive each product is. This can be seen in the number of times a product needs to be replenished. The faster the rate of replenishment, the higher the "return on shelf" and the more financially viable it is for the retailer and manufacturer.

is not typically publicly available; however, Brand B has the largest share of the global nappy market and generates annual sales of USD\$10 billion in 2019 (Industry meeting, February 2019). They commit USD\$8.3 BN per year to market the brand (Business Chief 2016), which places Brand B as the largest advertiser in dollar terms of all major US consumer brands despite relatively low revenue as a proportion of marketing spend.

This gives an indication of the broad presence the brand has in the lives of expecting and new parents, establishing the product as the norm. As a result, strong brand loyalty is built, stabilising the position of these two major stakeholders in the regime. Any new offerings in the category would need to gain the same level of acceptance as the incumbent product for regime actors to support it given the commercial implications.

The ubiquity of disposable nappies (in this case Brand A of disposable nappies) started influencing Anna even prior to becoming a mother:

I think maybe I just feel like Brand A is the first thing you kind of get drilled into you. Even when you don't think about kids, it's just like “what nappies?”, “Brand A”.

Similarly, Gina identified the role of brand marketing by large disposable nappy companies in establishing the product format as the norm.

I think disposable nappies are the status quo. It's clever marketing on Brand A's part.

Along with hospital and government institutions, Lara's friends played a role in their choice of disposable nappy practices.

I think you're hugely influenced by your friends with babies.

Through the lens of the MLP, the same intersection points that stabilise the nappy practice are evident in the regime. Figure 4 below, derived from Geels and Schot (2007) shows the status quo

and the two phenomena that maintain it. The compostable nappy practice trialled in this research is seen starting at the niche level of the MLP and approaching the regime. It is rejected due to the difficulties participants faced in adopting the new practice and the lock-in effects in the regime that make the incumbent practice persist. This sees the trialled solution return to the niche. The four common intersection points sit at the centre of the practice and in turn the regime. By zooming in we find a durable practice and by zooming out, we see the socio-technical system stabilising the practice explaining why the niche innovation trialled in this study was unable to threaten the regime.

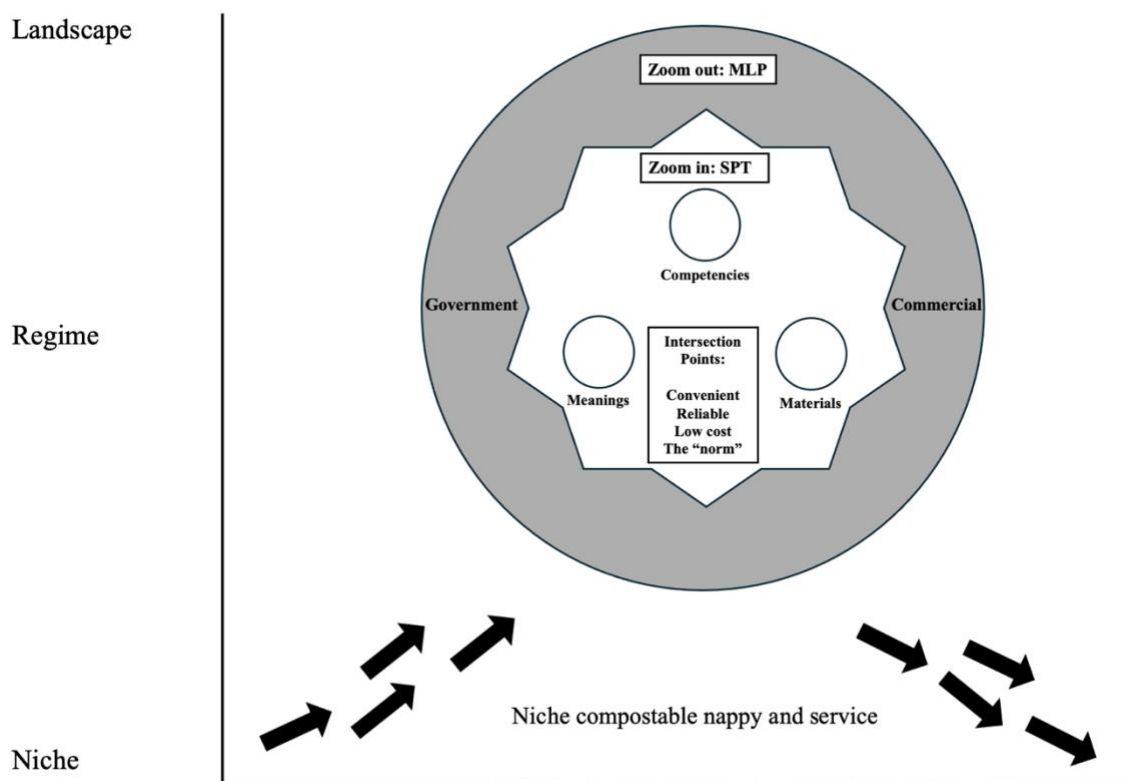


Figure 4. The practice in the centre is locked into the regime by four common intersection points.

Arrows representing the niche innovation are shown unable to threaten the regime.

(Geels and Schot 2007)

With these four intersection points now identified; we turn our attention to possible interventions which may be able to unlock opportunities for sustainability transitions. These are set out in the Section 6.5, below.

6.5 Discussion

6.5.1 MLP and SPT dynamics

The intersection points configure a persistent disposable nappy practice, stabilised by regime actors. Commercial entities like large nappy brands provide free products in maternity wards, distribute widely through supermarkets, run broad marketing campaigns, and supply childcare centres. Government bodies reinforce stability by providing nappies in public hospitals and maternity bags. Waste management policies, such as prohibiting the composting of human waste, further entrench disposable nappy practices. These lock-in effects by regime actors maintain and resist change in dominant nappy practices. Figure 5 illustrates how regime-level pressure in the MLP ensures the persistence of these practices.

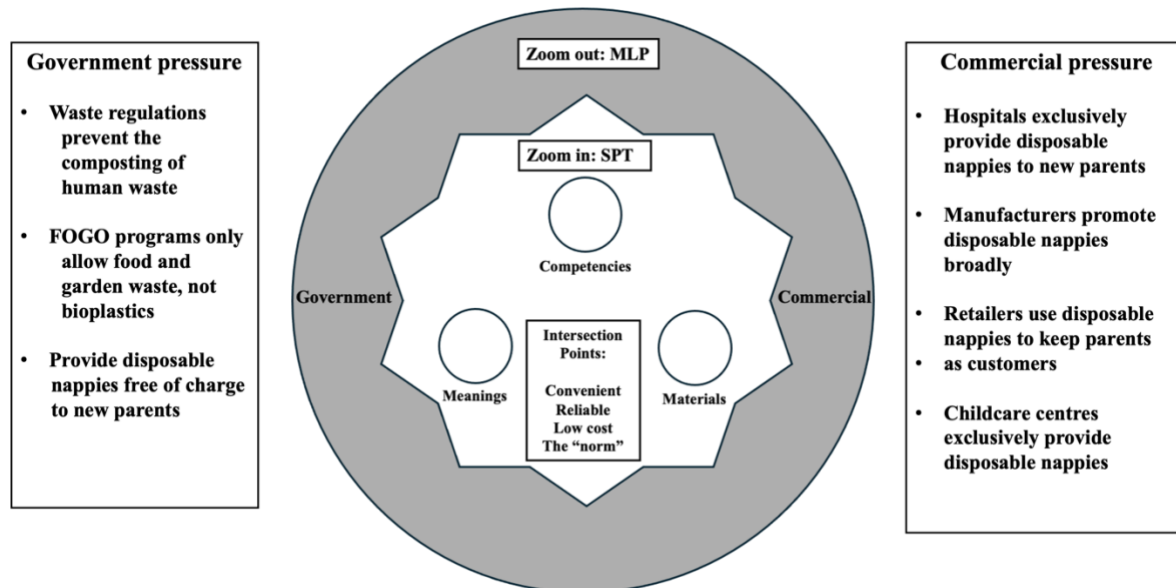


Figure 5. Regime-level actors in the MLP maintain dominant disposable nappy practices making the introduction of new nappy practices difficult.

The compostable nappy service trial showed significant lock-in effects of the incumbent practice. For meaningful change, both practice and regime factors must be challenged. Complexities of service delivery, collection, and composting were not fully explored in this research study. Barriers include regulations against composting human waste and contamination risks from plastic nappies. Despite these obstacles, the limited progress by regime actors over the past 30 years shows the value of a holistic dual lens approach with compostable nappies. (Knowaste 1989, Allred 2009, Resource.co 2013, Fater SpA 2017, Warner et al. 2017, Olivo 2019, CSIRO 2022, Welsh Government 2022, Statista 2024). This approach helps in understanding the dynamics of both the regime and the practice. Insights from this research may inform other product-service systems that aim to address the disposable nappy problem.

6.5.2 Possible Interventions

While comprehensive research into intervention development using the dual lens of MLP and SPT has yet to be conducted, Kanger et al. (2020) developed a framework of six policy intervention points based on a review of the sustainability transitions literature that used the MLP. Keller et al. (2022), built on that research by tying six practice change strategies derived from SPT to Kanger's six MLP policy interventions. Keller et al. (2022)'s research showed that of the six MLP-SPT intervention points, three dominate the current literature. These include combining (1) the stimulation of niches from an MLP perspective with new practices or regenerating old practices to new niches, (2) acceleration of niches from the MLP with accelerating the spread of new practices and (3) regime destabilisation efforts in the MLP with the reconfiguring, disruption, and substitution of existing practices with new practice. The development of five potential interventions to address the four points of constraint that emerged in this research are set out in Table 3. They are guided, to some extent from Keller et al. (2022), taking into account Keller's small sample size and the inherent complexity of the exercise (Hargreaves et al. 2013).

Table 3. Summary of the four points of intersection, five potential interventions, specific propositions and proponents

| Constraint | Specific issue | Five potential intervention approaches | Specific propositions related to compostable nappies | Proponents |
|--------------------|---|--|--|--|
| Convenience | Requirement for a nappy and service that is convenient to purchase, use and dispose of. | Product and service innovation to enable convenient product access, use and disposal. | <p>Development of an entirely compostable nappy</p> <p>Development of an affordable, subsidised composting service</p> <p>The lifting of the ban on composting human waste</p> | <p>Manufacturer</p> <p>Manufacturer or a third party</p> <p>Government</p> |
| Reliability | Requirement for a nappy that offers performance for extended periods of time | Product innovation to ensure nappy does not leak | Development of an entirely compostable nappy that matches the performance of a disposable nappy | Manufacturer |
| Price | <p>The price of nappies drives both the user in their choice of nappy practices and retailers at the regime level</p> <p>Practitioners are unwilling to pay for a dedicated collection and composting service</p> | <p>Product innovation to make compostable nappies affordable</p> <p>Product and service innovation</p> | <p>Development of a cost effective, entirely compostable nappy</p> <p>Introduce a mandatory Extended Producer Responsibility policy on all nappy manufacturers. This moves the incremental cost burden</p> | <p>Manufacturer</p> <p>Government</p> |

| | | | | |
|---------------------|--|---|---|--------------------------------|
| | | | of collection and composting from the practitioner to the manufacturer | |
| Norm setting | Practitioners are influenced by norms when choosing a nappy practice | Establishing new norms could encourage users to choose a new nappy practice | Introduction of compostable nappy practices across regime actors including pre-natal classes, maternity hospitals, take-home maternity bags and childcare centres | Commercial and public entities |

We have not attempted to neatly tie each of Keller et al. (2022)'s interventions to those suggested here. We do recognise that in aggregate, these interventions touch on Keller et al. (2022)'s dominant three, and most effective MLP-SPT interventions, namely niche stimulation, niche acceleration and regime destabilisation. This can be seen in the suggestion to develop both an entirely compostable nappy and a complete product service system which could be done by niche or regime actors and see new practices introduced, particularly at the end of life stage of the product. The intervention to introduce EPR to create a cost-effective product service system is another example of regime destabilisation where a policy intervention destabilises incumbent manufacturers. New norms derived from new compostable nappy practices are another example of regime destabilisation that can result in successful sustainability transitions.

The interventions feature suggestions mostly targeting actors in the regime and reflect the significant influence that the regime has on holding practices in place. This is a departure from the popular application of the Theory of Planned Behaviour (TPB). TPB focuses on individual intentions and beliefs influencing behaviour, while the zoom in zoom out approach emphasizes collective action and societal change to address socio-technical challenges (Ajzen 1991). Private sector 'regime-level actors, specifically nappy manufacturers will either need to be willing to disrupt their own business models or be moved to do so by exogenous pressures such as the

local, state and national-level policy interventions suggested above or global agreements currently being negotiated such as the UN plastics treaty (United Nations Environment Programme 2022).

6.6 Conclusion

This paper introduced new perspectives on dominant nappy practices and their regimes by using a dual theoretical lens to identify intersection points of constraint. Various interventions are suggested to guide innovations, policies, and awareness campaigns to normalise sustainable, compostable nappy practices. Given the scale of nappy waste and the ineffectiveness of recycling attempts, this approach is significant. By combining SPT and MLP, we highlighted real-world intervention points. Future research could apply this method in the Global South, where the nappy waste crisis is more acute. Implementing these interventions could pilot pro-environmental practices, potentially destabilising the current regime and addressing the global plastic waste crisis.

Declaration of interest statement

The authors declare no conflicts of interest regarding this manuscript. This research was conducted without external funding. The lead researcher, a Director of a company licensed to market the niche nappy innovation outside Australia, declares no competing financial interests related to this study.

Chapter 7. Findings, Contributions and Implications

7.1 Chapter Introduction

This final chapter is divided into four sections. The first section restates the research objectives and questions and then summarises the key findings and contributions. The second section sets out the implications of the findings and possible future directions across industry and academia. The third section outlines the limitations of this research while the fourth section closes the chapter with final reflections.

7.2 Findings and Contributions

7.2.1 Findings

The goal of this research was to gain a better understanding of why unsustainable nappy consumption practices persist and ways alternative practices can gain traction. To do so, two primary questions and three associated sub-questions were developed. These are set out below with the relevant findings discussed below each.

Primary Question 1. What are the dynamics that influence the persistence of disposable nappies as a normative practice?

Sub-question 1.1:

In the nappy regime, what are the power dynamics across the incumbent stakeholders?

Findings from the first research phase, “A Multi-Level Perspective of the Nappy Industry” suggested that the disposable nappy regime is stabilised by the power dynamics among key stakeholders. These include supermarkets, childcare centres, waste regulators and waste management companies. Supermarkets mediate between manufacturers and consumers, enforcing the convenience, reliability and low-cost standards that new entrants must meet for supermarkets to achieve their financial goals. Supermarkets prioritise meeting these needs of new mothers, as mothers are one of their most valuable customer segments. Childcare centres, which often provide nappies, reinforce these standards as they need a nappy that also provides convenience, reliability and low-cost to best serve their customers and meet financial

imperatives. Waste management companies support the regime by handling nappy waste in landfills.

The niche nappy innovator highlighted in the research gained a brief foothold in a very specific set of circumstances but faced setbacks due to two regime-level stakeholders. Firstly, the council whose composting facility reached capacity and state-based waste regulator who imposed a ban on the acceptance of compostable biofilms in council managed Food Organic Garden Organic collection programs. In aggregate results of the research showed the power dynamics across the state-based regulator, the council, the supermarket and childcare centre.

Findings from the third research phase, “Intersections between the nappy regime and practices”, showed that niche nappy innovators would need to overcome significant barriers for the compostable solution to threaten normative disposable nappy practices. These barriers included the requirement by key regime stakeholders (supermarkets and childcare centres) at a macro, socio technical level and mothers at a micro, household level to match the incumbent disposable nappy practice’s performance, reliability and low-cost. According to the supermarket executive, this requirement was driven by commercial pressures to secure new mothers as customers. The supermarket executive reported that mothers do 80% of a households’ weekly shop and where a mother buys nappies is where they typically do their entire weekly shop. Consequently the value of a mother’s average weekly shop was higher than other customer groups. As was shown in the second research phase, “A compostable nappy service field trial”, mothers are managing new, competing, parent-related practices. The findings showed that this is what drives a mother’s demand for a high performance, reliable and low-cost nappy practice and what creates a durable and thus normative, disposable nappy practice.

Sub-question 1.2

What is the relationship between domestic scale, everyday nappy practices carried out by individuals and stakeholders in the nappy regime to produce a persistent nappy practice?

Findings from all three research phases suggested a close relationship between the disposable nappy practices at the household level and stakeholders at the regime level. In the third phase

“Intersections between the nappy regime and practices”, four intersection points were identified between domestic nappy practices and stakeholders in the nappy regime that reinforce the stability of disposable nappy practices. These points were convenience, reliability, low-cost and the normative status that disposable nappy practices have amongst the participants in the study. Supermarkets offer the most convenient, reliable and low-cost nappies that parents seek to secure their custom to achieve their commercial goals. The data showed that at the household level, prenatal classes, mass media marketing by major nappy brands, supermarkets, hospitals, childcare centres and free maternity take-home bags provided by the government all play a role in maintaining the incumbent nappy practice’s place as the dominant, normative nappy practice. Another important stabilising element which emerged in both phase 1 and phase 2 of the research was the role of misleading environmental marketing claims made by disposable nappy manufacturers. Also known as “greenwashing”, these claims are made to convince parents to buy eco-friendly nappies that are less environmentally friendly than the claim suggests. As discussed in Chapter 2, an early example of this dates back to 1991 when the largest global nappy brand responded with a misleading product claim in a national newspaper advertisement to a proposed ban on disposable nappies in the US. In phase 1, the supermarket executive expressed concern about brands greenwashing but relied on the brands themselves to make honest claims. The executive also expressed hope that the national competition regulator would be more active in policing the manufacturers. In phase 2, there were cases in the field trial of mothers who believed their nappy choice, which claimed to be 100% compostable when disposed of in landfill was in fact partially compostable and would not biodegrade in landfill. This phenomenon challenges the integrity of sustainable practices by embedding false narratives within everyday routines, thereby complicating efforts to foster genuine sustainability transitions.

In summary, the research results from the macro, MLP view to the micro, SPT perspective highlighted the entrenched stability of disposable nappy practices. This is due to the influence of powerful stakeholders and the reinforcement of these practices at various intersection points between domestic scale nappy practices and the regime that surrounds the practice.

Primary Question 2. Are there ways that a compostable nappy service can overcome adoption constraints?

Sub-question 2.1

What are the challenges and opportunities encountered by parents using a compostable nappy service?

1. Challenges

Findings from phase 2 of the research, “A compostable nappy service field trial”, show a series of significant challenges that parents encountered when trialling the compostable nappy practice. The research results showed that it was in fact mostly mothers (80%) who managed their child’s hygiene. This in and of itself has implication which are addressed in the following section. New mothers in the study are juggling a range of new practices from feeding to sleeping, doctor’s visits, work commitments and for those that were on maternity leave, preparations for childcare arrangements. These multiple new competing demands on new mother’s drive demand for a nappy practice that offers the most convenience, reliability and cost competitiveness.

The plastic disposable nappy practice meets these key requirements with a product that is easy to use and dispose of for parents, caregivers, and childcare centres. As one research participant said, the practice must be “brainless”. As another said, it needs to be so simple it could be done with your eyes closed, as nappy changes often are in the middle of the night. Reliability is another key consideration which the disposable nappy practice provides mothers given the significant product development which offers extended periods of absorption and minimal leaks. Research findings showed that these two factors – extended absorption and minimal leaks ensured baby slept through the night. Sleep for mother and child was a high priority for new mothers managing the competing practices. As one participant put it, the product itself needs to be “bomb proof”. A third key factor is the need for a low-cost option, given the increased financial burden on new parents. This is relevant even in the relatively high socio-economic location where the research took place. Findings showed some participants making a dedicated weekly trip to buy disposable nappies from a discount supermarket while doing the remainder of their weekly household shop at another supermarket. As a by-product of oil, and mass production globally, plastic is historically one of the lowest cost alternatives for manufacturers to choose.

Finally, new parents are influenced by normative nappy practices which have centred around the disposable nappy product since the mid 1990’s. Norms perpetuate themselves through self-

reinforcing mechanisms supported not only at the domestic level but also at the regime level. Mothers reported in the research that they always knew they were going to adopt a disposable nappy practice from a time well before they fell pregnant, such as the breadth of marketing campaigns by nappy manufacturers along with observations of the nappy practices their friends pursued. Other factors that made the disposable nappy practice the choice for parents in the study included the broad availability of disposable nappies in supermarkets, and the pursuit of the practice at maternity hospitals and childcare centres. There were instances reported in the data where parents seeking to follow reusable nappy practices were unable to do so when they went to hospital to give birth and when they enrolled their children at a childcare centre. Collectively, these factors present significant challenges for the compostable nappy service to gain traction with parents.

2. Opportunities

Given the stability of the disposable nappy regime and practices, opportunities to overcome these significant challenges are inherently difficult to realise. Firstly, there is a need for product development to create compostable nappies that match the performance, reliability, and cost of current disposable nappy options. The first and second phases of research identified the need for new practices to match the incumbent practice across these three factors. This poses a significant challenge. Unlike the research and development conducted on plastic films that has taken place since plastics were first developed 70 years ago, compostable materials are far less advanced and cost significantly higher to produce.

Once a product is developed that can match the performance, reliability, and low cost of the incumbent nappy, broad stakeholder support must be mobilised to challenge the entrenched normative preference for disposables among parents. Niche innovators can enlist the support of stakeholders such as prenatal class providers, supermarkets, hospitals, childcare centres, and government-provided maternal health services.

A third opportunity addresses the cost barrier of managing dedicated collection and composting services for compostable nappies. A crucial aspect is enabling the nappies to be composted effectively. This can be achieved through introducing a mandatory Extended Producer

Responsibility (EPR) regulation on nappy manufacturers. EPR shifts the responsibility for handling products after use from users to manufacturers. Manufacturers then become legally and financially accountable for the disposal, recycling, or treatment of their products once they are no longer in use. This policy aims to include environmental and social costs into product pricing, encouraging manufacturers to create more environmentally friendly products and packaging. Ultimately, it promotes resource efficiency and reduces waste.

7.2.2 Contributions of the Research

This research addresses a number of gaps in the literature and in doing so contributes new insights in both the practice and sustainability transitions literature. Firstly, research to date had limited insights on the existence of multiple new, competing household practices that new mothers face. Secondly limited insights existed into how new parents choose a nappy practice in the face of these multiple new consumption practices. Thirdly, there was a lack of research at both the practice and socio-technical systems levels regarding nappy use. Fourthly, the interactions among stakeholders within the nappy regime were poorly understood. Lastly, there was little understanding of how new innovations in the nappy category can gain traction and become mainstream. The section below explains how each of these gaps were addressed and discusses the new contributions made.

1. New understandings about the competing practices that new mothers face

This research showed that new parents face the challenge of integrating new competing practices, such as feeding, laundering, and childcare, into their daily routines. These practices not only compete for time and attention but also introduce decisions around sustainability and convenience. Understanding these dynamics is crucial for designing effective interventions.

2. New insights about nappy practice selection

This study provided insights into the high value parents place on convenience, reliability, and low cost in their choice of nappies driven by new competing parenting practices. Parents prioritise nappies that are easy to use and dispose of, reducing the daily burden of childcare. Reliability, in terms of absorbency and leakage prevention, is critical to ensure the child's

comfort and to prevent frequent changes, which could be disruptive. Disposable nappies, being widely available and competitively priced due to economies of scale, often become the default choice. The study also highlighted that new parents are heavily influenced by mass marketing and recommendations from friends and family, which often favour disposable options due to their proven track record of reliability and convenience.

3. New insights about nappy practices at the household and socio-technical systems level

This research revealed how competing practices at the household level influence a parent's choice of nappy practice and how lock-in effects across regime-level actors collectively support that practice. At the household level, the need to balance various childcare tasks with other daily responsibilities leads parents to choose the most convenient and reliable nappy options. At the socio-technical level, the study highlighted the entrenched position of disposable nappies, supported by a network of manufacturers, retailers, childcare centres, waste management systems and waste regulations that favour their continued use. The integration of disposable nappies into societal norms and institutional practices, such as recommendations from healthcare providers and availability in supermarkets, reinforces their dominance. The dual-level analysis demonstrated how individual choices, and broader systemic factors interact to sustain the current nappy practice.

4. New perspectives on the dynamics of stakeholder interactions within the nappy industry

The research identified the power dynamics and interdependencies among stakeholders in the nappy industry that reinforce the dominance of disposable nappies. Manufacturers, retailers, and waste management companies form a tightly interconnected network that benefits from the status quo. Manufacturers produce nappies at a scale that ensures low costs, retailers prioritise products that sell well and meet consumer demands for convenience and reliability, and waste management companies have established processes for handling nappy waste. The study shed light on the significant barriers faced by alternative nappy solutions, such as compostable

nappies, in gaining support from these key players. These barriers include the poorer performance and higher cost of alternative products to match the performance and cost of disposables, as well as the lack of infrastructure for compostable nappy disposal.

5. New knowledge about how new nappy innovations can gain traction

This research demonstrated the challenges and opportunities for a compostable nappy service, emphasizing the need for performance parity with disposables, cost reduction, and supportive regulatory frameworks. For compostable nappies to gain mainstream adoption, they must offer similar or better absorbency and reliability as disposable nappies while being competitively priced. Additionally, the research underscored the necessity of supportive policies and infrastructure, such as the inclusion of compostable nappies in municipal composting programs. Engaging stakeholders, including manufacturers, retailers, childcare centres and waste management companies, is crucial for creating a supportive ecosystem that facilitates the adoption of compostable nappy solutions. The findings suggest that a coordinated approach involving macro - level interventions such as policy incentives, consumer education, and industry collaboration along with micro-level practice interventions across competences, materials and meanings can drive the transition towards sustainable nappy practices. By addressing these gaps, the research provided a new understanding of the factors influencing disposable nappy use and insights for promoting sustainable alternatives.

7.3 Implications and future directions

This section explores the broader significance of these research findings. The findings underscore the multifaceted nature of challenges associated with unsustainable nappy practices. They highlight the influence of entrenched stakeholders in the socio-technical system and the stable disposable nappy practices that the system supports. Below I have set out practical implications (industry and policymakers) and possible future research directions.

7.3.1 Practice Implications

The findings from this research have significant practical implications. Using both MLP and SPT, showed that a response to the disposable nappy waste problem needs to be a cross-sector effort. As the literature review showed, attempts by just one stakeholder, for example nappy manufacturers to reduce the size of the product or downcycle their nappy waste isn't sufficient (Olivo 2005, Fater SpA 2017, Nonwovens Industry 2017). Similarly, a policy maker applying a subsidy on reusable nappies or a tax or ban on disposable nappies was also not effective (Pendry et al. 2012). The findings of this research challenge the prevailing notion that all that is needed to achieve sustainability transitions is more awareness campaigns and education about sustainable nappy alternatives (Kollmuss and Agyeman 2002). By taking an approach that looks at the practice and the socio-technical system within which it sits, a far more intricate set of relationships is revealed. The research showed that nappy practices encompass several crucial characteristics that shape its persistence and influence potential transitions to more sustainable alternatives. Below I have set out practical implications based on the research findings.

- **Industry**

The research showed that in order to address the disposable nappy waste problem, engagement is needed with four important stakeholders across the product lifecycle. The first are nappy manufacturers. They have the capability, resources and know-how to innovate in order to develop a one-piece compostable nappy rather than pursue the continuation of recycling efforts. They would need to do so in concert with policy makers (see next section) who would need to adjust existing laws preventing the composting of human waste. They also have the capacity to develop new business models to provide a deliver and collect model for consumers. The waste management industry then needs to provide suitable industrial composting facilities to manage this waste. In the state of New South Wales where this research was conducted, a state-wide mandate on Food Organic Garden Organic waste collection has already been announced and the waste management industry has responded accordingly with the launch of new industrial composting facilities. Retailers then play a key role in stocking new innovations and promoting this new pro-environmental nappy practice with parents. As one of the largest consumers of nappies childcare centres can also play their part by providing compostable nappies to their parents and partnering with waste management to establish a collection and composting service.

Building partnerships across all stakeholders in the industry can ensure these new nappy options are integrated into existing supply chains and consumer practices.

- **Policymakers**

The research highlighted the barriers present owing to policy and regulatory settings. Conversely there are opportunities to support nappy innovation with new policy and regulatory settings. Policymakers could consider revising regulations that currently prohibit composting human waste and exclude the disposal of biofilms in Food Organic Garden Organic (FOGO) services. Implementing Extended Producer Responsibility (EPR) regulations can shift the responsibility of nappy disposal from consumers to manufacturers, incentivising them to develop more sustainable products and invest in proper waste management solutions. Government support in the form of grants, subsidies, and infrastructure development can help niche innovators overcome the high costs associated with developing and implementing new compostable nappy systems. For government hospitals in New South Wales who currently supply new parents with a take home bag of baby supplies including disposable nappies, could also support the effort by providing compostable nappy alternatives instead. In addition, a greater level of enforcement of existing misleading marketing claims by the government's consumer and competition watch dog is required to firstly protect the interests of citizens and secondly create a level playing field for manufacturers. Lastly, maternity hospitals could consider changing policies and supply compostable nappy alternatives instead of disposable nappies.

7.3.2 Future research directions

- **Conduct the field trial in a Global South context**

There would be value in repeating the field trial conducted in this study in a Global South context, where the nappy waste problem is becoming increasingly urgent. Given the different geographical context, the research approach is likely to differ and as a result the framework may need to be adapted. As discussed in Chapter 2, the problem is accelerating in the Global South due to an increasing middle class demanding the conveniences of the Global North. Coupling this with a lack of formal waste management infrastructure, large amounts of nappy waste are leaking into the environment causing detrimental effect on natural systems and the tourist sectors

of some countries. Applying the research approach used in this study in a Global South context, could reveal the unique challenges and opportunities in these regions, including cultural, economic, and infrastructural factors that influence nappy practices. Researchers could also examine the effectiveness of policy responses, such as bans on disposable nappies, and their impact on waste reduction. In countries such as Vanuatu, outright bans on the importation of disposable nappies were initially announced but later paused to allow for a more thorough investigation of alternative nappy products (Olivo 2019, RNZ 2020, European Union et al. 2022). Although SPREP's research identified reusable and compostable nappies as promising options, it did not consider the entire nappy practice or how to engage regime actors effectively. Adopting a holistic research approach would provide a more comprehensive assessment.

- **Apply this research approach to other daily, mundane, household practices**

Beyond disposable nappies, there are many other daily, mundane consumption practices with single-use plastic element associated with them which have been resistant to change. Examples include single-use plastic bottles, single-use plastic bags and plastic packaging. Similar to the two decade focus on attempts at recycling plastic nappies, to date, recycling has been the focus to shift these practices in a more sustainable direction. These efforts have borne little fruit given only 9% of all plastic as ever been successfully recycled (Geyer et al. 2017). This holds the promise of new insights into the nature of these durable practices emerging and possible new interventions being developed.

- **Parenting and gender roles**

The research showed that in the majority of households, mothers are at the centre of infant hygiene management. The many competing practices that mothers especially face, and which drives their choice of disposable nappy practices highlights the way parenting roles are unevenly distributed and the impact that that has on nappy consumption practices. Future research could explore this link further by choosing to look at the nappy practices of a cohort of non-birth parents to see if there are any differences from which new insights can be derived. It might be that with fewer competing practices to contend with, different and perhaps more sustainable practices emerge.

In summary, the persistence of unsustainable nappy practices is influenced by complex power dynamics and entrenched norms. Addressing these challenges requires a multifaceted approach involving product and service innovation, regulatory changes, stakeholder engagement, and cultural shifts. The implications of this research highlight the need for coordinated efforts across various sectors to promote sustainable nappy consumption practices and reduce their environmental impacts.

7.4 Limitations of the research

While this study provides valuable insights into the dynamics of disposable nappy practices and the potential for compostable nappy services to disrupt the current regime, several limitations must be acknowledged.

1. The research was conducted within a specific geographic area and focused on a particular demographic group, which limits the generalisability of the findings to other regions or populations. Additionally, the sample size, while sufficient for exploratory analysis, was relatively small and does not fully represent the broader population. The study employed a multi-methods approach, using qualitative interviews, user diaries and in-situ observations to gain in-depth insights and secondary data analysis to provide contextual understanding. However, self-reported data from participants may be subject to recall bias and social desirability bias. Furthermore, the reliance on secondary data sources from nappy industry analysis may have introduced limitations in data accuracy and completeness. The research was conducted over a limited time frame, which may affect the temporal relevance of the findings. Changes in market dynamics, consumer behaviour, or regulatory environments over time could influence the applicability of the results.
2. The conceptual framework used in this study, while robust, may not capture all relevant factors influencing nappy practices. Some theoretical assumptions may not hold true in different contexts or under varying conditions. For example, socioeconomic status can significantly influence consumer behaviour. Assumptions based on higher socioeconomic areas might not apply in lower-income areas where priorities and values differ. SPT

emphasises habitual behaviours and social norms. These can vary widely across different communities, influencing how sustainable practices are perceived and adopted.

Affordability and cost-effectiveness are crucial factors. Assumptions about willingness to pay for sustainable products can vary, affecting trial outcomes in different socioeconomic contexts. In MLP, the dynamics between stakeholders vary from one regions context to another.

3. Resource constraints, including limited funding and access to certain data, specifically the absence of a large nappy manufacturer in the research, impacted the scope and depth of the research.
4. Logistical challenges, such as difficulties in reaching certain participant groups for example parents with more than one child, also posed limitations.

By acknowledging these limitations, this study provides a transparent account of its scope and constraints, guiding future research to build upon its findings and address identified gaps.

7.5 Final Reflections

The nucleus of this research project dates back to 2001, when my wife and I were expecting our first son. Realising the massive scale of the global plastic nappy waste problem and its environmental effects inspired us to start a company and, ultimately, led me to pursue this research project.

This journey has highlighted the persistent challenges and resistance within the nappy industry and related policy frameworks. Despite the growing awareness of environmental issues and the urgent need for sustainable solutions, both corporate and governmental actions have largely been insufficient or misdirected. My research has sought to critically analyse these shortcomings and explore viable alternatives through the lens of sustainable consumption.

Throughout this project, I have delved into MLP and SPT frameworks to better understand the socio-technical transitions and practice changes required for meaningful change. By examining how everyday practices and systemic structures interact, my work aims to identify leverage points for transforming nappy consumption practices.

In conclusion, this research underscores the necessity for a comprehensive, multi-sector approach to develop effective interventions. It is my hope that this thesis not only makes some contribution to academic discourse but also serves as a catalyst for real-world change, inspiring further research, innovative solutions, and effective policy interventions.

Appendix A: Participant Information and Consent Form



PARTICIPANT INFORMATION SHEET

UTS HREC REF NO. ETH21-5978 - Prospects for mainstreaming a compostable nappy service

WHO IS CONDUCTING THIS RESEARCH?

My name is Jason Graham-Nye and I am a PhD student at UTS. My supervisors are Dr Nick Florin (Nick.Florin@uts.edu.au) and Dr Monique Retamal (Monique.Retamal@uts.edu.au).

WHAT IS THE RESEARCH ABOUT?

The purpose of this research is to understand how changes in nappy consumption come about and how new practices can be broadly adopted. It will include a field study of a compostable nappy by parents and interviews with stakeholders in the nappy industry. This is a sociological study to better understand the factors that influence consumption across all stakeholders including parents, childcare providers, manufacturers, retailers, waste management providers and waste regulators.

WHY HAVE I BEEN INVITED?

You have been invited to participate because you are either a parent with a child in nappies or have expertise in your field that can inform this research.

FUNDING

Funding for this project has been received from the Australian Government via a post graduate scholarship.

WHAT DOES MY PARTICIPATION INVOLVE?

Your involvement will include the following activities.

- a one-on-one semi-structured interview to be conducted at your office. This should take no more than 60 minutes of your time and will be audio recorded and transcribed. The data will be anonymised and will allow me to identify common themes across interview subjects.
- Topics will include general information about how your organisation interacts with nappies.

If you decide to participate, I will invite you to sign the attached consent form and send to me at Jason.Graham-Nye@student.uts.edu.au

ARE THERE ANY RISKS/INCONVENIENCE?

Yes, there are some risks/inconveniences to consider, mainly the time it will take to participate in the interview. There is also a safety risk related to Covid.

DO I HAVE TO TAKE PART IN THIS RESEARCH PROJECT?

Participation in this study is voluntary. It is completely up to you whether or not you decide to take part. If you do agree to take part, you are under no obligation to continue to participate. You can withdraw at any time

WHAT IF I WITHDRAW FROM THIS RESEARCH PROJECT?

If you wish to withdraw from the study once it has started, you can do so at any time without having to give a reason, by contacting me at Jason.W.Graham-Nye@student.uts.edu.au or on [REDACTED]. If you withdraw from the study, your recorded interviews, user diaries and photographs will be erased.

WHAT WILL HAPPEN TO INFORMATION ABOUT ME?

By signing the consent form you agree to participate in the study, where I will collect information regarding your insights obtained from interviews for the research project. All this information will be treated confidentially. I will have sole access to the data, and it will be securely stored at UTS.

It is anticipated that the results of this research project will be published and/or presented in a variety of forums. In any publication and/or presentation, information will be provided in such a way that you cannot be identified, except with your permission.

Research findings may also be used to inform future research projects. In all instances, your information will be treated as confidential and stored securely.

In accordance with relevant Australian and/or NSW Privacy laws, you have the right to request access to the information about you that is collected and stored by the research team. You also have the right to request that any information with which you disagree be corrected. Please inform the research team member named at the end of this document if you would like to access your information.

The results of this research may also be shared through open access (public) scientific databases, including internet databases. This will enable other researchers to use the data to investigate other important research questions. Results shared in this way will always be de-identified by removing all personal information (e.g. name, address, date of birth etc.).

WHAT IF I HAVE ANY QUERIES OR CONCERNS?

If you have queries or concerns about the research please feel free to contact me:

Jason Graham-Nye Jason.Graham-Nye@student.uts.edu.au

You could also contact my supervisors:

Dr Nick Florin Nick.Florin@uts.edu.au
Dr Monique Retamal Monique.Retamal@uts.edu.au

You may also contact the UTS Ethics Committee through the Research Ethics Officer (02 9514 9772, Research.Ethics@uts.edu.au). Any complaint you make will be treated in confidence and investigated

fully and you will be informed of the outcome. If you need to confirm the identity of the researchers or would prefer to discuss a complaint or reservation with an independent local contact their details are listed below.

You will be given a copy of this form to keep.

NOTE:

This study has been approved in line with the University of Technology Sydney Human Research Ethics Committee [UTS HREC] guidelines. If you have any concerns or complaints about any aspect of the conduct of this research that you wish to raise independently of the research team, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au, and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

CONSENT FORM**UTS HREC REF NO. ETH21-5978 - Prospects for mainstreaming a compostable nappy service**

I _____ *[participant's name]* agree to participate in the research project being conducted by Jason Graham-Nye, Institute for Sustainable Futures, University of Technology Sydney 15 Broadway, Ultimo, NSW 2007, _____

I understand that funding for this research has been provided by the Australian Government.

I have read the Participant Information Sheet or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research as described in the Participant Information Sheet.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time without affecting my relationship with the researchers or the University of Technology Sydney [if applicable] or my organisation.

I understand that I will be given a signed copy of this document to keep.

I am aware that I can contact Jason Graham-Nye if I have any concerns about the research.

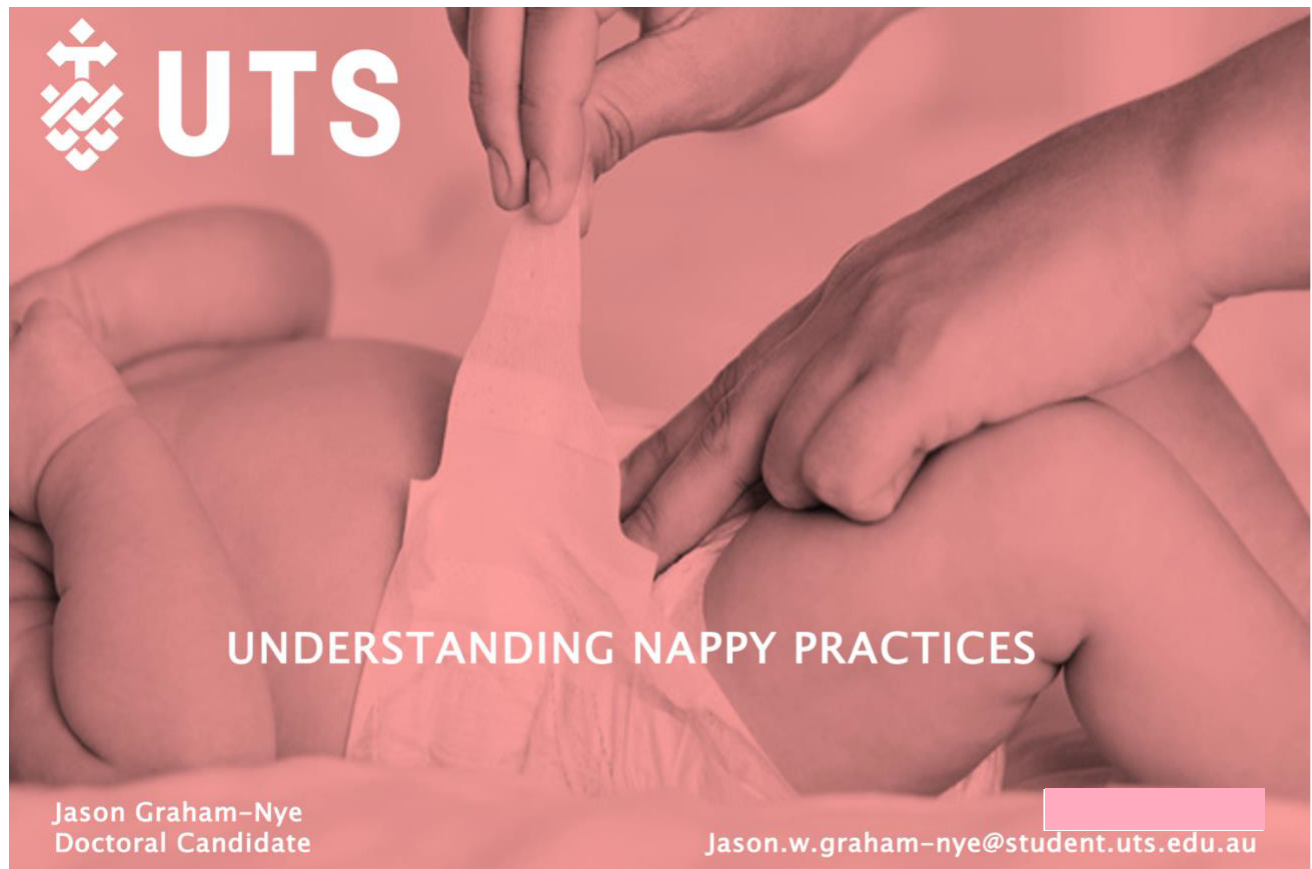
Name and Signature [participant]

____/____/____
Date

Name and Signature [researcher or delegate]

____/____/____
Date

Appendix B: Field introduction and user diaries



RESEARCH

I am exploring the barriers and enablers to more sustainable, nappy solutions by engaging all stakeholders connected to the practice of nappies.

STAKEHOLDERS:

- Councils & Regulators
- Waste Management Companies
- Supermarkets
- Childcare Centres
- Parents

Parents:

I am trying to understand a parent's day to day nappy practices. I am interested in how various elements of the practice interact and pose barriers or create enablers to alternative nappy solutions.

ELEMENTS:

- Product Performance
- Convenience & Disposal
- Habits & Norms
- Role of Care Givers / Childcare on the practice
- Price



A CIRCULAR SOLUTION

I have provided you with with nappies designed to be commercially composted along with compostable wipes and compostable nappy sacks.

A Circular nappy solution includes a nappy that is delivered, collected and then composted and the compost sold. The collection would typically be weekly and could be provided by your local Council or a private contractor.

The focus of this research is on the parents and the product rather than the collection service and composting. I am asking you to dispose of used nappies and wipes in the compostable sacks provided in order to simulate separating the used products from other garbage. However, I am also asking you to put the compostable sacks in your regular garbage bin for your usual weekly council garbage collection. For this research the nappies will be landfilled but please imagine that they are being collected and composted. Please use the compostable nappy sacks to bring used nappies home when you are out and about or when your little one is attending childcare.

Please use the compostable nappies and wipes as much as possible during the field trial. Please do not put other nappies or wipes in the compostable sacks. Please do not attempt to home compost the nappies or wipes.



THE DAILY NAPPY DIARY

In this research, I am hoping to gain an understanding of why participants would use or not use these kinds of nappies. I am also trying to record how using these nappies may or may not change the day-to-day habits of participants and how the product is or is not incorporated into daily life.

To achieve this, I am asking you to fill in the nappy diary at the end of each day over the next 7 days. Please record your honest feedback on the product, the process, and your reflections on the experience in the diary. Over- sharing is okay in here – the researchers won't be sharing it with anyone else!

If for any reason, you don't use the nappies some of the days (sickness, childcare, going away or one of a million other reasons) then please just record that in the diary. This is not meant to be a "stop everything to do this" but more a look at normal life and what issues emerge when introducing a new kind of nappy.

These are some suggested questions to help guide your entries each day:

- What elements of the nappy do you particularly like or not like?
- How did the nappies work with other materials?
- Did certain events get in the way of making the nappies work?
- Were there any incidences with other family members or carers related to the nappies?

DAILY NAPPY DIARY – DAY ONE

| Number of nappies changed | Who changed the baby? | Where was the baby changed? | Comments & Reflections |
|------------------------------------|-----------------------------|-----------------------------------|------------------------|
| | | | |

DAILY NAPPY DIARY – DAY TWO

| Number of nappies changed | Who changed the baby? | Where was the baby changed? | Comments & Reflections |
|---------------------------|-----------------------|-----------------------------|------------------------|
| | | | |

DAILY NAPPY DIARY – DAY THREE

| Number of nappies changed | Who changed the baby? | Where was the baby changed? | Comments & Reflections |
|------------------------------------|-----------------------------|-----------------------------------|------------------------|
| | | | |

DAILY NAPPY DIARY – DAY FOUR

| Number of nappies changed | Who changed the baby? | Where was the baby changed? | Comments & Reflections |
|------------------------------------|-----------------------------|-----------------------------------|------------------------|
| | | | |

DAILY NAPPY DIARY – DAY FIVE

| Number of nappies changed | Who changed the baby? | Where was the baby changed? | Comments & Reflections |
|------------------------------------|-----------------------------|-----------------------------------|------------------------|
| | | | |

DAILY NAPPY DIARY – DAY SIX

| Number of nappies changed | Who changed the baby? | Where was the baby changed? | Comments & Reflections |
|---------------------------|-----------------------|-----------------------------|------------------------|
| | | | |

DAILY NAPPY DIARY – DAY SEVEN

| Number of nappies changed | Who changed the baby? | Where was the baby changed? | Comments & Reflections |
|---------------------------|-----------------------|-----------------------------|------------------------|
| | | | |

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