

Creating a Sustainable Future through the Development of a Behaviour Change Framework

by

Kara Smit



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Supervisor: Dr. J. Stimie

Co-supervisor: Prof. C. Schutte

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Declaration

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Abstract

Creating a Sustainable Future through the Development of a Behaviour Change Framework

Rapid urbanization is taking place in South Africa and so is the need for affordable, healthy, sustainable housing and infrastructure. There is currently a great shortage of housing in South Africa, and a need exists to build new houses. However, the buildings and infrastructure assets the industry constructs account for a considerable portion of global greenhouse gas emissions, which is one of the biggest causes of climate change. Additionally, residents also have a large impact on the environment.

When considering the rising population increase and the need for urban housing developments, it is evident that innovative measures need to be put in place to contain and curb global warming as well as other sustainability problems. It is known that the cause of environmental challenges, such as climate change, can be pinned down to unsustainable patterns of human activity. Thus, the primary objective of this study is the development of a Sustainable Living Behaviour Change Framework (SLBCF) that can be used to optimize sustainable living within the context of institutionally owned rental estates.

In support of the primary objective a number of secondary objectives are also pursued. Firstly, the research aims to give definition to the South African urban housing landscape and the urban housing requirements for 2030. The focus secondly shifts to an in-depth analysis of the environmental impact of housing developments, and which are the main contributing factors. In the pursuit of this secondary objective, the residential building life cycle needs to be evaluated. The third secondary objective is to present the most prevalent and applicable findings of contemporary debates and emerging themes regarding behaviour change. The fourth secondary objective is to present the SLBCF. The final secondary objective of this study is to validate the framework. The conclusion reached at the end of the study is that the SLBCF when used as recommended, will indeed optimize sustainable living within the context of institutionally owned rental estates.

Opsomming

Die Skep van 'n Volhoubare Toekoms deur die Ontwikkeling van 'n Gedragsveranderingsraamwerk

("Creating a Sustainable Future through the Development of a Behaviour Change Framework")

Snelle verstedeliking in Suid-Afrika gee aanleiding tot 'n dringende behoefte aan bekostigbare, geskikte en volhoubare behuising, asook behoorlike infrastruktuur. Die groot behuisingstekort in Suid-Afrika genoodsaak gevolglik behoorlike behuising. Uitbreiding van die konstruksiebedryf, maak egter 'n aansienlike deel van die wêreldwye kweekhuisgasvrystelling uit, wat een van die belangrikste oorsake van klimaatsverandering is. 'n Ander bydraende faktor wat ook 'n nadelige uitwerking op die omgewing het, is die inwoners self.

Word die groter toename in bevolkingsaanwas asook die behoefte aan die ontwikkeling van stedelike behuising in ag geneem, dan is dit duidelik dat innoverende maatreëls ingestel moet word om aardverwarming sowel as ander volhoubaarheidsprobleme, te bekamp. Dit is algemeen bekend dat menslike aktiwiteite en optrede as oorsake vir omgewingsuitdagings soos klimaatsverandering, aangevoer kan word. Die primêre doel van hierdie studie is dus die ontwikkeling van 'n Volhoubare Gedragsveranderingsraamwerk wat beskikbaarstelling van verhuringskomplekse deur ontwikkelaars sal verseker wat dan optimaal benut moet word.

Ter ondersteuning van die primêre doelstelling word 'n aantal sekondêre doelstellings ook nagestreef. Eerstens het die navorsing ten doel om definisie te gee aan die Suid-Afrikaanse stedelike behuisinglandskap asook vereistes vir stedelike behuising vir 2030. Daarna verskuif die fokus na 'n indiepte-ontleding van die omgewingsimpak as gevolg van behuisingontwikkeling en wat die belangrikste bydraende faktore is. In die strewende na hierdie sekondêre doelwit, moet die lewensduur van residensiële geboue ge-evalueer word. Die derde sekondêre doel is om die mees algemene en toepaslike bevindings van hedendaagse debatte en toekomstige temas rakende gedragsverandering, aan te bied. Die vierde sekondêre doel is om die Volhoubare Gedragsveranderingsraamwerk aan te bied. Die finale doel van hierdie studie is die uitvoering daarvan. Daar is tot die gevolgtrekking gekom dat die Volhoubare Gedragsveranderingsraamwerk, soos aanbeveel, gevolg sal word om volhoubaarheid van verhuringskomplekse van institusionele eienaars te optimaliseer.

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List of Abbreviations

ABC	Antecedent Behaviour Consequence
ASGISA	Accelerated and Shared Growth Initiative for South Africa
ANC	African National Congress
BCMM	Behaviour Change Management Model
CO ₂	Carbon Dioxide
CFA	Conceptual Framework Analysis
DOI	Diffusion of Innovation
Gt CO ₂ e	Gigatonnes of Equivalent Carbon Dioxide
CPS	Cyber Physical Systems
CSIR	Council for Scientific and Industrial Research
EVT	Expectancy Value Theory
FIR	Fourth Industrial Revolution
GBCSA	Green Building Council of South Africa
GEAR	Growth, Employment and Redistribution
GHG	Green House Gasses
GMST	Global Mean Surface Temperature
HBM	Health Belief Model
IU	Infrastructure and Urban Development
IUDF	Integrated Urban Development Framework
MSAT	Global Mean Land Surface Air Temperature
NDP	National Development Plan
RBLC	Residential Building Life Cycle
RDP	Reconstruction and Development Programme
SLBCF	Sustainable Behaviour Change Framework
SoC	Stages of Change Model
SPT	Social Practice Theory
TBL	Triple Bottom Line
TPB	Theory of Planned Behaviour
UN	United Nations

Chapter 1

Introduction

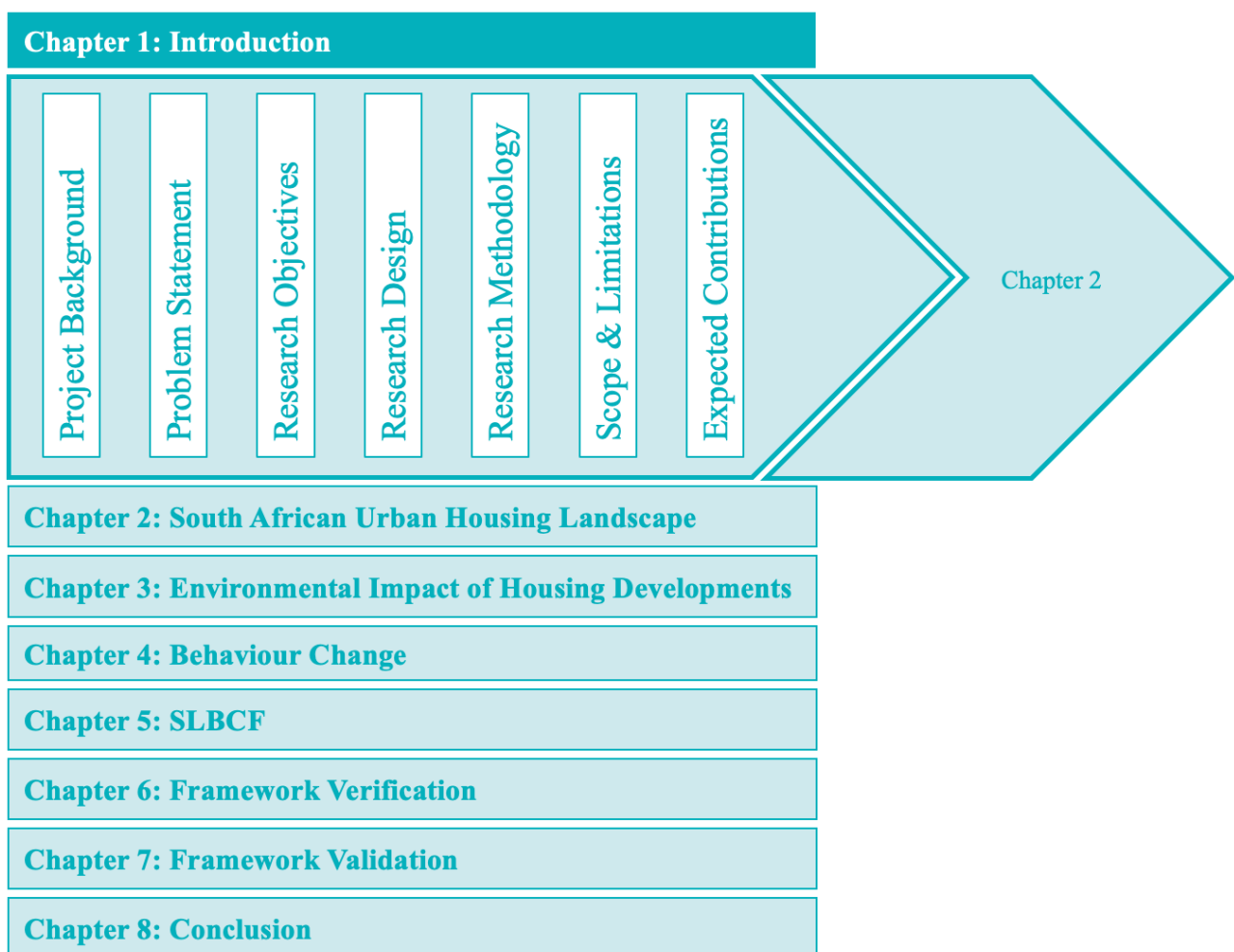


Figure 1.1: Chapter 1 Outline

The objective of this chapter is to introduce the research undertaken. The outline of Chapter 1 is presented in Figure 1.1. The chapter commences with a brief background which leads to the problem statement and the research objectives. Thereafter the research design and methodology is presented

followed to address the identified problem. Finally, the chapter concludes with the scope, limitations and expected contributions of this study.

1.1 Project Background

South Africa is currently faced with many challenges that could impact the well-being of society. These challenges include climate change, resource scarcity and rapid urbanization. People are daily migrating to urban areas, where they need affordable, healthy, sustainable housing and infrastructure. Thus, there is currently a great shortage of housing in South Africa, and a need exists for building new houses. However, the buildings and infrastructure assets the industry constructs account for a considerable portion of global greenhouse gas (GHG) emissions, which is one of the biggest causes of climate change (Stimie, 2018). Additionally, residents also have a large impact on the environment. Influencing factors include fuel consumption, waste and high electricity consumption.

This section elaborates more on the factors mentioned. Firstly, urbanisation and the need for sustainable housing will be introduced. Secondly, the sustainability problem will be presented followed by environmental change and global warming that the world is currently facing. Lastly, behaviour change and how it can be used to impact environmental change will be presented in this chapter.

1.1.1 Urbanisation and Sustainable Housing

The human population is daily increasing with a rapid speed. According to the Worldometer¹, the world population is expected to increase from the current 7.8 billion to about 9 billion around 2050. It is reported that the population growth in Africa is among the highest in the world and increasing at a rapid pace (Vlek and Steg, 2007). Additionally, every person needs a space to live in and is entitled to certain materials to ensure development. Roux *et al.* (2018) argues that high levels of population expansion is resulting in urbanisation increasing at a rapid pace. Most of South Africa's population lives in urban centres. This growing population places immense pressure on the infrastructure of major cities. An increase in population growth results in a need for new housing developments. Roux *et al.* (2018) mentions that the number of building plans approved increases yearly. The consumption of operational energy by buildings has the single largest impact on the environment. It is therefore of vital importance to ensure future sustainability of these growing urban settlements (Roux *et al.*, 2018).

1.1.2 The Sustainability Problem

Many years ago, the first official public use of the word *sustain* was used by the Germans and Swiss with sustainable forestry. The aim was to keep the forest productive over a long time. A similar philosophy was used for sustainable fisheries. After that, during the 1960's up until the

¹Worldometer: Worldometers.info is run by an international team of developers, researchers, and volunteers with the goal of making world statistics available in a thought-provoking and time relevant format to a wide audience around the world (Worldometer).

1970's, the term *sustainable* was extended to refer to the need to sustain the environment as well as human society (Kushlin *et al.*, 2003). The United Nations (UN) was a critical role player during the facilitation of the international debate on sustainability. During their time of leading, many initiatives and commitments were undertaken by member countries. A meeting was held in Sweden during 1972, where the governments gathered for the United Nations Conference on the Human Environment (Borowy and Schmelzer, 2017). During this conference, concerns were raised about development and environmental challenges. It was established that there is a great need for environmental protection while in other parts of the world extreme poverty was a problem and there is a need for economic deployment (Borowy and Schmelzer, 2017). According to Borowy and Schmelzer (2017) finding a balance between these seemingly opposing objectives complicated the achievement of sustainable development goals.

Morelli (2011) defines environmental sustainability as a condition of balance, resilience, and interconnectedness. This allows society to satisfy its needs without exceeding the capacity of its supporting ecosystem to continue regenerating the service needed to meet those needs. Over the past fifty years human behaviour has changed vital ecosystem services more rapidly than in any other period in history. As human population continues to grow, material consumption intensifies and production technology further increases. Consequently, the quality and quantity of environmental resources steadily decreases Vlek and Steg (2007). The concern regarding shortages in freshwater availability, loss of biodiversity, global warming and urban air pollution remains. It is evident that human settlements and road infrastructure are proliferating in rapidly urbanizing areas throughout the world.

Whether sustainability is considered as a 3-legged table with the legs representing the environment, the economy and society, or as a dualistic relationship between the ecosystems and the humans inhabiting it, there should at least be agreed that it is of vital importance to ensure the provision of clean water, clean air and that productive land is a necessity for a responsible socio-economic system. It is apparent, that in a world where there is no sustainable productive environment that provides a resource foundation, it is almost impossible to have a sustainable society. Additionally, a sustainable economy is very dependent on a sustainable income of energy, material and environmental resources. Alternatively, without it, economic systems will collapse.

1.1.3 Environmental Change and Global Warming

Global warming² occurs when carbon dioxide CO₂ and other air pollutants or greenhouse gases collect in the atmosphere and absorb sunlight and solar radiation that have bounced off the earth's surface. Usually, the radiation would escape into space, however these pollutants, which can last up to centuries in the atmosphere, trap the heat and causes the planet to get hotter. This is also known as the greenhouse effect (Bebbington *et al.*, 2014). The burning of fossil fuels in order to make electricity is one of the largest source of heat-trapping pollution, producing up to two billion tons of CO₂ per year. As a result, coal-burning power plants are by far the biggest polluters. The second second-largest source of carbon pollution is the transportation sector. This sector generates about 1.7

²Global Warming: It refers to the increase of global mean surface temperature with respect to the pre-industrial period (1850-1900) (Haustein *et al.*, 2017).

billion tons of CO₂ emissions per year (Bebbington *et al.*, 2014).

Yearly, more research discoveries are made regarding global warming. With the new knowledge gained, it became evident that environmental, economic, and health consequences are likely to occur if current trends continue. According to Bebbington *et al.* (2014) these consequences that are linked to global warming include:

1. Melting glaciers, early snow-melt, as well as severe droughts could cause dramatic water shortages and increase the risk of wildfires;
2. Rising sea levels could lead to coastal flooding;
3. Forests, cities, and farms could face heat waves, heavy downpours and increased flooding. All these factors can destroy agriculture and fisheries;
4. Disruption of habitats such as coral reefs could drive various plant and animal species to extinction.
5. Allergies, asthma, and infectious disease outbreaks will be more common due to increased growth of pollen-producing ragweed, higher levels of air pollution, and the spread of conditions favourable to pathogens and mosquitoes.

This calls for adaption and mitigation innovative measures in order to contain and curb global warming. Curbing dangerous climate change will require deep cuts in emissions, as well as the use of alternatives to fossil fuels. The ways in which new measure can be used to curb global warming includes new energy-efficient technology and the use of cleaner fuels; also new policies and interventions should be put in place to reduce carbon emissions in all sectors of life. As scientists continue to develop new ways to modernize power plants, consume less fuel while driving and generate cleaner electricity, the challenge is to ensure solutions are put to use and widely adopted. Thus, human behaviour needs to be addressed and ways in which to change human behaviour should be researched and implemented.

It is important to note that this section only briefly discusses causes of global warming and methods in which this problem can be addressed. However, in Chapter 3 and 4 a more in-depth study will be done regarding these topics.

1.1.4 Behaviour Change to Impact Environmental Change

When considering the rising population increase and the need for urban housing developments, it is evident that innovative measures needs to be put in place to contain and curb global warming as well as other sustainability problems. It is known that the cause of environmental challenges, such as climate change, can be pinned down to unsustainable patterns of human activity. Thus, large-scale changes are needed in every sector of society in order to make a change to the current trend that is followed (Hargreaves, 2011).

In order to bring a change to the sustainability crisis the world is facing, changes need to be made to the human activities that are causing this. Several methods to promote pro-environmental behaviour and sustainable consumption have been attempted. However, it has been questioned whether these pro-environmental and sustainability consumption behaviour change frameworks are effective or not. Thus, there is still a need for an effective framework that can be used to optimize sustainable behaviour.

1.2 Problem Statement

In light of the rapid increase in population and urbanisation, it is clear that at some point urban housing developments will increase. With the increase in urbanisation and urban housing developments, the carbon footprint left by residents of these new houses will also increase if no changes are made.

The problem is that there is no efficient method available that could be used to change unsustainable behaviour within the context of institutionally owned rental estates³. Thus, there is a need for the development of a Sustainable Living Behaviour Change Framework (SLBCF) to optimize sustainable living within the context of institutionally owned rental estates.

This opportunity to develop a SLBCF for constitutionally owned rental estates could assist introducing the residential industries' carbon footprint, also general damages to the environment can be minimised. Additionally, this framework could act as a guide for property developers, property owners and end-users, in order to reduce the carbon footprint, and encourage overall better sustainable behaviour.

1.3 Research Objectives

This research aims to develop a Sustainable Living Behaviour Change Framework which will contribute to optimize sustainable living within the context of institutionally owned rental estates. Table 1.1 summarises the research problem, primary and secondary objectives and also the subsequent research questions. Table 1.1 serves as a guideline for the layout of the research project. The objectives for each chapter will be stated at the beginning of the chapter to set the scope for the chapter.

³Institutionally owned rental estate (Verhuuringskomplekse met institusionele eienaars): It refers to where an estate's majority shareholder or sole owner is an institutional investor such as a mutual fund, insurance company, closed-end investment company, or something else. Rental estate refers to homes that are purchased by this investor and inhabited by tenants on a lease or other type of rental agreement.

Table 1.1: Research Objective Overview

Problem Statement	Primary Objectives	Secondary Objectives	Research Question Structure	Doc Structure
The problem is that there is no efficient method available that could be used to change unsustainable behaviour within the context of institutionally owned rental estates. Thus, there is a need for the development of a Sustainable Living Behaviour Change Framework (SLBCF) to optimize sustainable living within the context of institutionally owned rental estates.	Describe the scope of the South African Urban Housing Landscape	Define the South Africa Urban Housing Landscape	Which policies and interventions has the government implemented in order to address the problem at hand?	2.1
		Determine the scope of the Urban Housing Requirements for 2030	What is the average growth rate of the level of urbanisation?	2.2
	What is the average growth rate of the need for houses in SA?			
	Establish the Environmental Impact of Housing Developments	Describe the Residential Building Life Cycle	What are the stages of the residential building life cycle?	3.1
			Which are the main contributing factors to unsustainability?	3.1.2
	Present a Framework of the most Prevalent and Applicable Findings of Behaviour Change Theory to this Study	Define Behaviour Change Theory	How can Individual Behaviour Change theories be incorporated in to the SLBCF?	4.1.1
			How can Social Behaviour Change theories be incorporated in to the SLBCF?	4.1.2
			How can Integrated Behaviour Change frameworks be incorporated in to the SLBCF?	4.1.3
		Define Motivation Theories	How can Need-Based theories be incorporated in to the SLBCF?	4.2.1
			How can Reward-Based theories be incorporated in to the SLBCF?	4.2.2
		Define Gamification	What is gamification?	4.3.1
			How can meaningful gamification be created?	4.3.2
			How has gamification been incorporated in the real-world?	4.3.3
	Candidate Solution	What is the candidate solution that should be used in corporation with the SLBCF?	4.4.1	
	Present a Sustainable Living Behaviour Change Model	Define the proposed SLBCF	What does the SLBCF consist of?	5.1
		Describe the SLBCF Execution Process	Which elements of Behaviour Change theories and debates will be incorporated?	5.2
	Which artefacts will be used in corporation with the SLBCF?			
	Model Validation	Define the Validation Design Methodology	What validation design methodology will be used?	7.1
Get the Opinion of Industry Expert		Is the characteristics of the SLBCF realistic and applicable to the industry?	7.2	
Adjust SLBCF		How is the SLBCF affected after validation changes?	7.3	

Document Structure

Chapter 2 investigates the South African Urban Housing Landscape. Firstly, an overview will be presented of the Urban Housing Landscape as well as policies that were implemented that address the sustainability issue in South Africa. The chapter concludes with the urban housing requirements for 2030.

Chapter 3 investigates the impact housing developments has on the environment. In this chapter the environmental impact of housing developments during the total lifecycle is described in more detail. Each lifecycle will be presented and described in more detail. As a result, the burning platforms of where change is needed can be identified. Additionally, factors of unsustainable behaviour patterns can be targeted.

Chapter 4 investigates different theories of behaviour change. The primary objective of this chapter is to present a framework of the most prevalent and applicable findings of behaviour change theory to this study. Firstly, an overview of behaviour change theory and the evolution of these theories will be presented. Secondly, three individual behaviour change theories will be presented. Thirdly, two social behaviour change theories will be presented and fourthly, an integrated theory of behaviour change. Thereafter, theories of motivation will be addressed. Need-based theories and reward-based theories are examples of motivation theories and will be presented in this chapter. Lastly, gamification will be defined.

Chapter 5 introduces the Sustainable Living Behaviour Change Framework (SLBCF) which will be used to optimize sustainable living within the context of institutionally owned rental estates. In the first part of this chapter, the five phases of the framework will be introduced. Secondly, the framework's artefacts will be presented and discussed.

Chapter 6 verifies that all the requirements produced throughout the literature study have been added to the conceptual framework.

Chapter 7 validates the SLBCF. Interviews were held with subject matter experts in the industry. This leads to a revised and updated version of the framework at the end of Chapter 7.

Chapter 8 concludes the research study and proposes future research avenues.

1.4 Research Design

This section will explore the meaning of a conceptual framework and how it can be incorporated into the research design. The goal is to gain a better understanding of the aspects that help build research and how to successfully address the most important objectives of this study. In this section, the research frameworks that will be considered are theoretical and conceptual.

There are numerous different definitions used for the development of a conceptual framework for business and management research. Jabareen (2009a) defines a *conceptual framework* as 'a network, or a plane, of interlinked concepts that together provide a comprehensive understanding of a phenomenon or phenomena' (p. 51). With this definition in mind, we are enabled to combine different concepts into a conceptual model or framework. This allows for the interconnectedness of information and concepts to be displayed, also it serves as a foundation for further theory building (Anderson et al., 2017).

A framework takes the ontological⁴ and epistemological⁵ context into account. A framework is usually evaluated against the data that is collected while studying a phenomena. Any distinctions can be used as justification to reference multiple theories, concepts or models to explain a phenomena (Anderson et al., 2017). As a result, when referencing more than one model, it is seen as the starting point of the synthesis of a new developed framework (Imenda, 2014). This represents the multidisciplinary and integrated approach to the research study. Finally, the conceptual framework can then replace the theoretical framework after extensive validation (Anderson et al., 2017).

Figure 1.4 represents a summary of the differences between a theoretical and a conceptual framework:

⁴Ontological: Ontology focuses on describing the phenomena and its underlying interactions (the study of reality)

⁵Epistemological: It focuses on describing different ways of understanding the phenomena (the study of knowledge)

Table 1.2: Theoretical vs. Conceptual Framework, reproduced from Imenda (2014)

	Theoretical Framework	Conceptual Framework
Origin	Adapted from data gathering and reviewed literature.	Built from a variety of theoretical and conceptual perspectives. Adapted from existing theoretical perspectives.
Goal	Assists in highlighting the main concepts and variables in the research. Gives a general approach for research and design. Gives direction on how to collect, interpret and explain data.	Focuses on the main concepts and variables in the research. Gives a general approach for research and design. Gives direction on how to collect, interpret and explain data. Gives guidance for future research.
Scope	Broader application beyond the current context and research problem at hand.	Restricted to the context of the specific research problem.
Conceptual Meaning	Partial or complete application of a theory.	Integration of concepts that are relevant.
Research Approach	Mainly impartial, particularly where hypothesis testing happens.	Presenting early concept, particularly where research problem is not easily explainable through the use of only one theoretical perspective.
Methodological Approach	Mostly quantitative research. Experimental designs, empirical surveys and tests are used. Attempts to standardize context.	Both qualitative and quantitative research are used. Empirical and descriptive surveys, direct observations and interviews are incorporated. Priority is placed on the context

Based on what was mentioned in the research objectives from Section 1.3 and the summary reproduced Imenda (2014), it becomes clear that the research study will develop a conceptual framework. Jabareen (2009b) defines the main features of a conceptual framework as follows:

- A conceptual framework is not just a collection of concepts, but rather, the concepts play an integral role in the construct;
- A qualitative analysis can be used to develop the conceptual framework;
- A conceptual framework provides understanding;

- Not only does a conceptual framework provide an analytical setting, but it also gives an interpretative approach to social reality;
- Conceptual frameworks do not allow us to predict an outcome;
- Lastly, a conceptual framework provides soft interpretations of intentions, rather than knowledge of hard facts.

1.4.1 Developing a Conceptual Framework

For the purpose of this study, the technique developed by Jabareen (2009b) was found to be applicable and will be used in this study. The data that will be used for this study should be effective in representing the relevant social, political, cultural, and environmental phenomenon, and the multidisciplinary literature that focuses on the phenomenon of the study in question. The data should also represent practices that are related to the phenomenon. Thus, data should be gathered from a variety of sources such as articles, interviews, books and practices (Jabareen, 2009a). Jabareen (2009a) states that the process of conceptual framework analysis is both comparative and iterative. It requires a careful movement between data and concepts as well as a comparison across evidence to control the scope of the emerging theory.

The following procedure, according to Jabareen (2009b) should be followed and consists of the following phases:

Phase 1: Mapping the selected data sources

Firstly, the spectrum of multidisciplinary literature needs to be mapped. This is done by a comprehensive review of multidisciplinary texts. The data collection should be all-inclusive and complete to facilitate a holistic mapping to ensure validity.

Phase 2: Extensive reading and categorising the selected data

Secondly, the researcher reads the selected data and categorises it by discipline, the scale of importance and representative power within each discipline. Furthermore, this process will maximise the effectiveness of the inquiry and ensure the successful representation of every discipline.

Phase 3: Identifying and naming the concepts

The third phase aims to read and reread the selected data in order to discover the concepts. The outcome is a list of concepts that are competing and occasionally contradicting.

Phase 4: Deconstructing and categorising the concepts

The fourth phase aims to deconstruct the concepts discovered in phase three. In the process of deconstruction, it is critical to identify the main attributes, assumptions, characteristics and role of the concepts. The concepts can then be categorised according to their features and, ontological, methodological and epistemological roles.

Phase 5: Integrating the concepts

In the fifth phase, concepts with similarities are grouped to reduce the number of concepts to a acceptable amount.

Phase 6: Synthesis, resynthesis, and making it all make sense

The researcher now synthesises the concepts into a theoretical framework. This requires the researcher to be open, tolerant and flexible with theorisation as the iterative process of synthesis and resynthesis continues up until a general theoretical framework makes sense.

Phase 7: Validating the conceptual framework

In the seventh phase, the researcher must validate the conceptual framework by seeking feedback from subject matter experts. The goal is to determine whether the framework and concepts make sense to other scholars and practitioners.

Phase 8: Rethink the conceptual framework

Lastly, since the theoretical framework will always be dynamic, it may be revised according to new insights, literature, comments, and so on.

This method proposed by Jabareen (2009a) follows a logical order and was thus used by the researcher. More detail will be provided regarding the implementation of this method in Section 1.5.

1.4.2 Validation of the Research Study

The SLBCF as well as the implementation methodology was presented to industry experts. The knowledge gained from the expert interviews was used to reassess the framework and improve it where necessary. Caution was taken not to adapt the framework to something so radical that it requires a second validation phase.

1.5 Research Methodology

The research conducted in this study has a qualitative nature and the chosen methodology that will be used is based on the Conceptual Framework Analysis (CFA), as proposed by Jabareen (2009a). The eight phases in the CFA process were addressed in specific sections of this study. Table 1.3 illustrates which phase is addressed in which section of this study.

Table 1.3: Research Methodology Overview

CFA Phase	Section or Chapter in Study
Phase 1	Project Background (Section 1.1)
Phase 2	Problem Statement (Section 1.2), Literature Review (Chapter 2,3,4)
Phase 3	Research Objectives (Section 1.3), Researching existing frameworks (Chapter 4)
Phase 4	Conceptual Framework Draft (Section 4.4.1, Chapter 5)
Phase 5	Refining Conceptual Framework (Chapter 5)
Phase 6	Refining Conceptual Framework (Chapter 5)
Phase 7	Verification of Conceptual Framework (Chapter 6)
Phase 8	Validate Conceptual Framework (Chapter 7)

During the initial phase of this study, the main aim was to get a broader perspective and understanding of the literature landscape surrounding the theme of behaviour change. Additionally, research was done on the housing landscape of South Africa and the environmental impact of housing developments. During this phase of the study, the problem definition was defined as well as the research objectives. Additionally, the overview of the literature study was defined.

The second phase of this study focused on a more in depth investigation of literature and the development of a preliminary framework. The literature investigations were based on the knowledge gained in the first part of the research. From this in depth investigation of current theories and frameworks, a preliminary framework was developed for further review and validation.

Lastly, the aim of the validation was to prove the accuracy of the framework as well as to test if it is applicable within its context. After the validation, the knowledge gained from the industry expert interviews was used to update and refine the framework.

1.6 Scope and Limitations of Research Study

The main objective of this study is to develop a Sustainable Living Behaviour Change Framework (SLBCF) to optimize sustainable living specifically within the context of **institutionally owned rental estates**.

During the initial phases of the research done in Chapter 4, numerous topics and behaviour change theories were investigated but could not be included in the scope of the study. Some behaviour change frameworks were briefly investigated, however, the depths of the frameworks could not be included in the scope of this study. These theories and frameworks include:

- The Social Cognitive Theory;
- Social Norms Theory;
- Hertzberg's Two Factor Theory;
- Vroom's Theory of Expectancy and

- McGregors Theory X and Theory Y.

Additionally, the framework consists of much detail and there is still so much that could have been added to further define and advance the framework. The following topics were identified, but not included in the final scope:

- Detailed discussion of the construction stage, maintenance and management stage and the dissolution and disposal stage.
- Addressing of the uncontrollables of the residential building life cycle and incorporating them into the framework.
- Detailed screening audit mechanism of the SLBCF.

1.7 Expected Contributions

As mentioned in Section 1.2, the SLBCF can guide property developers, property owners and end-users, in order to reduce their carbon footprint, and encourage overall better behaviour in light of sustainability for institutionally owned rental estates. This could result in estate-wide carbon reduction, increased sustainability by increasing carbon output awareness. Furthermore, this framework can further be used for any behaviour change that is desired by property owners. For example, behaviour change can be encouraged when looking at *on-time* payments of invoices and good resident behaviour.

Chapter 2

The South African Urban Housing Landscape

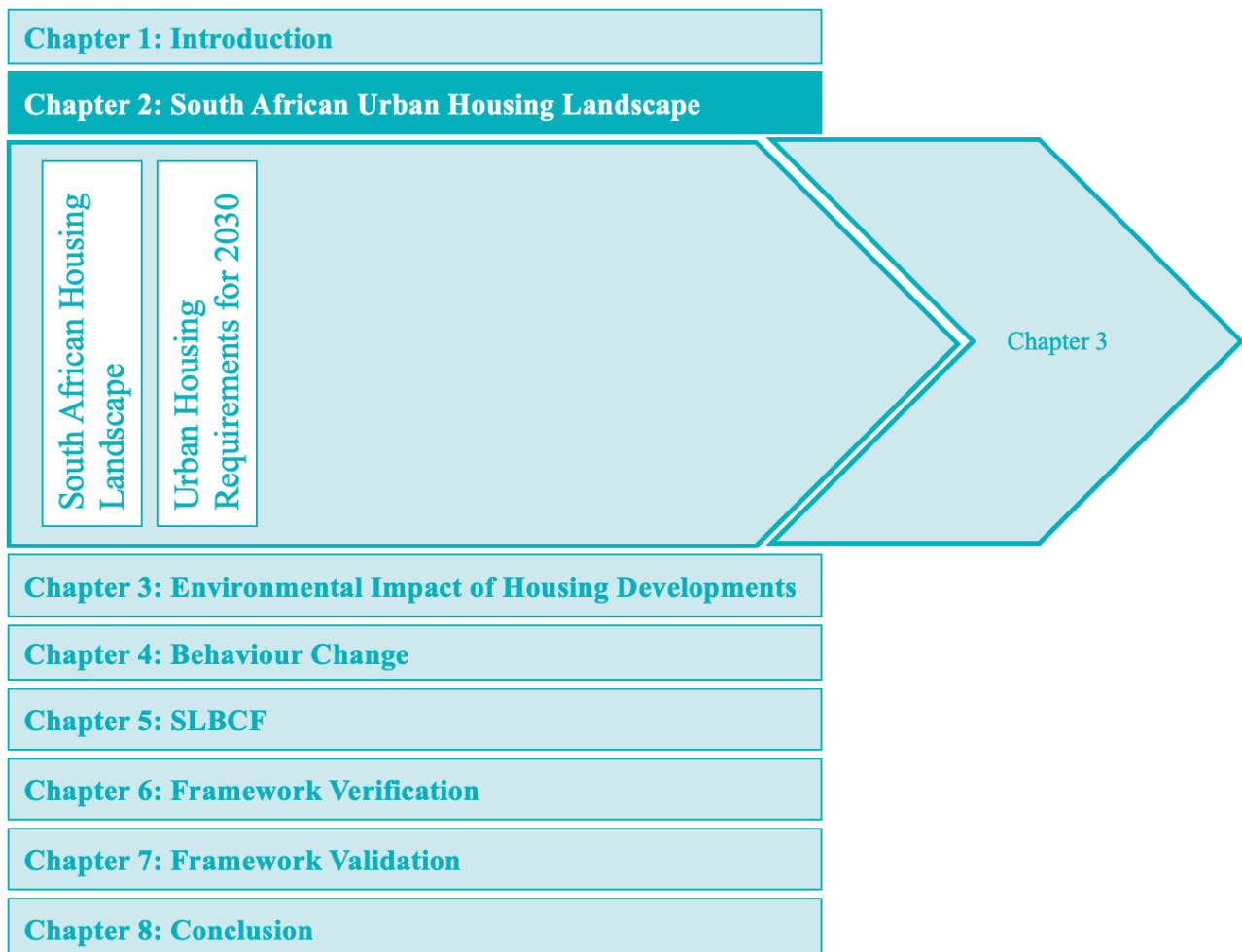


Figure 2.1: Chapter 2 Outline

Table 2.1: Chapter 2: Research Objective Overview

Problem Statement	Objective Hierarchy	Sub Objectives	Research Question Structure	Doc Structure
The problem is that there is no efficient method available that could be used to change unsustainable behaviour within the context of institutionally owned rental estates. Thus, there is a need for the development of a Sustainable Living Behaviour Change Framework (SLBCF) to optimize sustainable living within the context of institutionally owned rental estates.	Describe the scope of the South African Urban Housing Landscape	Define the South Africa Urban Housing Landscape	Which policies and interventions has the government implemented in order to address the problem at hand?	2.1
		Determine the scope of the Urban Housing Requirements for 2030	What is the average growth rate of the level of urbanisation?	2.2
			What is the average growth rate of the need for houses in SA?	

The primary objective of this chapter is to describe the scope of the South African Urban Housing¹ Landscape. Thus, the South African Landscape will be presented in more detail. Policies and interventions that are implemented addressing the sustainability issue in South Africa will be presented. The chapter concludes with the second primary objective of this chapter namely the urban housing requirements for 2030. Table 2.1 displays the objectives of this chapter as stated in Section 1.3.

2.1 South African Housing Landscape

South Africa is currently faced with many challenges that could impact the well-being of society. These challenges include climate change, resource scarcity and rapid urbanization. According to the World Economic Forum, 200,000 people in the world are daily migrating to urban areas, where they need affordable, healthy, sustainable housing and infrastructure. However, the buildings and infrastructure assets the industry constructs account for a considerable portion of global greenhouse gas (GHG) emissions, which is one of the biggest causes of climate change. Additionally, the industry is the largest consumer of raw materials, further depleting the world's scarce resources (Stimie, 2018).

After coming to power in April 1994, the ANC promised that a democratic state would act to navigate the mixed economy on a new economic growth path through different macro-economic policies. The first significant attempt at creating a policy framework was a document titled the Reconstruction and Development Programme (RDP). The RDP was the political declaration of the ANC during its election campaign for the first democratic elections in South Africa in 1994 and would be used as the framework for the transition to a democratic state. Nation building as well as improving the living standards of all South Africans citizens through a local government sphere is at the core of the RDP (Stats SA, 2017). Williams (2006) is of the opinion that housing is one of the primary targets of the RDP, with the aim to build more than one million houses in five years, and to provide electricity and water to households.

Williams (2006) is of the opinion that subsequent to the RDP, the ANC government has developed additional macro-economic frameworks, which include:

¹Urban Housing: A safe and affordable rental option that allows for easy and safe commuting.

1. Growth, Employment and Redistribution (GEAR) - 1996
2. Accelerated and Shared Growth Initiative for South Africa (ASGISA) - 2005
3. National Development Plan (NDP) - 2012

Every one of these macro-economic frameworks did make a contribution in creating a better life for all South Africans. However, according to Ansari (2017), the ANC government has greatly failed to deliver on the two decades of promises of industrialization and economic redistribution. This resulted in unmet expectations, which was created by these policies and the waves of service delivery protests across South Africa. Service delivery protests are mostly caused by the lack of access to basic services, including access to water, sanitation, electricity, refuse removal and basic housing.

2.2 Urban Housing Requirements for 2030

Housing is one of the largest challenges the South African government has to overcome. According to Stats SA (2017) there were 51.8 million people living in 14.5 million households in 2011 in South Africa. Research done by Stats SA (2017), estimates that the South African population will grow to 70 million people by 2030. 70% of these people will be urbanized. Figure 2.2 illustrates the estimated increasing growth of the level of urbanisation as well as the need for urban houses in 2030.

Table 2.2: Key South African Demographic Realities, reproduced from Stats SA (2017)

	2001	2011	2018	2030
Total Population	44.9 mil	51.8 mil	55.9 mil	70 mil
Average Size of Household	3.57	3.57	3.57	3.57
Total Number of Household	12.5 mil	14.5 mil	15.6 mil	19.6 mil
Level of Urbanisation	57%	62%	66%	70%
Need for Urban Houses	7.1 mil	8.9 mil	10.2 mil	13.7 mil

The department of human settlements identified four housing categories, *formal dwelling*; *traditional dwelling*; *shack not in backyard* and *shack in backyard* (Stats SA, 2017). Figure 2.3 displays the changes in the distribution of households per housing category in the period 2001 to 2018.

Table 2.3: Household per Housing Category, reproduced from Stats SA (2017)

Housing Category	2001	2011	2018
Formal dwelling	64%	74%	81%
Traditional dwelling	15%	8%	6%
Shack not in back yard	12%	9%	8%
Shack in back yard	4%	5%	5%
Total households living in informal dwelling	2 mil	2 mil	2.1 mil

During the period between 2001 and 2011 the private sector constructed around 660000 new housing units. Although the number of households living in a formal dwelling increased by more than 3,5 million between 2001 and 2011, there were still no less than 2 million households in 2011 living in an informal settlement or a shack. In the period 2014 to 2018 an additional 410000 low-cost houses were build. The former Minister of Human Settlements, Nomaindia Mfeketo confirmed in 2018 that although some progress has been made regarding the delivery of more low-cost houses the backlog of low-cost homes are still almost 2,1 million.

Between 2001 to 2011 the proportion of South African households that rent their primary houses or dwellings increased from 19% to 25%. In urban areas, it increased from 26% in 2001 to 32% in 2011 (Eisenhardt and Graebner, 2007). The above mentioned statistics will be used to determine the urban housing requirements and the demand for urban housing over the next 12 years.

In an attempt to estimate the 2030 urban housing requirements, a number of assumptions from the statistics presented in this section were made. According to Stats SA (2017), these include the following:

1. The trend regarding declining household sizes (discussed above) were not considered, and the average household size was considered to be 3,57;
2. The implication is that there will be 13,7 million urban households in 2030;
3. The South African population will grow to 70 million by 2030 and 70% of the population or 49 000 000 people will live in urban areas;
4. In 2018 there were 10,2 million urban households;
5. Of the 10,2 million urbans households 2,1 million are living in informal settlements.

An additional 3,5 million urban housing units are needed to be constructed just to cater for the growing urban population. Furthermore, an additional 2,1 million units have to be constructed if the low-cost housing backlog is to be eradicated. The implication is thus that 5,6 million new urban homes are needed over the next 12 years to cater for the ever increasing demand for urban houses. This results in 460000 housing units per year (Stimie, 2018).

It was mentioned that no less than 32% of households rent their homes. If we accept that this proportion will not change over the next 12 years, a total of 4,4 million households will be renting their homes by 2030. Of the 5,6 million new urban households approximately 1,8 million will thus be rental homes. This implies that at least 150000 new housing units will have to be built every year over the next 12 years for rental purposes (Stimie, 2018).

2.3 Chapter Conclusion

This chapter started by investigating the scope of the South African Urban Housing Landscape. Policies and interventions that are implemented addressing the sustainability issue in South Africa was presented. The chapter concluded with the second objective of this chapter namely the urban

housing requirements for 2030.

Chapter 3

The Environmental Impact of Housing Developments

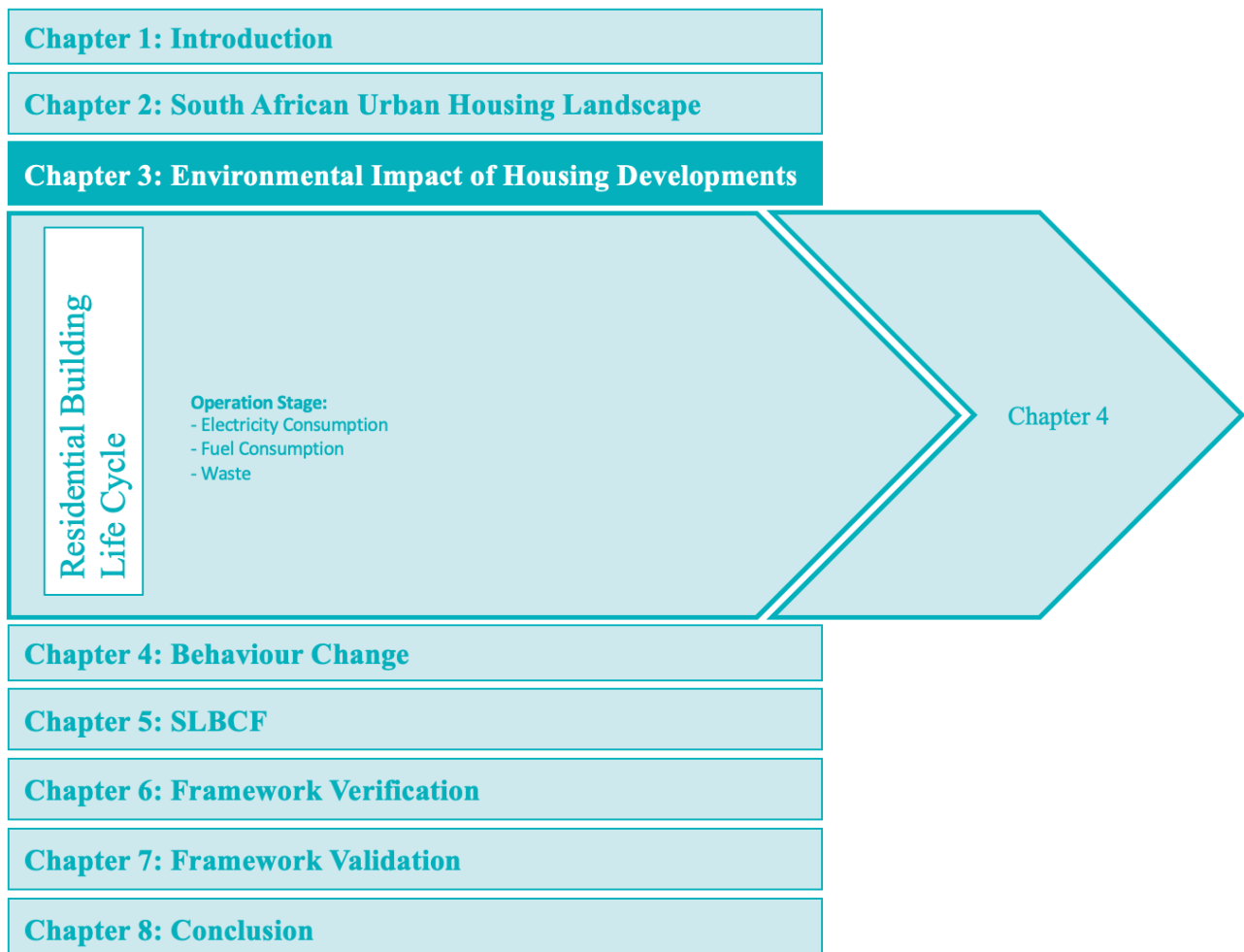


Figure 3.1: Chapter 3 Outline

Table 3.1: Chapter 3: Research Objective Overview

Problem Statement	Objective Hierarchy	Sub Objectives	Research Question Structure	Doc Structure
The problem is that there is no efficient method available that could be used to change unsustainable behaviour within the context of institutionally owned rental estates. Thus, there is a need for the development of a Sustainable Living Behaviour Change Framework (SLBCF) to optimize sustainable living within the context of institutionally owned rental estates.	Establish the Environmental Impact of Housing Developments	Describe the Residential Building Life Cycle	What are the stages of the residential building life cycle?	3.1
			Which are the main contributing factors to unsustainability?	3.1.2

The main objective of this study is to develop a Sustainable Living Behaviour Change Framework (SLBCF) to optimize sustainable living within the context of institutionally owned rental estates. In order to achieve this objection, the impact housing developments have on the environment has to be investigated and quantified in more detail. Thus, the primary objective of this chapter is to describe the environmental impact of housing developments during the total lifecycle. This will assist in establishing where exactly change is required and which factors of unsustainable behaviour patterns should be targeted. The outline of Chapter 3 is presented in Figure 3.1. In the first section the scope of the residential building cycle, as well as the different stages, is presented. The residential building cycle consists of four stages namely the construction stage, operation stage, maintenance and management stage and lastly, the dissolution and disposal stage. For the purpose of this study, the main focus will fall on the operation stage. Firstly, in Section 3.1.1, the construction stage, maintenance and management stage and the dissolution and disposal stage will be presented in short. In Section 3.1.2 the operation stage and what it entails is presented. This section consists of three subsections that presents the main factors which contribute to unsustainability in the residential industry. These three factors include electricity consumption, fuel consumption and waste. Finally, Section 3.1.2 also mentions which elements of this stage are controllable and which are not. Table 3.1 displays the objectives of this chapter as stated in Section 1.3.

3.1 Residential Building Life Cycle

The negative impact housing developments have on the environment was mentioned in Section 1.1.1. The building industry causes ozone layer depletion, resource depletion, global warming and ecosystem destruction. This has put the construction industry and the built environment under the spotlight since its activities have a significant impact on the environment. Housing developments have an impact on the environment throughout the whole life cycle. These impacts occur from the initial work on-site until the construction period, operational period and to the final demolition when a building comes to an end of its life. As a result, there is a progressively growing concern about the impact of housing developments on overall environmental health (Ansah and Ametepey, 2014). The impact housing developments through the various stages will thus be evaluated in more detail.

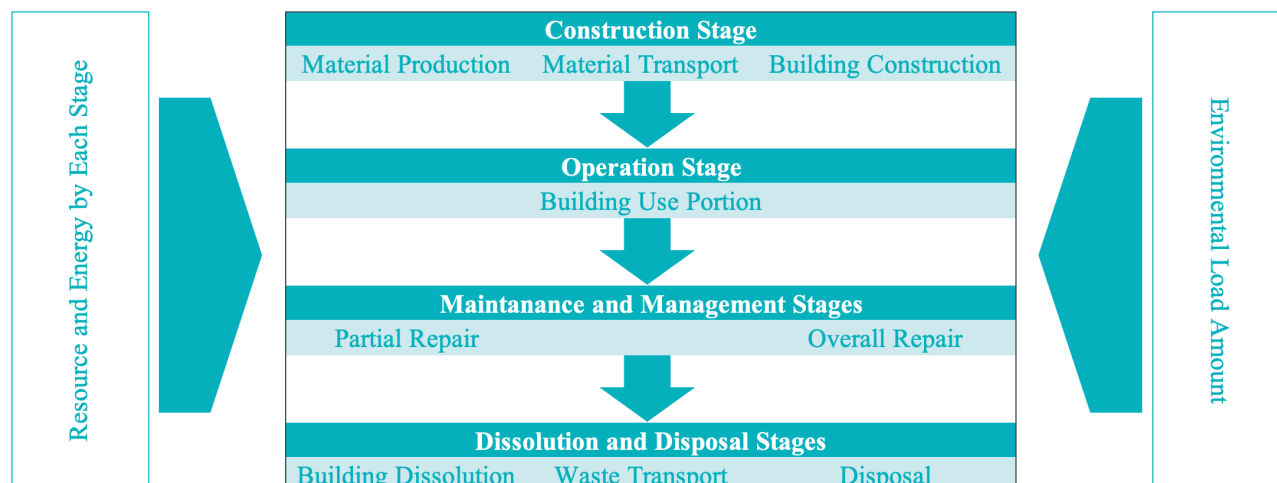


Figure 3.2: Building Life Cycle Stages, reproduced from Tae et al. (2011)

The residential building life cycle (RBLC) consist, according to Tae et al. (2011), of four phases. These phases are illustrated in Figure 3.2. As mentioned at the beginning of this chapter, only the operation stage will be presented in detail. The rest of the stages and their contributing factors are not easily controllable and thus fall outside the scope of this study. A summary of the construction stage, maintenance and management stage and the dissolution and disposal stage will be presented first. Secondly, the operation stage will be presented in more detail.

Table 3.2: Summary of the Residential Building Life Cycle Phases

Residential Building Life Cycle			
Phase Number	Phase Name	Contributing Factors	Controllability
Phase 1	Construction	New materials, electricity consumption for construction.	Uncontrollable
Phase 2	Operation	Electricity consumption, fuel consumption, waste.	Controllable
Phase 3	Maintenance and Management	New materials, electricity consumption for construction, waste generated.	Uncontrollable
Phase 4	Dissolution and Disposal	Electricity consumption for demolishing, waste generated.	Uncontrollable

Table 3.2 is a summary of the important aspects of the different phases of the residential building life cycle. The table indicates which phases are controllable and which are not.

3.1.1 Summary of the Construction, Maintenance and Disposal Stages

Ansah and Ametepey (2014) mention that the construction industry exerts enormous pressure on global natural resources. The environmental significance of these pressures comes into play when some of these resources are exhaustible and non-renewable, bringing the construction industry in conflict with the physical environment. Most of the construction processes consist of unsustainable

design and results in constant degradation of the environment (Ansah and Ametepey, 2014).

The industry relies heavily on the natural environment for supplying raw materials such as sand, timber and aggregates for the building process. According to the Worldwatch Institute (2003), the extraction of natural resources causes irreversible changes to the environment of the coastal areas and countryside, both from an ecological and a scenic point of view (Ansah and Ametepey, 2014). The subsequent transfer of these areas into geographically dispersed sites, not only results in further consumption of energy, but it also increases the amount of particulate matter in the atmosphere. According to Laurencine (2015), 19% of annual global greenhouse gasses (GHG) are produced by the construction industry. This includes the gasses released by the materials such as concrete and steel used for construction as well as the machinery used during construction activities.

To further add to this, dust and other emissions include toxic substances such as sulphur oxides and nitrogen. These substances are released during the production and transportation of materials as well as from site activities (Ansah and Ametepey, 2014). Insulation and refrigeration plants have significantly depleted the ozone layer (Ansah and Ametepey, 2014). Pollutants have been released into the biosphere which is causing serious water and land contamination. This occurrence happens frequently due to on-site negligence which results in toxic spillages which are then released into underground aquatic systems and reservoirs. Construction also adds to the loss of forests by the use of timber in buildings and when providing energy for manufacturing building materials. Both the burning of fossil fuels and deforestation contributes directly to air pollution and global warming. Additionally, the building industry is considered to be a major consumer of energy and the use of finite fossil fuel resources. For this reason, the building industry is known as a large contributor to carbon dioxide emissions (Ansah and Ametepey, 2014).

According to Ansah and Ametepey (2014), the top most important environmental impacts of construction activities are:

- raw materials consumption;
- noise and vibration generation;
- water consumption;
- electricity consumption;
- dust generation from machinery;
- ordinary waste and
- fuel consumption.

The maintenance stage can be seen as a combination of the construction and disposal stages. The first part of the maintenance stage usually consists of breaking down, removing or disposing of materials and constructions. Thereafter the construction or parts thereof is rebuilt or reconstructed. Maintenance and refurbishments usually occur before the building is demolished. Large quantities of natural resources are used once again during refurbishments. Additionally, large quantities of solid waste are created during this stage (Ngwepe and Aigbavboa, 2015). Most of the negatively

contributing factors of the maintenance stage are very similar to the construction stage and the disposal stage.

Demolition is the process of dismantling or separating the components of a structure. During this stage, large structures create large quantities of solid waste and this solid waste has to be dealt with in some way. According to Ngwepe and Aigbavboa (2015), either the waste is going for incineration, the process during which large emissions of GHG are released affecting the air quality; or recycling, or waste generated is dumped in landfills. More environmental impacts associated with this stage is the release of GHG emissions through burning fossil fuel used for the demolition machinery as well as the transportation of waste, or materials to recovery sites (Ngwepe and Aigbavboa, 2015). Disposed materials may decompose resulting in the release of CO_2 and CO_4 (methane).

A detailed analysis of sustainable construction, maintenance and disposal methods falls outside the scope of this study. The objective of this chapter is to gain a deeper understanding of the impact of the operation stage. In the next section, the focus falls on the environmental impact of the operation stage.

3.1.2 Operation Stage

The operation stage of a building is most probably the longest because some buildings have a life span of more than 50 years. Residents use water and energy daily and equipment such as heat-ventilation and air-conditioning systems, power lighting systems and electricity and telecommunications networks amongst others (Ngwepe and Aigbavboa, 2015). Most buildings also require basic essential services such as pipelines for the provision of water and disposal of sewage waste.

Ngwepe and Aigbavboa (2015) argue that the environmental impacts of a building during the operation stage can be of the same order of magnitude as those generated during the whole life cycle. However, most of the negative influencing behaviours are manageable and can be controlled. It is also possible to develop an SLBCF that directly address these factors and could possibly be used to change resident behaviour.

According to Clift and Druckman (2015), there are two main contributing categories of a household's carbon footprint. These include the following: the direct emissions that arise due to energy use in the home and burning personal transportation fuels. However, according to Giusti (2009), a significant contribution of GHG emissions comes from waste management practices. Thus, for the purpose of this study, electricity consumption, fuel consumption and waste will be considered as the main contributing factors which will be included in the further development of the SLBCF.

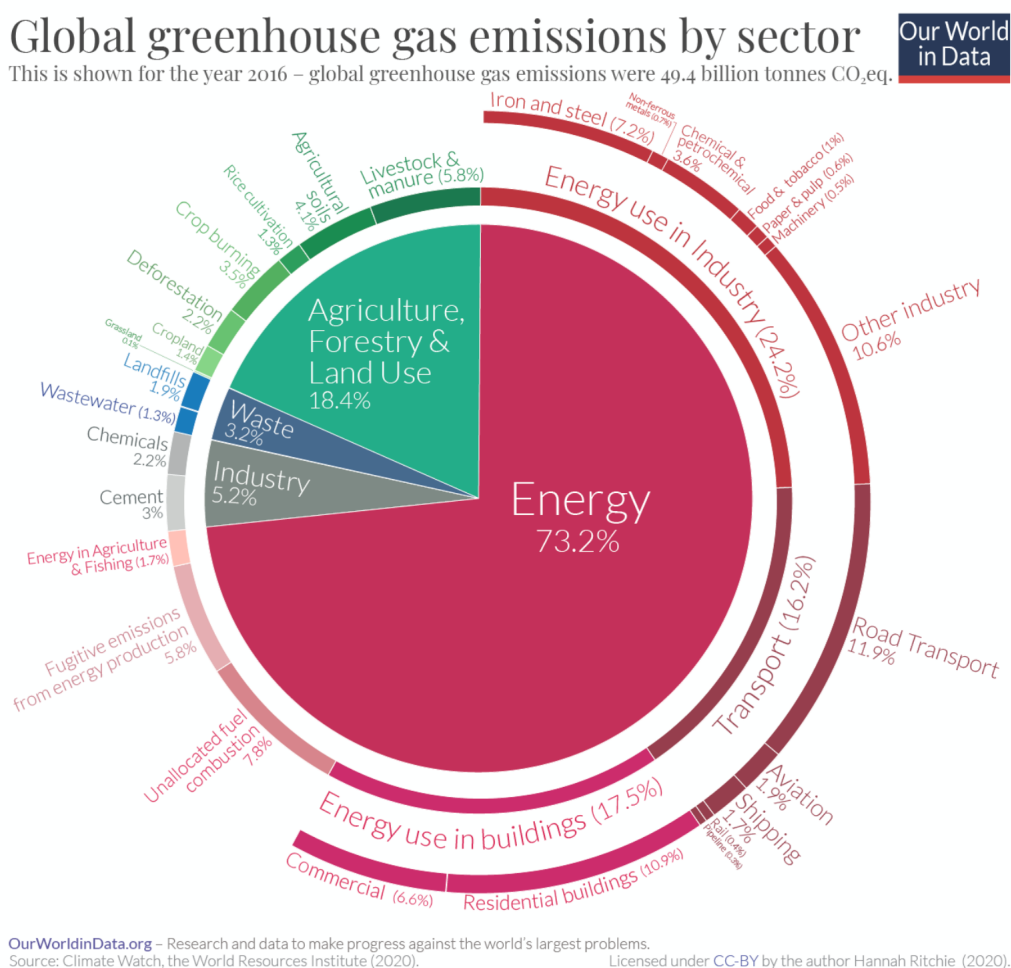


Figure 3.3: Global GHG Emissions by Sector, reproduced from Our World in Data (2020)

For the purpose of this study we will refer to the carbon footprint as the impact of a certain action. According to ETAP (2007), carbon footprint can be defined as follow: the *Carbon Footprint* is a measure of the impact human activities have on the environment in terms of the amount of greenhouse gases produced, measured in tonnes of carbon dioxide. Figure 3.3 illustrates the global GHG emissions by sector for the year of 2016. As seen in Figure 3.3, energy use in buildings, transport and waste all has a significant contribution to the GHG emissions produced globally. According to the statistics released by Our World in Data (2020)¹, South Africa's GHG emissions in 2019 equates to 478.61 million tonnes CO₂ eq.

¹Our World in Data is a scientific online publication that focuses on large global problems such as poverty, disease, hunger, climate change, war, existential risks, and inequality.

Table 3.3: Operation Stage Contributing Factors

Operation Stage Contributing Factors		
Contributing Factor	Carbon Footprint	Desired Behaviour
Electricity Consumption	52.17 million tonnes CO ₂ eq.	Switch off lights, use gass stove.
Fuel Consumption	65.95 million tonnes CO ₂ eq.	Drive electric car, use public transportation.
Waste	15.32 million tonnes CO ₂ eq.	Sort waste at source, recycle.

Table 3.3 is a summary of the three main contributing factors of the operation stage. The table presents the carbon footprint of each contributing factor as well as desired behaviours that could decrease GHG emissions in this sector.

3.1.2.1 Electricity Consumption

Electricity consumption in residential buildings result in 10.9% of total GHG emissions (Our World in Data, 2020). Energy-related emissions in residential buildings include the generation of electricity for lighting, appliances, cooking, heating at home and more. It can be assumed that if South Africa's total annual emissions equate to 478.61 million tonnes CO₂, that the carbon footprint of the electricity consumption in residential building result in approximately 52.17 million tonnes CO₂ eq.

Understanding electricity use behaviour is critical for designing behaviour change interventions. The study done by Williams *et al.* (2020) uses structured questionnaires to examine electricity use behaviour among high-income households in Johannesburg, South Africa. The findings of this study indicate evidence of electricity-saving behaviour, but the proportion of households doing so was less than 50% for many actions. This is indicative of widespread wasteful habits. Other wasteful electricity use habits include leaving electronic appliances on *standby* mode, not turning off electric water heaters and not defrosting fridges without automatic settings. The results of this study is presented in Figure 3.4.

Table 3.4: Socio-economic characteristics of participants and households, reproduced from Williams et al. (2020)

Household Socio-Economic Factors	Value (n = 91)	Max (min) Values
Gender of household head		
Female	46%	-
Male	54%	-
Mean age of household head	48.8	82 (19)
Mean household size	3.4	7 (1)
Adults	1.7	
Children	1.7	6 (0)
Education of household head		
University degree and above	63%	-
Diploma	13%	-
Matric	24%	-
Proportion of household heads employed	91%	
Mean number of employed individuals in household	1.9	5(0)
Average monthly income		
<R10,000	1%	
R10,000–30,000	4%	
+R30,000	95%	
Proportion of households receiving social grants	3%	-
Mean number of rooms	9.4	17 (3)
Mean number of bedrooms	3.9	6 (3)
Ownership of appliances		
Air conditioner/fans	76%	
Heaters	79%	
Refrigerator	100%	
Instant type water heater	44%	
Electric jug	99%	
Home electrics (TVs, DVDs, Cell phones, iPads)	100%	
Electric water heater	98%	
Tumble dryer	80%	
Pool pump	95%	
Washing machine	99%	
Dishwasher	93%	
Electric blanket	58%	

These results of this study are important because it supports the argument that there is a need for the development of an SLBCF. The results show that there is room for improvement in human behaviour regarding sustainability. As a result, reducing the impact human behaviour has on sustainability can partly be addressed by motivating environmentally-sustainable actions through the use of an SLBCF.

3.1.2.2 Fuel Consumption

Fuel consumption for road transport results in 11.9% of total GHG emissions (Our World in Data, 2020). Transport emissions include the burning of petrol and diesel from all forms of road transport which includes cars, trucks, motorcycles, lorries and buses. According to Our World in Data (2020),

60% of road transport emissions come from passenger travel (buses, cars and motorcycles); and the remaining 40% from road freight (trucks and lorries). The assumption can be made that if South Africa's total annual emissions equate to 478.61 million tonnes CO₂, that the carbon footprint of the fuel consumption results in approximately 65.95 million tonnes CO₂ eq. This means that, if the whole road transport sector could be electrified, and be transitioned to a fully decarbonized electricity mix, emissions could be reduced by 11.9%.

According to C2ES (2021)², modern transportation relies heavily on petrol, and passenger cars and light-duty trucks contribute approximately half of the carbon dioxide emissions from the transportation sector. C2ES (2021) states that there is a lot that can be done to reduce the impacts of driving, starting with the type of car that is driven. Switching from a vehicle that gets 8 km/L to a vehicle that gets 10 km/L car reduces GHG emissions by approximately 1.7 tonnes annually.

C2ES (2021) mentions the following ways in which GHG emissions can be reduced in the transportation sector:

- Electric vehicles;
- optimal driving techniques;
- public transport;
- biking and walking.

3.1.2.3 Waste

Waste results in 3.2% of total GHG emissions (Our World in Data, 2020). Waste is made up of two categories namely, wastewater and landfills. Wastewater includes all organic matter and residues from plants, animals, humans and their waste products can collect in wastewater systems. Landfills are often low-oxygen environments. In landfills, organic matter is converted to methane when it decomposes. When this organic matter decomposes it produces methane and nitrous oxide. It has already been mentioned that South Africa's total annual emissions equate to 478.61 million tonnes CO₂, which means that the carbon footprint of waste results in approximately 15.32 million tonnes CO₂ eq.

Most of South Africa is experiencing a landfill airspace crisis. When recyclable items are thrown into the garbage instead of recycling it, it eventually ends up in landfills. These items take up much needed space that could otherwise be occupied by non-recyclable materials. Once the existing landfills reach capacity, new areas will have to be repurposed to create landfills (Giusti, 2009).

According to (GreenCape, 2020), the availability and quality of waste are dependent on the level of material separation done by households. It is difficult to extract value from municipal solid waste due to its complex nature and depending on who the owner of the waste is. Municipal solid waste is a

²Center for Climate and Energy Solutions (C2ES): It is an environmental non-profit organization based in Arlington, Virginia. Launched in 2011, C2ES is the successor to the Pew Center on Global Climate Change.

mix of general household articles, which include general and hazardous waste, all of which come in various ratios, and all of which can be substantially contaminated. According to GreenCape (2020), South Africans do not have a culture of separating waste at source. This makes extracting value costly and difficult. Regarding households, there are no incentives or disincentives to separate waste at the source. According to Strydom (2018), a very small percentage of South Africans regularly recycle most of their recyclables, which was only 4% and 7.2% in 2010 and 2015, respectively. According to the Department of Environmental Affairs (2012), 90% of an estimated 59 million tonnes of general waste produced in South Africa in 2011 ended up in landfills, while only 10% was recycled. Despite the benefits and urgent need for recycling, studies report that as little as 5.2% of households recycled waste in 2015 (Department of Environmental Affairs, 2012).

3.2 Chapter Conclusion

In this chapter the impact housing developments have on the environment was presented. The primary objective of this chapter was achieved by describing the environmental impact of housing developments during the total lifecycle. This will assist in establishing where exactly change is required and which factors of unsustainable behaviour patterns should be targeted.

Chapter 4

Behaviour Change: Contemporary Debates and Emerging Themes

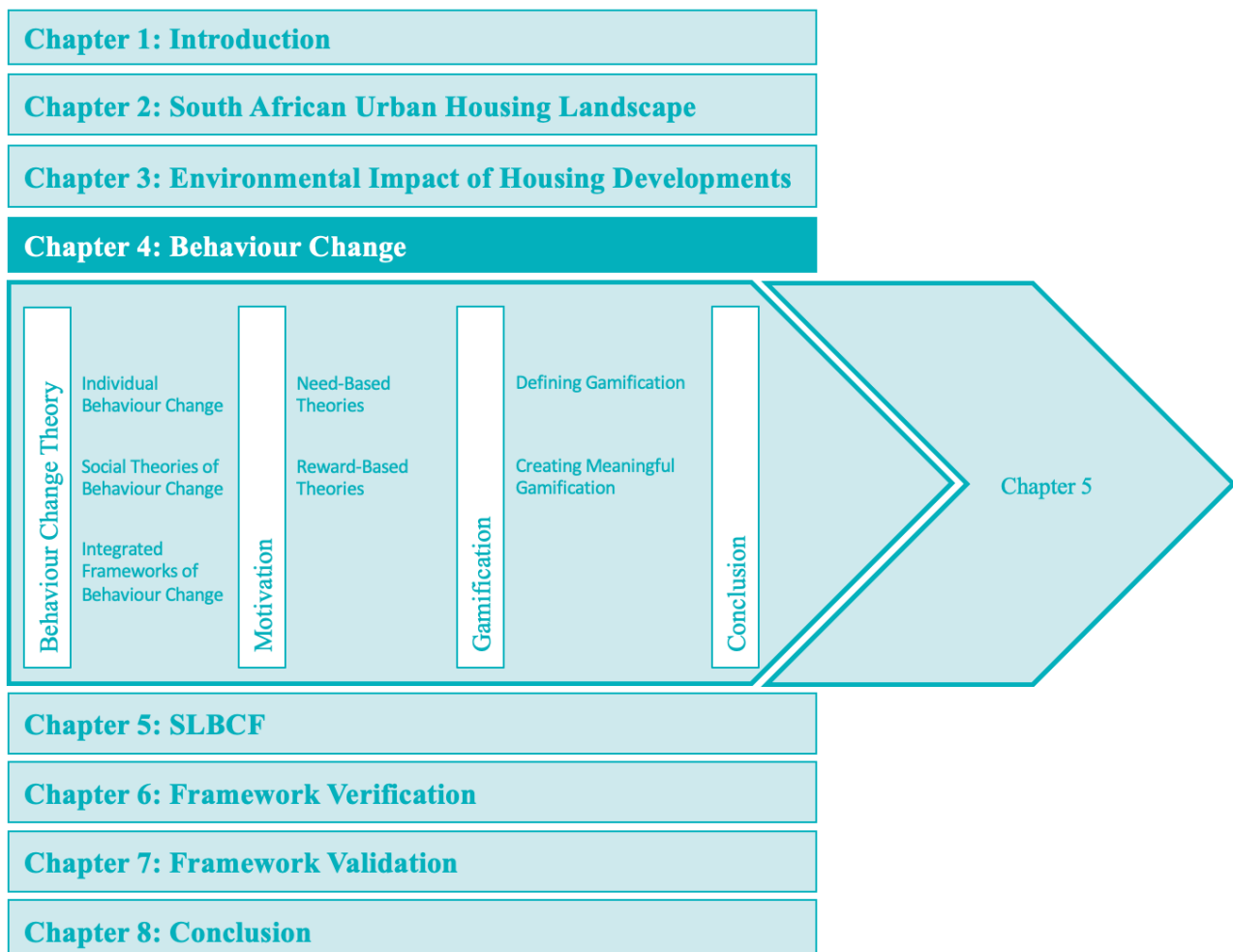


Figure 4.1: Chapter 4 Outline

Table 4.1: Chapter 4: Research Objective Overview

Problem Statement	Objective Hierarchy	Sub Objectives	Research Question Structure	Doc Structure
The problem is that there is no efficient method available that could be used to change unsustainable behaviour within the context of institutionally owned rental estates. Thus, there is a need for the development of a Sustainable Living Behaviour Change Framework (SLBCF) to optimize sustainable living within the context of institutionally owned rental estates.	Present a framework of the most prevalent and applicable findings of behaviour change theory to this study	Define Behaviour Change Theory	How can Individual Behaviour Change theories be incorporated in to the SLBCF?	4.1.1
			How can Social Behaviour Change theories be incorporated in to the SLBCF??	4.1.2
			How can Integrated Behaviour Change frameworks be incorporated in to the SLBCF?	4.1.3
		Define Motivation Theories	How can Need-Based theories be incorporated in to the SLBCF?	4.2.1
			How can Reward-Based theories be incorporated in to the SLBCF?	4.2.2
		Define Gamification	What is gamification?	4.3.1
			How can meaningful gamification be created?	4.3.2
			How has gamification been incorporated in the real-world?	4.3.3
		Candidate Solution	What is the candidate solution that should be used in corporation with the SLBCF?	4.4.1

The outline of Chapter 4 is presented in Figure 4.1. There are a few ways of approaching behaviour change. During the course of this study, the theory of behaviour change will first be presented. It is important to first understand behaviour and what influences behaviour change before looking at behaviour change frameworks. Thus, in this study, theories of behaviour change will be researched and analysed. If the theory of behaviour and behaviour change is understood it allows for a better understanding when analysing or developing behaviour change frameworks. The theory of behaviour change is seen as the foundation for developing an SLBCF. For the purpose of this study, motivation is seen as an aspect that can be used to change behaviour. Rodgers and Loitz (2009) define motivation as the energy that directs behaviour. The primary objective of this chapter is to present a framework of the most prevalent and applicable findings of behaviour change theory to this study. This will assist in determining which theories and models will be most appropriate to incorporate when developing an SLBCF. In pursuit of the primary objective, a number of aspects will be addressed in this chapter. In the following section, the focus will fall on the following aspects: An overview of behaviour change theory and the evolution of these theories will first be presented. Secondly, three individual behaviour change theories will be presented. Thirdly, two social behaviour change theories will be presented and fourthly, an integrated theory of behaviour change. In Section 4.2, theories of motivation will be addressed. Need-based theories and rewards-based theories are examples of motivation theories and will be presented in Section 4.2.1 and Section 4.2.2. In Section 4.3, gamification is will be defined. Gamification is a motivational technology that attempts to influence user behaviour by activating individual motives via game-design elements. As a result, this chapter will conclude with a section that represents gamification and its elements. Figure 4.1 displays the objectives of this chapter as stated in Section 1.3.

4.1 Behaviour Change Theory

Behaviour change lies at the heart of many challenges facing society, such as improving environmental sustainability. Over the last century, an extensive range of theories and models have been developed seeking to explain the processes underlying behaviour change for use in behaviour change frameworks. There is a need for these research products to be portrayed in a more consistent and less ambiguous way to allow better integration, development, comparison and use. In Chapter 1 the need for the development of an SLBCF has been established. There are many contemporary theories regarding behaviour change that could be incorporated into the SLBCF. In this chapter, these theories will be investigated.

During the course of this chapter different references will be made to either a theory, model or framework. These terms are used interchangeably in the literature. In an attempt to avoid confusion, the identification and definition of the different research products are presented in Table 4.2. However, the collective of these will be referred to as a *framework*.

Table 4.2: Definition of Research Products

Framework	A broad overview, outline, or skeleton of interlinked items (i.e. a system, concept or text) which supports a particular framework to a specific objective (BusinessDictionary, 2019). A conceptual framework is a network, or "a plane", of interlinked concepts that together provide a comprehensive understanding of a phenomenon or phenomena. The concepts that constitute a conceptual framework support one another, articulate their respective phenomena, and establish a framework-specific philosophy (Jabareen, 2009b).
Model	A theoretical model gives an abstract description of a given system (Achinstein, 1965). A model is not the real-world, but merely a human construct to help better understand the real world systems. In general, all models have an information input, an information processor, and an output of expected results (Starting Point, 2019).
Theory	A theory is a set of interrelated constructs (concepts), definitions, and propositions that present a systematic view of phenomena by specifying relations among variables, with the purpose of explaining and predicting the phenomena (Kerlinger and Lee, 2000).

Over the last 40 years, attempts were made to create human behaviour theories that identify determinants. This was done in order to create opportunities to use these determinants to influence the behaviour or change it. The theories focus on analysing the individual's beliefs, values and attitudes as predictors of behaviour (Hargreaves, 2011). A well-known behaviour theory developed by Ajzen (2012) is titled the theory of planned behaviour. This theory suggests that behavioural intention, which necessarily precedes actual behaviour, is a result of interactions between an individual's attitude towards the behaviour in question, the individual's beliefs about the behaviour and the perceived behavioural control (Hargreaves, 2011). In contrast to this, critics such as Stern (2000), argue that these frameworks are excessively individualistic. Additionally, this theory fails to see the ways in which social relations and context are inherent to the performance of social practices and not just variables within individuals' decision-making processes. As a result, a framework that was developed based around ideas of social practice attempted to address many of the shortcomings of the previously mentioned framework.

In conclusion, many different behaviour change theories have been tested over the years. Morris et al. (2012) divided a few significant behaviour change frameworks into specific classifications namely: Individual Behaviour Change Theories, Social Theories of Behaviour Change and Integrated

Frameworks of Behaviour Change. Most studies define behaviour while looking at the individual as the locus of behaviour. In this case, according to Morris *et al.* (2012), the framework will then be categorized as an Individual Behaviour Change Theory. Alternatively, other frameworks move away from the individual and rather focus on the behaviour itself, or relationships between behaviour, individuals and the physical and social environments in which they occur. These frameworks, Morris *et al.* (2012) classify as Social Theories of Behaviour Change. The last category namely, Integrated Frameworks of Behaviour Change, is a combination of the two previously mentioned categories. Morris *et al.* (2012) mention a few frameworks that in his opinion falls under this category. There are numerous behaviour change frameworks. A detailed presentation of the main characteristics of all these frameworks fall outside the scope of this study. For the purpose of the study and the ultimate development of the SLBCF, this study will lean on Morris's classifications of the behaviour change frameworks as it is a simple, yet meaningful way of categorizing the frameworks.

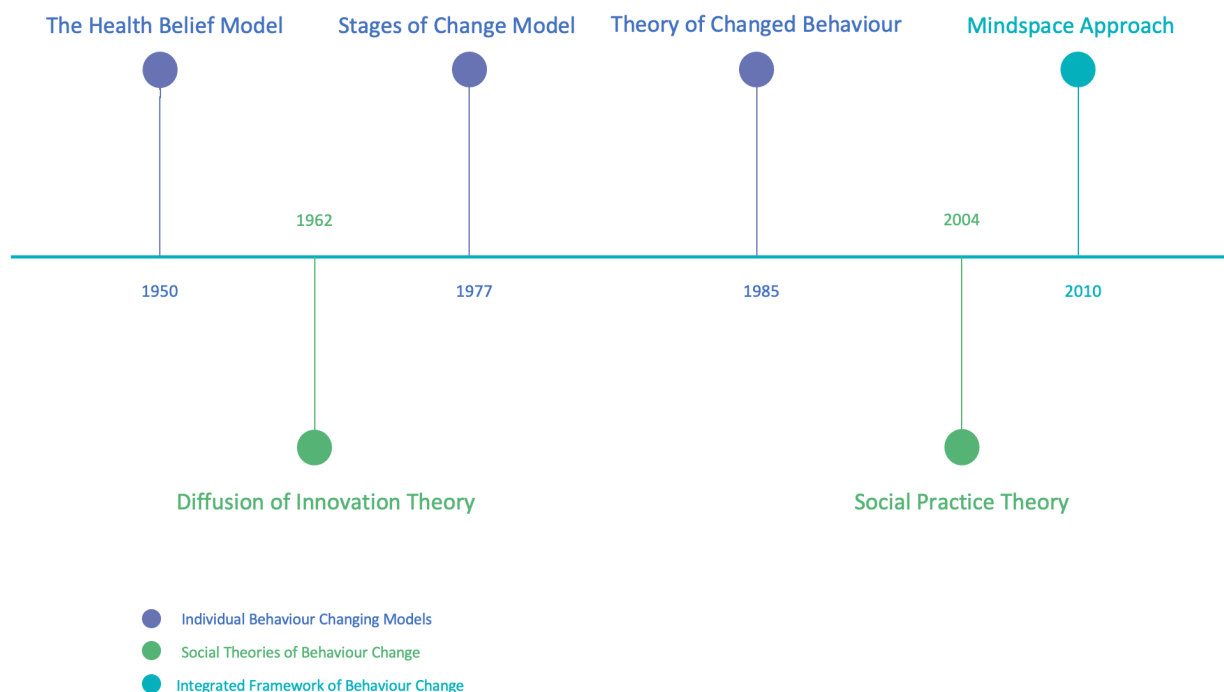


Figure 4.2: Behaviour Change Framework Timeline

Research regarding the above-mentioned theories provides evidence that these frameworks can in fact bring change to an individual's actions when facing environmental challenges. For the purpose of the study and the ultimate development of the SLBCF, the frameworks in Morris *et al.* (2012) work will be presented in more detail. A detailed presentation of the main characteristics of all frameworks fall outside the scope of this study. In the following section, Individual Behaviour Change will be introduced and discussed. Figure 4.2 illustrates the different behaviour change frameworks that will be discussed in this chapter. The figure allocates the theories according to the date it was developed on a timeline.

4.1.1 Individual Behaviour Change

In this section, the contemporary discourse regarding the Individual Behaviour Change Frameworks will be presented. As mentioned in 4.1, there are several ways in which behaviour could be conceptualised and most studies define behaviour while looking at the individual as the locus of behaviour. According to Morris *et al.* (2012), these are classified as individual behaviour change theories. The following research products will be introduced: The Health Belief Model (HBM), the Stages of Change Model (SoC) and the Theory of Planned Behaviour (TPB). These three behaviour change frameworks focus on the individual.

In an attempt to facilitate easy comparison and contextualisation, each one of these frameworks will be presented by using the following artefacts and structure:

- The behaviour change framework timeline will be presented, and the relevant approach's position on the timeline will be highlighted;
- The history, key deliverables, applications and shortcomings of the framework will be presented in a table format;
- A schematic representation of the framework, illustrating the main elements and interaction between elements;
- Each section will be concluded by a short discussion of the framework dynamics.

4.1.1.1 The Health Belief Model

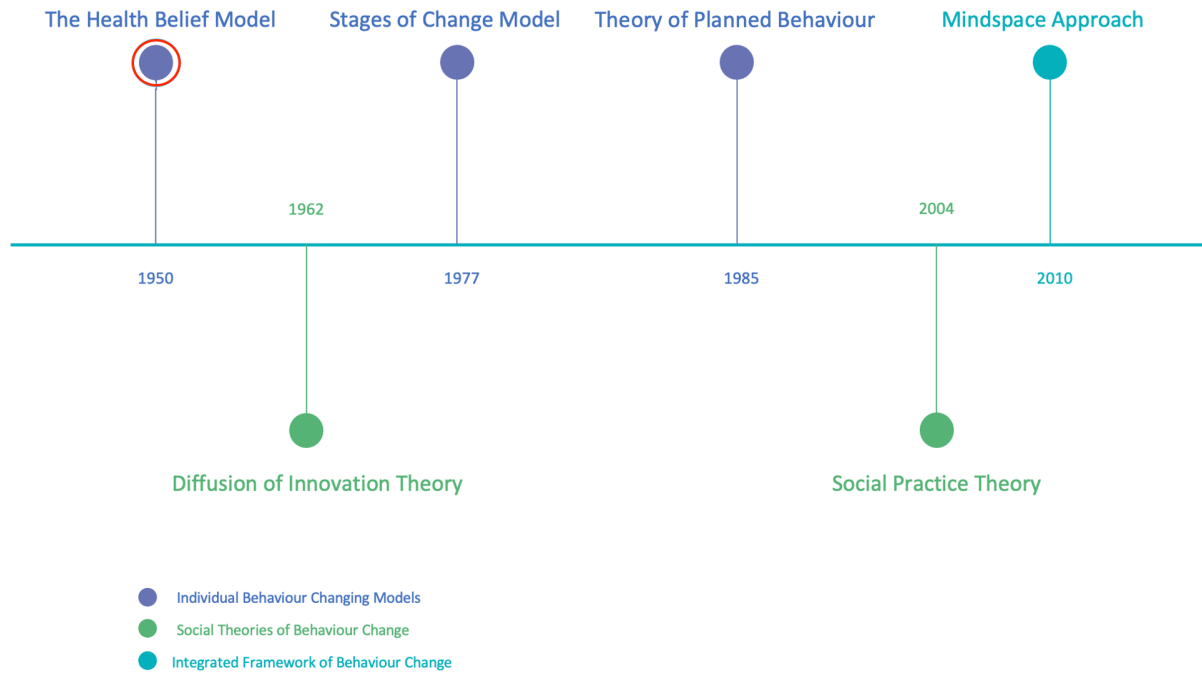


Figure 4.3: Behaviour Change Framework Timeline

Table 4.3 presents the main characteristics of the health belief model:

Table 4.3: The Health Belief Model

The Health Belief Model	
History	Developed in the 1950s by social psychologists, Hochbaum and his colleagues, who were working in the U.S. Public Health Service (Mckellar and Sillence, 2020).
Key Deliverables	Designed to understand the failure of people to adopt disease prevention strategies or screening tests for the early detection of disease. It mainly predicts patterns of behaviour (Mckellar and Sillence, 2020).
Applications	Healthcare Industry: Aid understanding in sexual risk-taking behaviour among various ages and cultural groups (Mckellar and Sillence, 2020).
Shortcomings or Critique	The rules and components about inter-relationships are not well-defined. It does not include economic or social determinants of behaviour (Mckellar and Sillence, 2020).

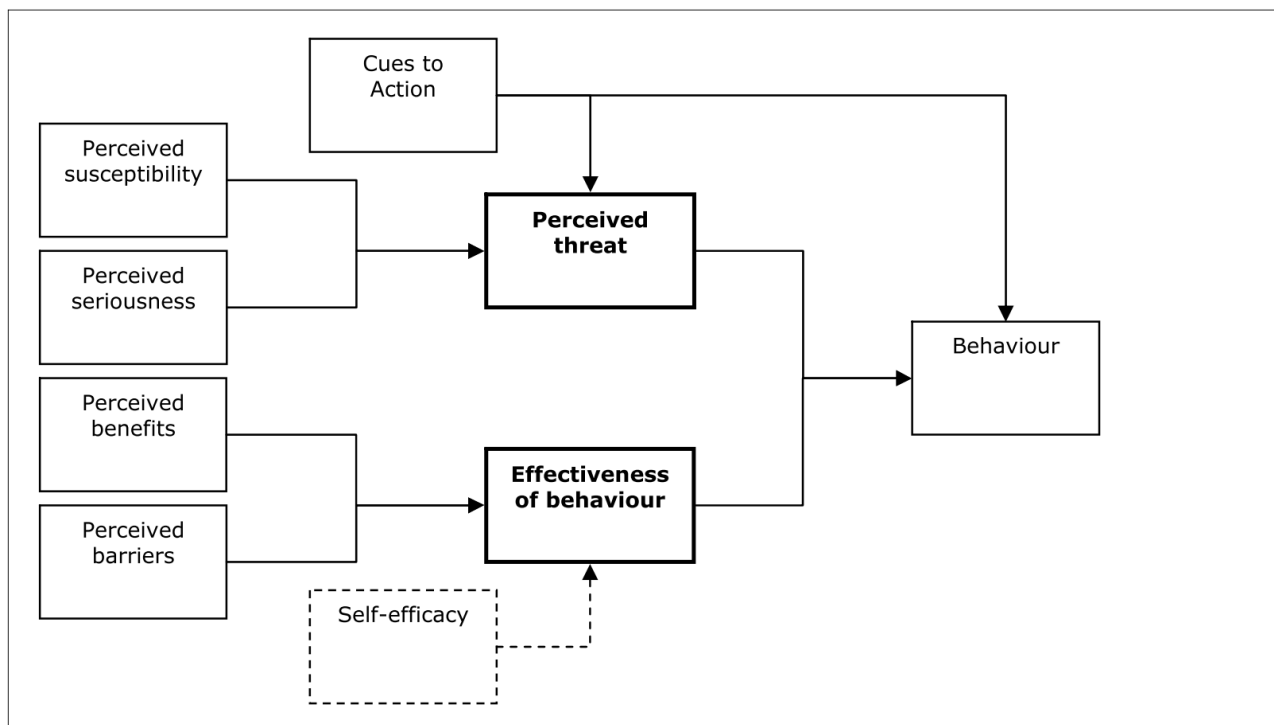


Figure 4.4: The Health Belief Model, Morris *et al.* (2012)

Figure 4.4 is a visual representation of the elements of the Health Belief Model (HBM). The HBM is known as a cognitive model that presumes that behaviour is determined by many beliefs about threats to the individual's well-being and the outcomes of certain behaviours. These beliefs are supplemented by additional stimuli known as *cues to action* that results in the actual adoption of behaviour. The term *perceived threat* is seen as the core of the model because it is linked to the individual's inclination to take action. It consists of two sets of beliefs about the perceived susceptibility or vulnerability to a particular threat, also the importance of the expected consequences that could result from it (Morris *et al.*, 2012). According to Nisbet and Gick (2008), the model can be summarised as follow:

"in order for behaviour to change, people must feel personally vulnerable to a health threat, view the possible consequences as severe, and see that taking action is likely to either prevent or reduce the risk at an acceptable cost with few barriers. In addition, a person must feel competent (have self-efficacy) to execute and maintain the new behaviour. Some trigger, either internal... or external..., is required to ensure actual behaviour ensues."

The self-efficacy of the individual is a further key component of the HBM. Also, the HBM identifies two types of *cues to action* namely, internal and external. The internal type, if looked at it from the health industry, could for example be symptoms of ill health. The external refers to the receipt of information or media campaigns (Morris *et al.*, 2012).

In the following section, the Stages of Change model will be introduced. Similar to the Health Belief Model, Morris *et al.* (2012) also classify this model as an individual behaviour change theory.

4.1.1.2 The Stages of Change Model

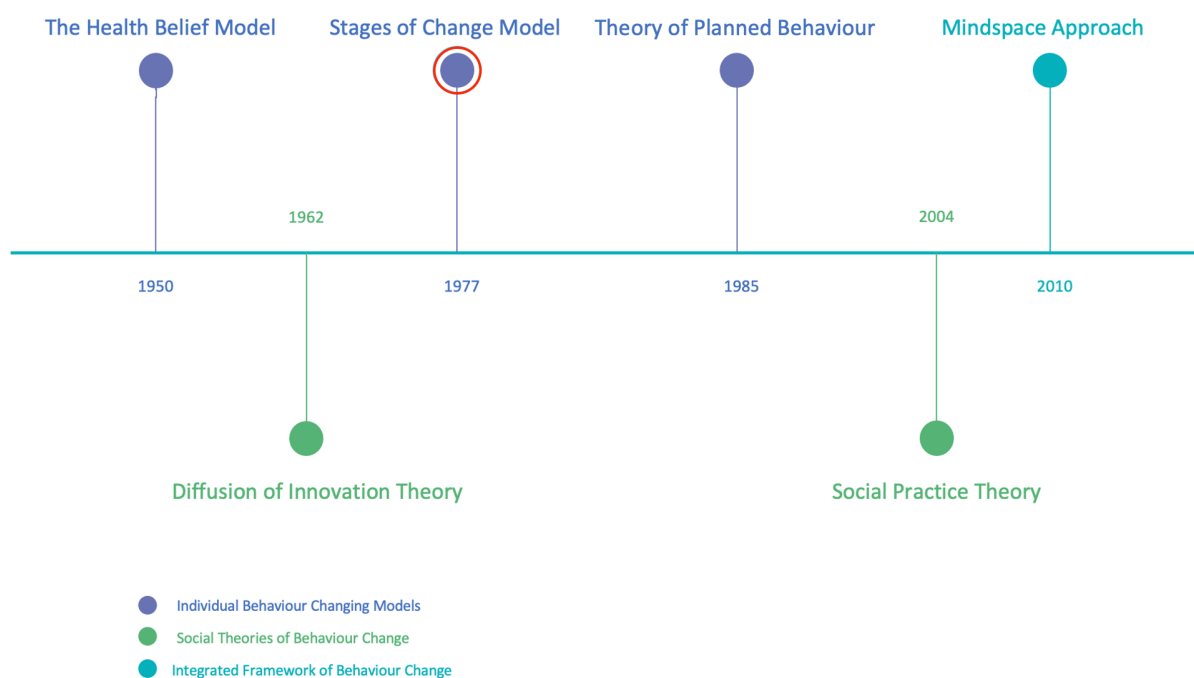


Figure 4.5: Behaviour Change Framework Timeline

Table 4.4: The Stages of Change Model

The Stages of Change Model	
History	Carlo Di Clemente and colleagues developed the transtheoretical model in 1977 (Morris <i>et al.</i> , 2012).
Key Deliverables	The rationale behind a staged model is that individuals at the same stage should face similar problems and barriers, and thus can be helped by the same type of framework (Morris <i>et al.</i> , 2012).
Applications	This model was first developed in relation to smoking, and now it is commonly applied to other addictive behaviours (Morris <i>et al.</i> , 2012).
Shortcomings or Critique	The model's concepts are not very well defined. The model is not very clear on how the individual changes or why some change more rapidly and effectively than others. Also, the model is egoistic (focus is on self) and consequently misses the structural environmental, economic and social aspects (Morris <i>et al.</i> , 2012).

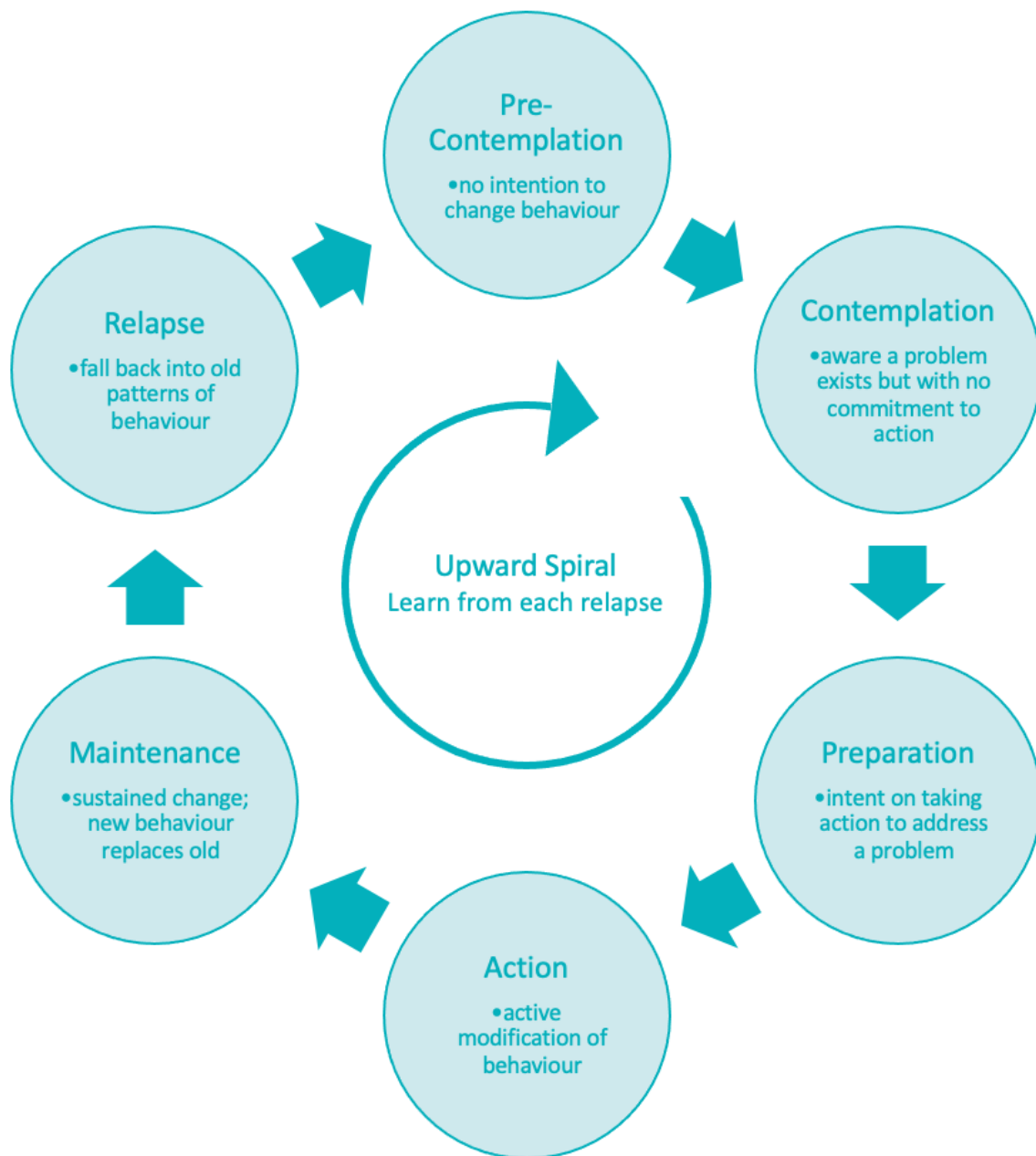


Figure 4.6: Stages of Change Model, adapted from Morris *et al.* (2012)

The SoC model, which is presented in Figure 4.6, is based on analysis and use different theories of psychotherapy, hence the name *trans-theoretical* Glanz *et al.* (2002). The model sub-divides people between five different categories that each represent a milestone, or also known as *levels of motivational readiness* along a sequence of behaviour change (Morris *et al.*, 2012). These stages are titled pre-contemplation, contemplation, preparation, action and maintenance. The transition between these stages is driven by two main components namely, self-efficacy and decisional balance.

The following section introduces the Theory of Planned Behaviour.

4.1.1.3 The Theory of Planned Behaviour

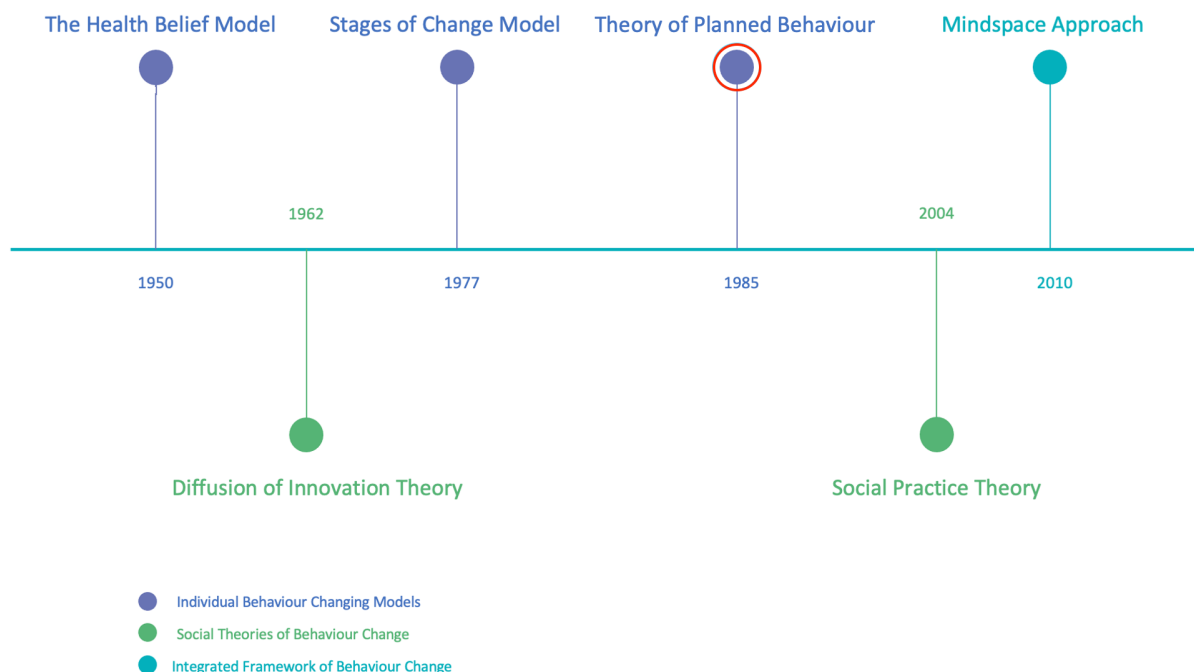


Figure 4.7: Behaviour Change Framework Timeline

Table 4.5: Theory of Planned Behaviour

The Theory of Planned Behaviour	
History	This theory was developed from the theory of reasoned action, which was initially proposed by Martin Fishbein together with Icek Ajzen in 1980. Since its introduction in 1985, the theory of planned behaviour has, by any objective measure, become one of the most frequently cited and influential theories for the prediction of human social behaviour (Ajzen, 2012).
Key Deliverables	The TPB is well suited to predict behaviour and is also used to analyse behaviour patterns (Morris et al., 2012).
Applications	The TPB has been used to predict and explain a wide range of health behaviours and intentions including drinking, smoking, health services utilization, substance use and breastfeeding, among others (Ajzen, 2012).
Shortcomings or Critique	The TPB is not necessarily considered useful in relation to designing a type of framework resulting in behaviour change (Morris et al., 2012). Morris et al. (2012) argue that the most frequently mentioned biasing factors ostensibly neglected in the TPB are emotions and affect. Also, limiting in its inability to consider economic and environmental influences.

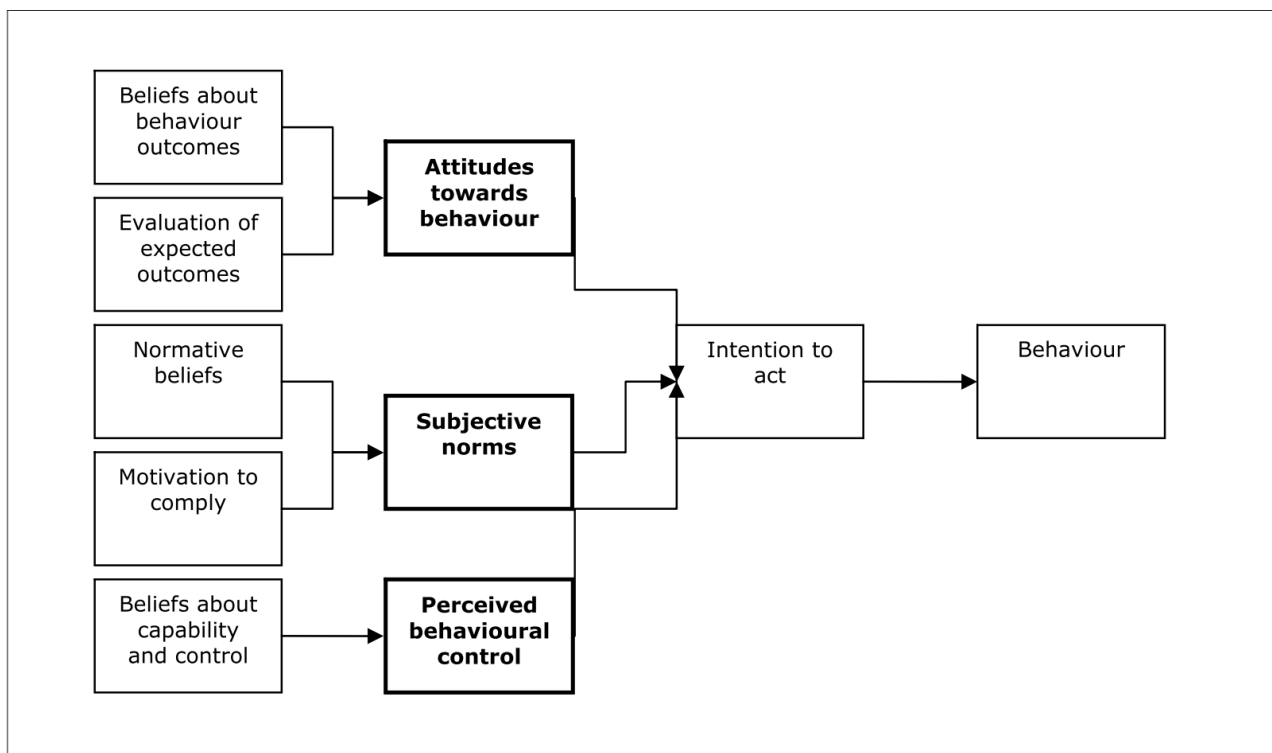


Figure 4.8: The Theory of Planned Behaviour, reproduced from Morris *et al.* (2012)

The TPB states that behavioural achievement depends on both motivation and ability (behavioural control). The TPB is comprised of the following important constructs that collectively represent a person's actual control over the behaviour:

- Attitudes towards behaviour: This refers to the degree to which a person has a favourable or unfavourable evaluation of the behaviour of interest.
- Intention to act: It refers to the motivational factors that influence a given behaviour where the stronger the intention to perform the behaviour, the more likely the behaviour will be performed.
- Subjective norms: This refers to the belief about whether most people approve or disapprove of the behaviour.
- Perceived behavioural control: This refers to a person's perception of the ease or difficulty of performing the behaviour of interest.

In a simple form, behavioural intention for the TPB can be expressed as the following mathematical function:

$$BI = w_A A + w_{SN} SN + w_{PBC}$$

The three factors being proportional to their underlying beliefs:

$$A \propto \sum_{i=1}^n b_i e_i$$

$$SN \propto \sum_{i=1}^n n_i m_i$$

$$PBC \propto \sum_{i=1}^n c_i p_i$$

BI	Behavioural Intention
A	Attitude toward behaviour
SN	Subjective norm
PBC	Perceived Behavioural Control
b	The strength of each belief concerning an outcome or attribute
e	The evaluation of the outcome or attribute
n	The strength of each normative belief of each referent
m	The motivation to comply with the referent
c	The strength of each control belief
p	The perceived power of the control factor
w	Empirically derived weight/coefficient

To the extent that it is an accurate reflection of actual behavioural control, perceived behavioural control can, together with intention, be used to predict behaviour.

$$B = w_{BI}BI + w_{PBC}PBC$$

B	Behavior
BI	Behavioral intention
PBC	Perceived Behavioral Control
c	The strength of each control belief
p	the perceived power of the control factor
w	Empirically derived weight or coefficient

This theory adopts a cognitive approach to explain behaviour while focusing on the individual's attitudes and beliefs (Morris et al., 2012). The theory does not specify where these beliefs originated, it merely points to a host of possible background factors that may influence the beliefs the individual hold. The TPB has shown more utility in public health than the HBM, but it is still limited in its inability to consider economic and environmental influences. However, there is still value in explaining and predicting behaviour in order to identify influences on behaviour that could be used for establishing change (Morris et al., 2012).

The following section will introduce Social Behaviour Change theories.

4.1.2 Social Theories of Behaviour Change

In this section, the focus will move away from the individual and rather fall on theories of behaviour itself. Social theories focus on the behaviour itself, relationships between behaviour, and the physical environments in which they occur. Morris *et al.* (2012) identify two different theories which are classified as social and technological behaviour changing models. These theories are Social Practice Theory and Diffusion of Innovation Theory and will be presented in the following section.

4.1.2.1 Social Practice Theory

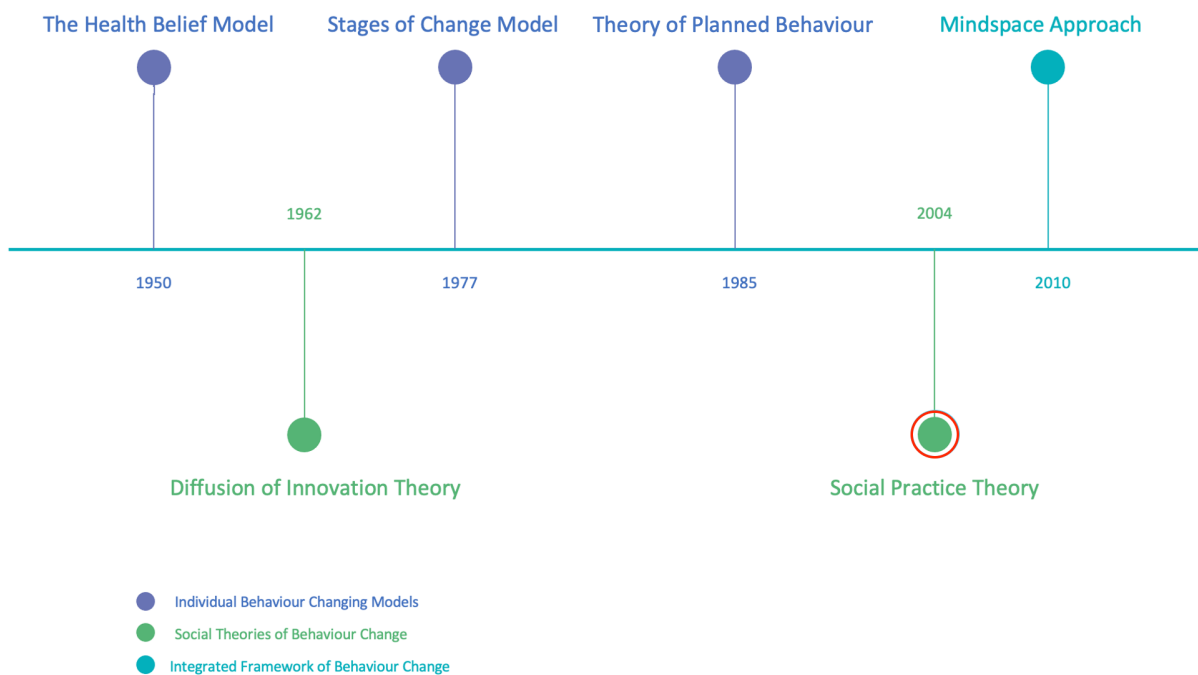


Figure 4.9: Behaviour Change Framework Timeline

Table 4.6: Social Practice Theory

Social Practise Theory	
History	Reckwitz (2004) formulated the Social Practice Theory with which he argues that practices are configured by elements, interconnected to one another, that comprise the conditions of existence for a practice. Welch and Warde (2015a) translated this idea into a conceptual framework containing three elements that together form the social practice and shape the practice in their process of interaction.
Key Deliverables	The core aspect of SPT is the recognition that human practices are seen as arrangements of many interconnected elements. These elements can include mental and physical activities, norms, technologies used, knowledge or meanings. According to Reckwitz (2004), these elements form part of people's behaviour and actions as part of their everyday lives. This theory specifically emphasises material contexts within which practices take place, and it draws attention to their impact upon behaviour.
Applications	Morris et al. (2012) is of the opinion that this theory is being used increasingly specifically in the field of human behaviour. This theory is particularly used in the context of energy use and consumption.
Shortcomings or Critique	The theory has an exclusive focus on rational reasoning, excluding unconscious influences on behaviour and the role of emotions beyond anticipated affective outcomes Sniehotta et al. (2014). Moreover, the static explanatory nature of the TPB does aid in understanding the evidenced effects of behaviour on cognitions and future behaviour.

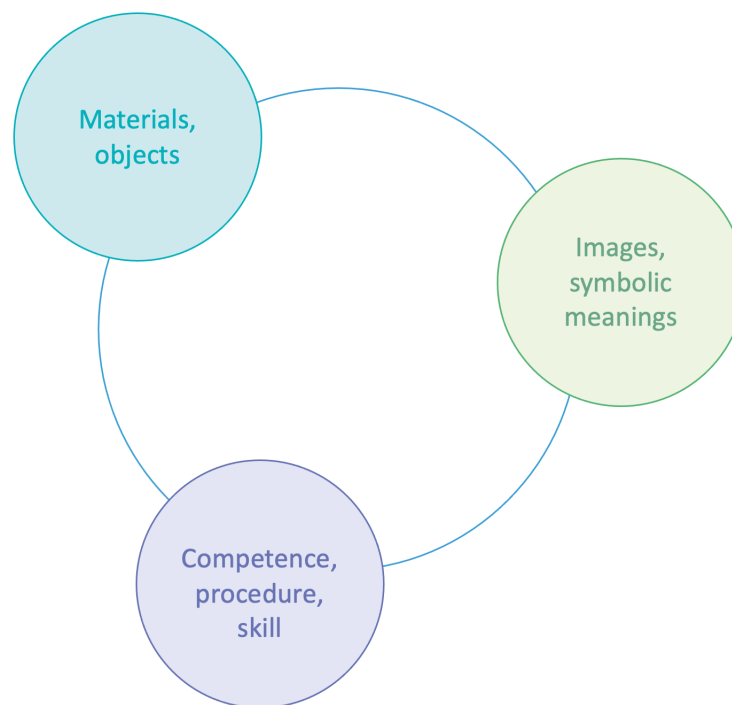


Figure 4.10: The Three Elements, reproduced from Welch and Warde (2015a)

Figure 4.10 has been adapted from Welch and Warde (2015a) and represents the SPT. The family resemblance of practice theories lies in the shared contention that individuals' behaviour primarily takes place through the medium of social practices. According to Welch and Warde (2015b) practices are organised forms of activity. Welch and Warde (2015b) further comment that practices can generally be recognized as entities distinct from the individuals that perform them and often require participation with others for their successful performance. Behaviour is the observable performance of social practices. Practices become the central focus of enquiry, rather than individuals and their

attitudes or any other analytical category such as norms or social structures (Welch and Warde, 2015b).

The *materials*, in Figure 4.10, represent physical objects that facilitate activities to be performed in specific ways. Secondly, *meanings* refer to images, concepts or interpretations that are associated with activities that stipulate when and how it can be performed. Lastly, *skills* refer to competencies that allow, or lead to activities that are undertaken in a specific way (Morris et al., 2012). Welch and Warde (2015a) argue that material elements emphasise how practices are always deeply interwoven with objects, tools, technologies and infrastructures. Competence draws our attention to the skills that are necessary for the successful performance of a practice. Meanings include norms, cultural conventions and expectations. The main task of analysis, therefore, becomes identifying the components of practices and their configuration within the practice.

In the next section the Diffusion of Innovation theory will be introduced.

4.1.2.2 Diffusion of Innovation Theory

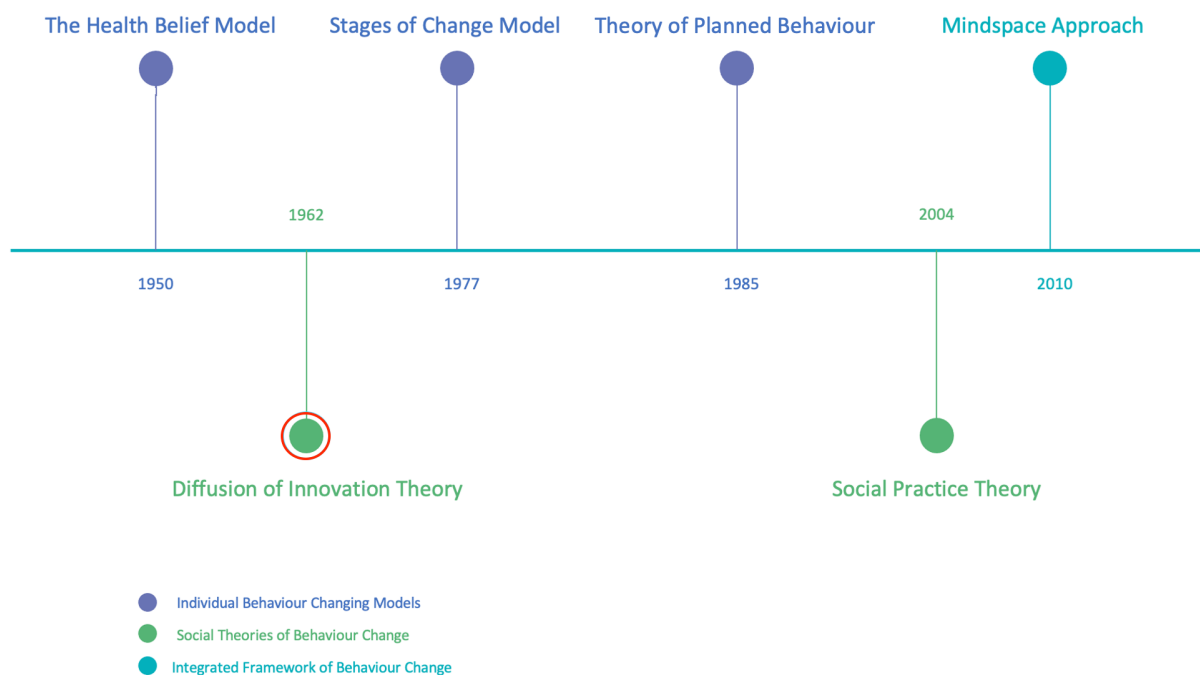


Figure 4.11: Behaviour Change Framework Timeline

Table 4.7: Diffusion of Innovation

Diffusion of Innovation Theory	
History	The Diffusion of Innovation (DOI) Theory was developed by E.M. Rogers in 1962. It originated in communication to give meaning to how an idea gains momentum over time and diffuses through a specific population or social system. The result of this diffusion is that people, who form part of a social system, adopt a new idea, behaviour or product (Rogers, 2003).
Key Deliverables	The DOI Theory focuses on innovation as a factor of behaviour change instead of looking at individual decision-makers or a social structure. Rogers (2003) defines innovation as an idea, practice, or object perceived as new. As a result, it can be perceived that innovation determines the rate of adoption to a larger extent than the characteristics of the adopters. This framework consists of four main elements of behaviour change namely, innovation, communication channels, time and social systems (Rogers, 2003). The writer further mentions that diffusion is a process where innovation is communicated through the use of channels over time among the members of a social system. This communication is unique, because of the messages that are concerned with new ideas.
Applications	This theory has mostly been used within a context the economics, and very little analysis has been done on non-economic outcomes such as sustainability (Rogers, 2003).
Shortcomings or Critique	The theory is drawn from new product development and marketing theory. Both fields are dominated by the assumption that users adopt new technology to maximise their utility. Also, the model does not integrate the overlapping effects of the different contexts and domains (Rogers, 2003).

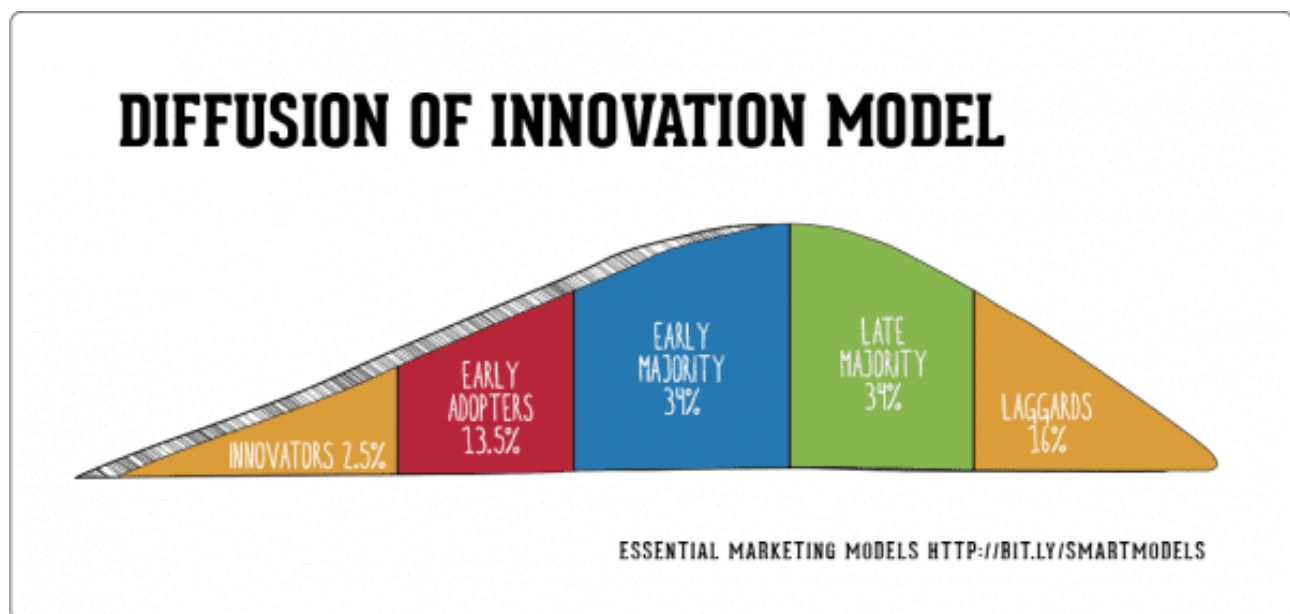


Figure 4.12: Diffusion of Innovation

According to Rogers (2003), behaviour change will occur more rapidly if innovations are seen as being a better option than the previous options. It should be consistent with existing values, suitable, the complexity should be low, one should be able to test it through limited trials and the results should be visible. Different communication channels have different and specific impacts regarding innovation diffusion. The DOI Theory highlights different roles of mass media and interpersonal channels. This is extremely useful when creating awareness amongst potential adopters and the latter being more effective in terms of persuading actual adoption (Rogers, 2003).

Diffusion networks, also known as social systems, is a key concept to this framework as diffusion occurs within them. These social systems establish boundaries around diffusion. Furthermore, this framework gives a description of the innovation-diffusion process which consists of significant similarities to stage models of behaviour change such as the Stages of Change model which was described in Section 4.1.1.2. As seen in Figure 4.13, this process starts with recognising the problem and individual adopters progress through the following five steps: knowledge, persuasion, decision, implementation and confirmation (Rogers, 2003).

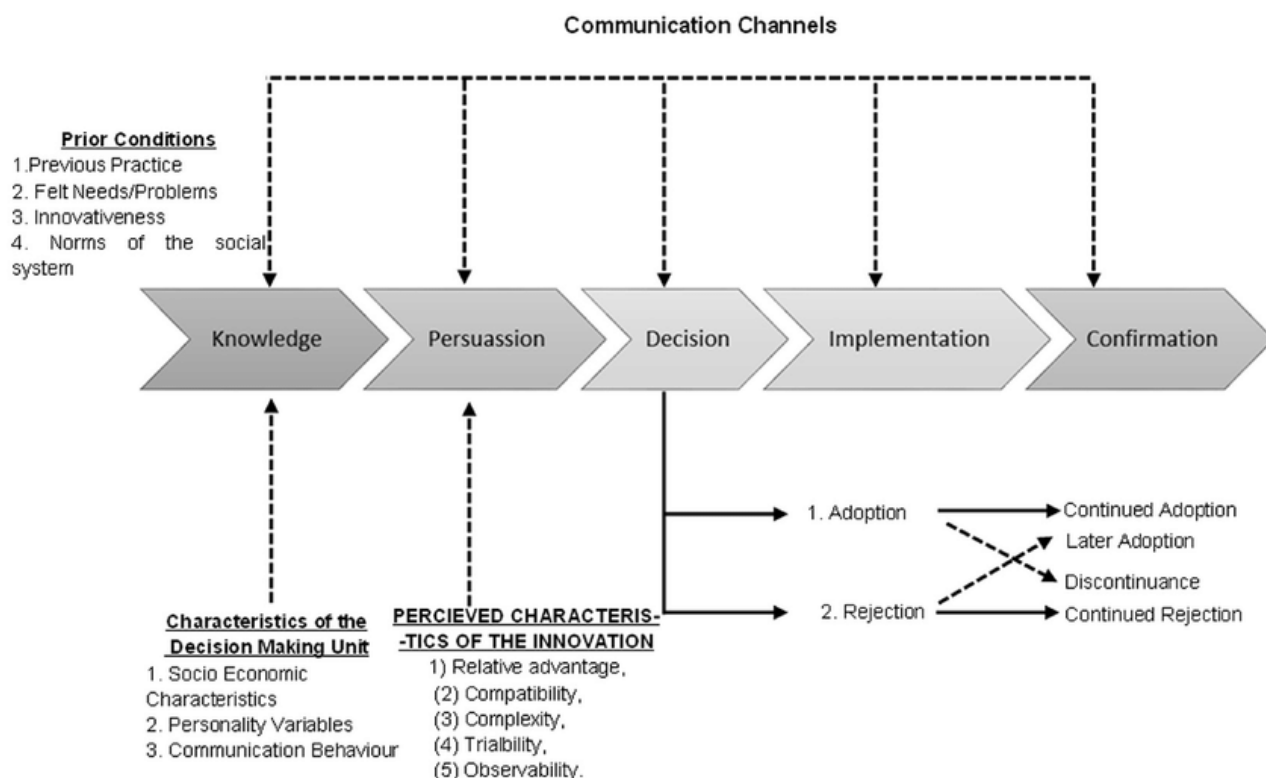


Figure 4.13: The Five Stages in the Decision Innovation Process, reproduced from Rogers (2003)

In the next section integrated frameworks of behaviour change will be introduced.

4.1.3 Integrated Frameworks of Behaviour Change

The complexity of behaviour as described in the literature referred to in this study has led to many attempts to distil core elements down into integrated frameworks so as to inform research design and intervention design, as well as assist non-experts in understanding behaviours and how they might engage with them. This distillation reduces the complexity of behaviour change and trades it off against usability and comprehensibility (Morris et al., 2012). Morris included only one framework classified as an integrated framework of behaviour change. This specific approach, known as the Mindspace Approach, will be introduced in this section.

The Mindspace Approach

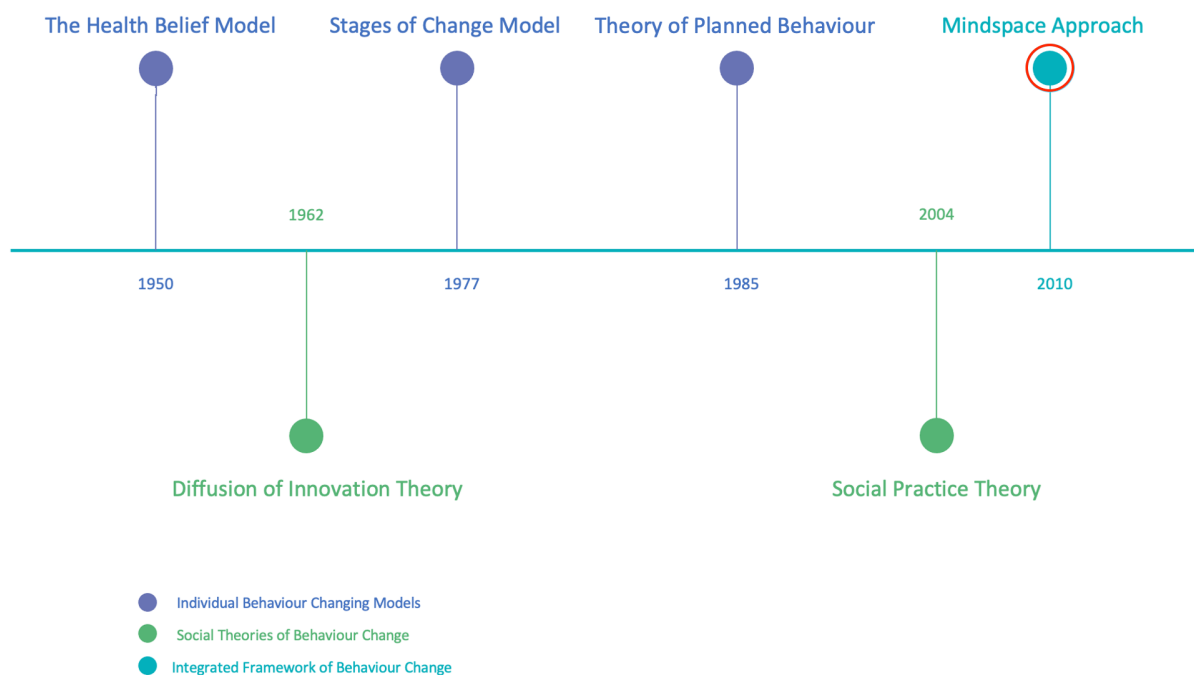


Figure 4.14: Behaviour Change Framework Timeline

Table 4.8: Mindspace Approach

Mindspace Approach	
History	The Mindspace Approach was developed by Dolan et al. in 2010. This framework served as the initial operating framework for the Behavioural Insights Team, the world’s first government institution dedicated to the application of behavioural science to better policymaking.
Key Deliverables	This mnemonic framework is based on research done in behavioural economics and psychology which attempted to point out key non-coercive influences that are related to behaviour. This approach strongly focuses on the individual decision-maker. This approach highlights the importance of context, however, it is restricted to unconscious and automatic judgements (individual cognitive processes) and does not incorporate structural social, economic or political influences on behaviour.
Applications	This framework has been widely applied in the field of energy use. A useful recent development is the energy cultures framework (Morris et al., 2012). This multi-disciplinary integrated model proposes that energy behaviours should be understood as outcomes of the interaction between cognitive norms, energy practices and material culture.
Shortcomings or Critique	Morris et al. (2012) argue that there are limitations to this framework. With reference to Table 4.9, Morris et al. (2012) suggest that the concept <i>messenger</i> implies that attention should be given to how communications are undertaken, also how communications flow between people, and which networks should be engaged with. However, it provides no assistance or guidance on how to do this. Its conclusions relating to the <i>messenger</i> , for example, suggest that attention should be given to issues such as how communications are undertaken, who should communicate with whom, and which networks the sector should seek to engage with, but provides no guidance as to how to go about this.

Table 4.9: Concepts From The Mindspace Approach, reproduced from Morris *et al.* (2012)

Messenger	We are heavily influenced by who communicates information
Incentives	Our responses to incentives are shaped by predictable mental shortcuts such as strongly avoiding losses
Norms	We are strongly influenced by what others do
Defaults	We <i>go with the flow</i> of pre-set options
Saliency	Our attention is drawn to what is novel and seems relevant to us
Priming	Our acts are often influenced by sub-conscious cues
Affect	Our emotional associations can powerfully shape our actions
Commitments	We seek to be consistent with our public promises, and reciprocate acts
Ego	We act in ways that make us feel better about ourselves

According to the Mindspace Approach the influences that have the most robust effect on behaviour is incentives, norms, defaults, saliency, priming, affect, messenger, commitment and ego. Dolan *et al.* (2012) mention that this approach is derived from the judgement of how best to categorise a large body of literature and behavioural influences. Dolan *et al.* (2012) also mention that there is no special significance to the ordering of the categories and that there is inevitably some overlap between the effects. In the following section frameworks of motivation will be addressed.

4.2 Motivation

It was mentioned in Section 4 that motivation is seen as an aspect that can be used to change behaviour. Karimi and Nickpayam (2017) argue that motivation is demonstrated by an individual's choice to engage in an activity and the intensity of effort or persistence in that activity. Motivation can be understood as a cognitive decision-making process in which the intention is to make the behaviour that is aimed at achieving a specific goal through monitoring and initiation (Locke *et al.*, 1981).

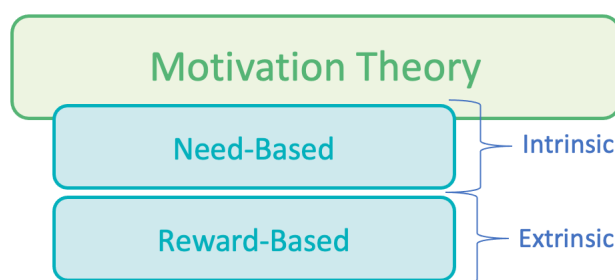


Figure 4.15: Intrinsic and Extrinsic Motivation

This section reviews and evaluates developments in motivational psychology as they pertain to individual behaviour. According to Karimi and Nickpayam (2017), current approaches concern two dominant clusters that play a role in determining an individual's motivation: extrinsic and intrinsic motivation. Intrinsic motivation refers to behaviour that is driven purely by internal rewards.

Additionally, the motivation to engage in a behaviour arises from within the individual because it is naturally satisfying. In contrast to this, extrinsic motivation involves engaging in a behaviour in order to earn external rewards or avoid punishment. Figure 4.15 illustrates which motivation theory uses intrinsic motivation and which theories use extrinsic motivation.

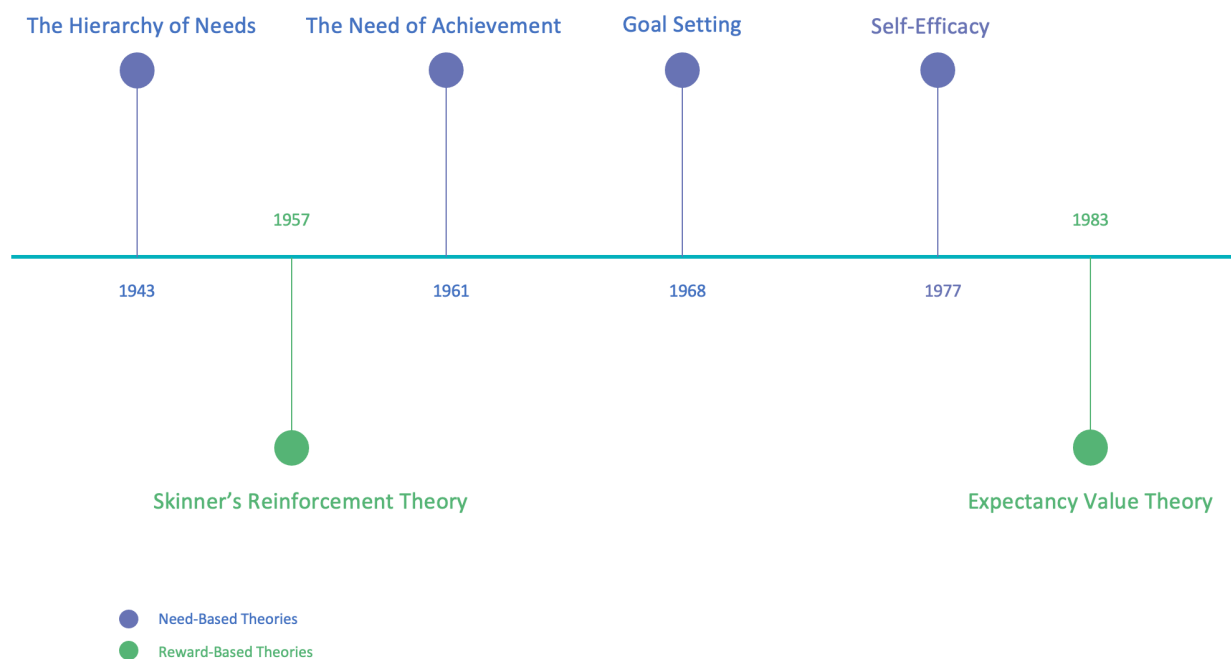


Figure 4.16: Motivation Theory Timeline

In this section, different motivation theories will be presented. Figure 4.16 illustrates the different motivation theories that will be discussed in this chapter. The figure allocates the theories according to the date it was developed on a timeline. Following Reiners and Wood (2015a), these theories are classified as either need-based theories or reward-based theories. At the one end, intrinsic motivation is the focus of Maslow's Hierarchy of Needs, Atkinson's Need of Achievement Theory, as well as Bandura's Self-Efficacy Theory and Goal Setting Theory. All these are classified as need-based theories. On the other end, we place extrinsic motivation which is the focus of Expectancy Value Theory and Skinner's Reinforcement Theory. These theories explain the motivation to perform behaviours or actions that induce extrinsic rewards Reiners and Wood (2015a). This research study follows Reiners and Wood (2015a) classification of motivation theories.

This section presents a brief overview, providing the highlights of each theory that will be discussed. A complete review of all motivation theories is outside the scope of this chapter. Reiners and Wood (2015a) also have two alternative classifications of motivation theories namely, social-based theories and self-determination theories. These theories falling under these classifications is also outside the scope of this study. Need-based theories and reward-based theories were specifically chosen for the purpose of this study in order to possibly use the characteristics of these theories in the development of an SLBCF.

In an attempt to facilitate easy comparison and contextualisation, a similar structure to the one that was used for behaviour change theories will be used for motivation theories. Each one of these theories will be presented by using the following artefacts and structure:

- The motivation theory timeline will be presented, and the relevant theory position on the timeline will be highlighted;
- The history, key deliverables, applications and shortcomings of the theories will be presented in a table format;
- A schematic representation of the theory, illustrating the main elements and interaction between elements.

4.2.1 Need-Based Theories

Following Reiners and Wood (2015a), the different need-based theories will be briefly discussed. The following theories were identified as the most prevalent and applicable for the purpose of this study: Maslow's hierarchy of needs, Need Achievement Theory, Goal Setting and Self Efficacy.

4.2.1.1 The Hierarchy of Needs

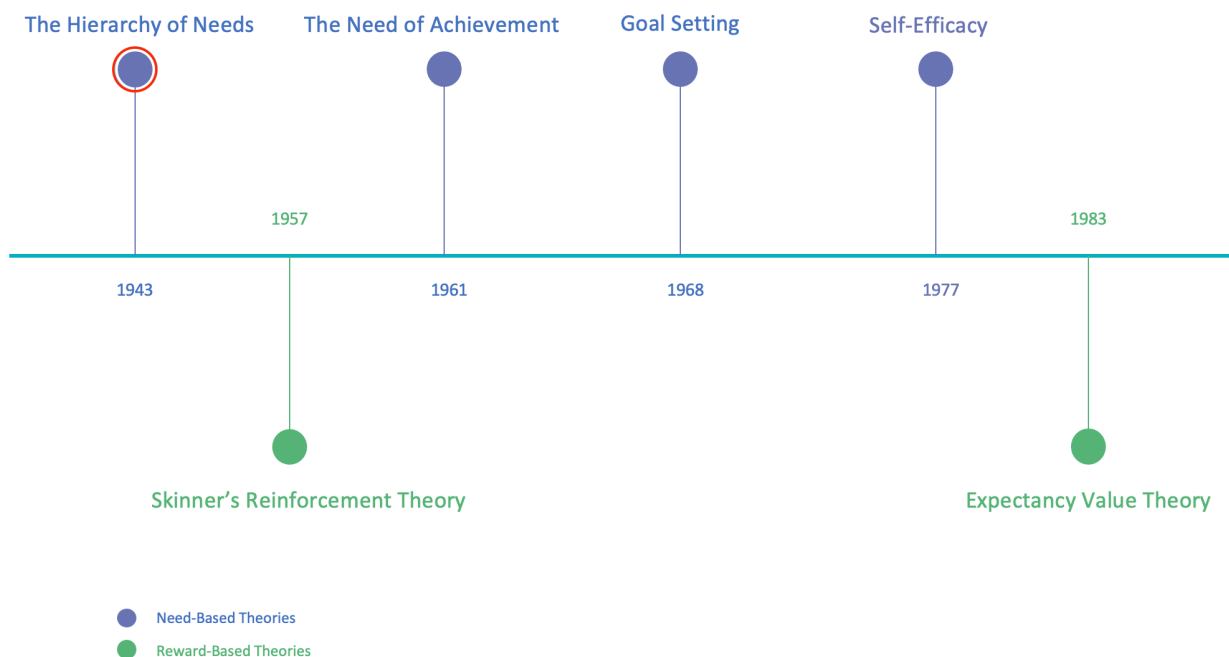


Figure 4.17: Motivation Theory Timeline

Figure 4.17 illustrates Maslow's hierarchy of need relative to the other motivation theories.

Table 4.10: The Hierarchy of Needs

Maslow's Hierarchy of Needs	
History	In 1943, the psychologist Abraham Maslow proposed one of the most well-known motivation theories known as Maslow's hierarchy of needs.
Key Deliverables	Kaur (2013) suggests that human behaviour is mostly driven by a desire to satisfy psychological and physical needs. The writer introduced five levels of basic needs that influence human activity. According to Kaur (2013) the need for psychological satisfaction and the need for safety and security are the biggest priority. Following, more complex needs such as the need for belonging, self-actualization and self-esteem. Further progression up the hierarchy of needs results in needs that produce incentives and positive goals. Maslow's hierarchy of needs is presented in Figure 4.18.
Applications	According to Kaur (2013), the greatest value of Maslow's need theory lies in the practical implications it has for every management of organisations. This theory has been applied in various organisational settings and managerial settings in the workplace.
Shortcomings or Critique	Kaur (2013) suggests that there are generally three major criticisms directed to the need theory and other content theories of motivation: There is scant empirical data to support their conclusions, they assume employees are basically alike, and they are not theories of motivation at all, but rather theories of job satisfaction.

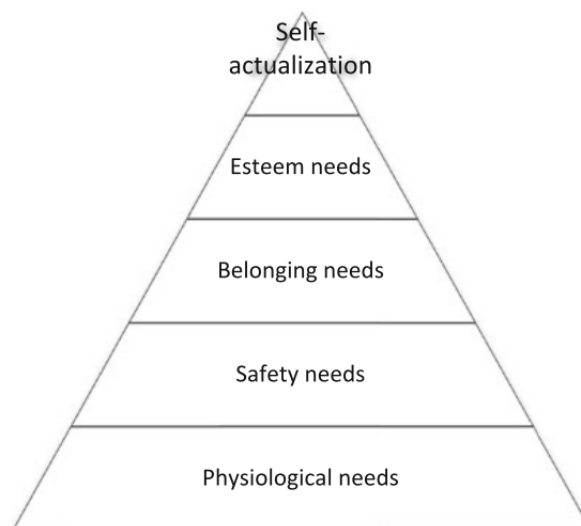


Figure 4.18: Maslow's hierarchy of needs, reproduced from (Siang and Rao, 2003)

Maslow's Hierarchy of Needs are explained as follow (Kaur, 2013):

- **Physiological needs:** This is the need at the bottom of the triangle and includes the lowest order need. This includes the need to satisfy fundamental biological drives such as food and shelter.
- **Safety needs** occupy the second level of needs. They refer to the need for a secure working environment free from any threats or harms.
- **Social needs:** These needs are activated after safety needs are met. Social needs refer to the need to be accepted and loved.

- Esteem needs: this represents the fourth level of needs. It includes the need for self-respect and approval.
- Self-actualisation: This occupies the last level of the triangle. This refers to the need to become all that one is capable of being to develop one's fullest potential.

In the following section, the need of achievement will be discussed.

4.2.1.2 The Need of Achievement

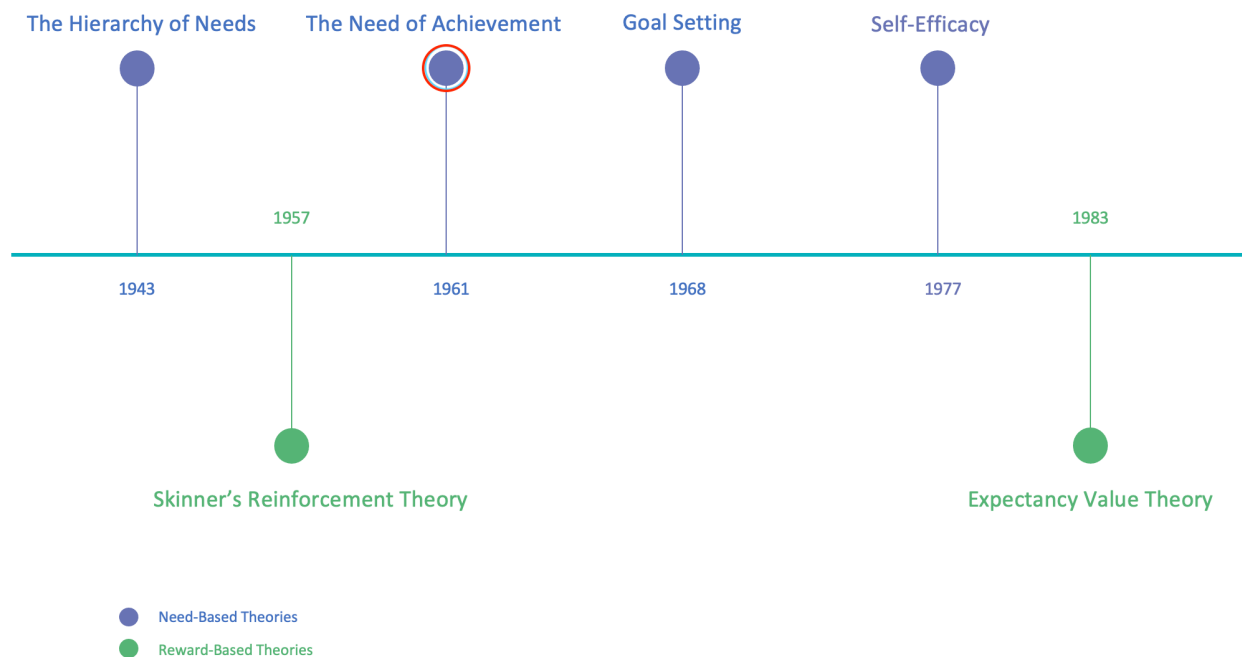


Figure 4.19: Motivation Theory Timeline

As illustrated in Figure 4.19, the need of achievement is the second theory that will be discussed which falls under the need-based theories classification.

Table 4.11: The Need of Achievement

The Need of Achievement	
History	The term <i>need of achievement</i> was first used by Henry Murray and the concept of this theory was subsequently popularized by the psychologist David McClelland in 1961 (Reiners and Wood, 2015a).
Key Deliverables	This motivational theory states that the needs for achievement, power, and affiliation significantly influence the behaviour of individuals, which is useful to understand from a managerial perspective. Reiners and Wood (2015a) suggest that achievement behaviour is directed at developing high rather than low ability. This could imply that where achievement is an option, success is desired to an extreme extent which indicates that high ability is desired and failure is avoided.
Applications	McClelland's theory can be applied to manage corporate teams by identifying and categorizing every team member amongst the three needs. Knowing their attributes may certainly help to manage their expectations and manage the team effectively (Reiners and Wood, 2015a).
Shortcomings or Critique	Need and satisfaction of needs is a psychological concept. Sometimes even the individual may not be aware of his own needs. In such a case, it will be difficult for the manager to understand the employee's needs. There is no direct cause and effect relationship between need and behaviour. One particular need may cause different types of behaviour in different individuals. On the other hand, a particular individual behaviour may be the result of different needs.

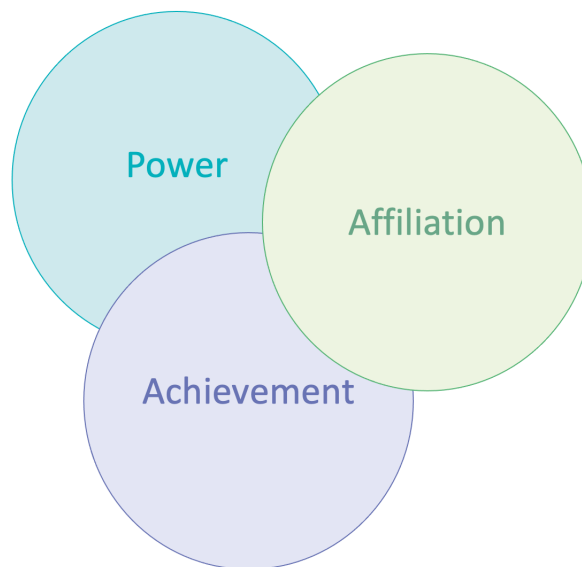


Figure 4.20: Need of Achievement Theory, adapted from Reiners and Wood (2015a)

In the next section the concept goal setting will be introduced.

4.2.1.3 Goal Setting

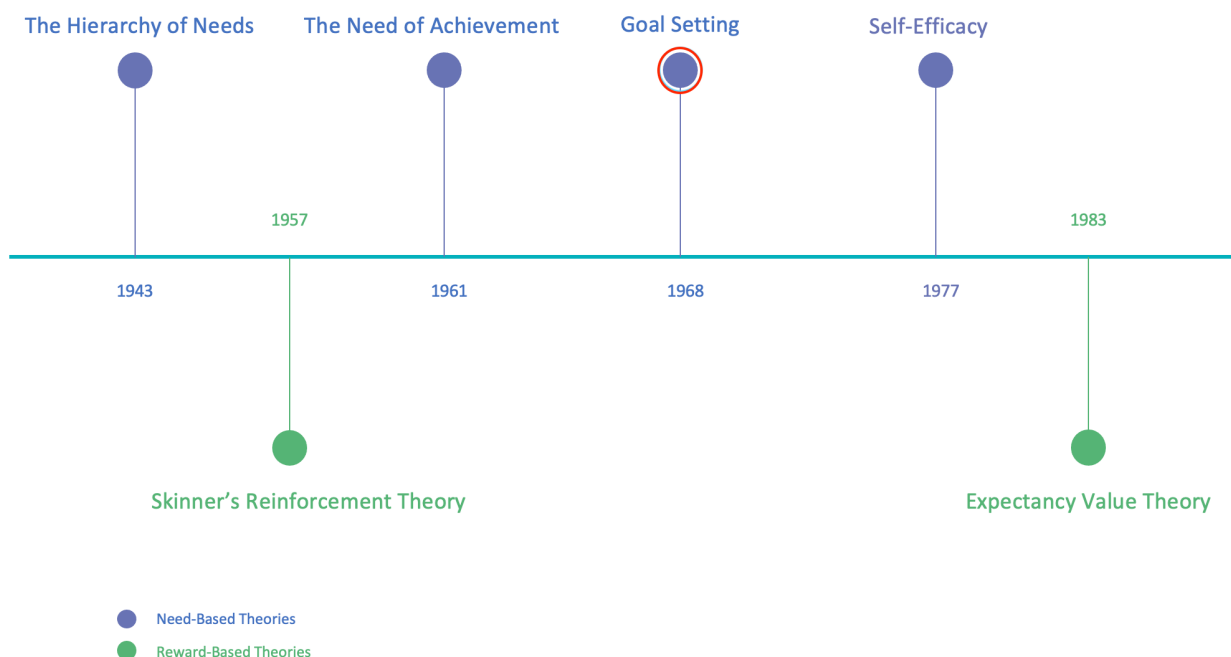


Figure 4.21: Motivation Theory Timeline

Table 4.12: Goal Setting

Goal Setting	
History	In 1968, Edwin Locke published his groundbreaking Goal Setting Theory. With this theory, he demonstrated that employees are motivated by clear, well-defined goals and feedback, and that challenges in the workplace could be used for good (Locke et al., 1981).
Key Deliverables	Locke et al. (1981) defined a goal as the aim or object the individual is trying to accomplish. Furthermore, the author suggests that specific, difficult and immediate goals results in more motivation to achieve, rather than long-term goals. Performance is affected by increasing persistence and directing attention in the ability to achieve the task at hand. Goal setting result in improving task performance given that the goals are sufficiently challenging and specific. Additionally, feedback needs to be provided in order to show the progress made, rewards are received for attaining the goal, and the given goals are actually accepted and agreed on by the individual (Locke et al., 1981). Gradual increase of the difficulty level of task requirements functions as a motivational construct for self-efficacy. The following section gives a broader perspective on self-efficacy.
Applications	This theory has been applied in different workplace settings. It is specifically used to motivate employees (Bozkurt et al., 2017).
Shortcomings or Critique	Goals that are too far above an employee's skills and competencies can have a negative effect on the employee's performance and motivation to complete the goal. More complex and difficult goals may lead to risky behaviour in an attempt to accomplish the goals in a timely manner (Bozkurt et al., 2017).

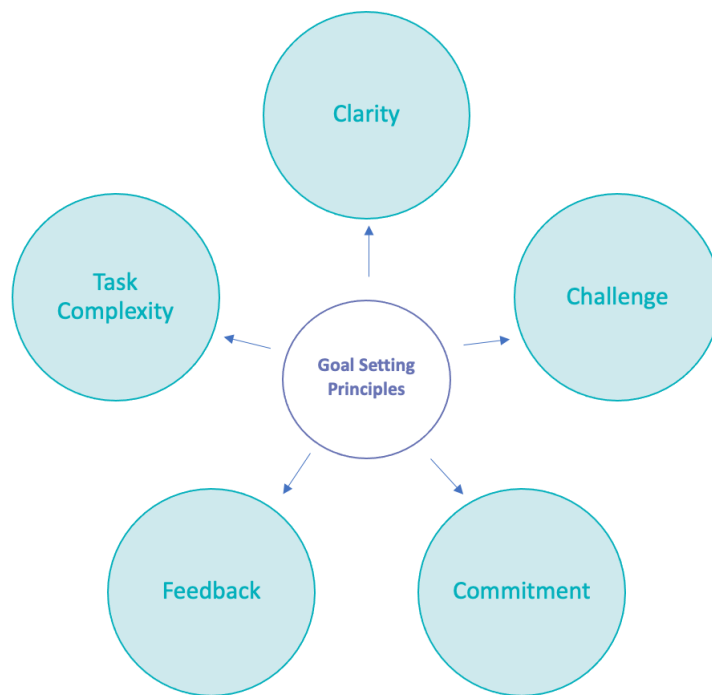


Figure 4.22: Goal Setting Theory, adapted from Locke et al. (1981)

4.2.1.4 Self-Efficacy

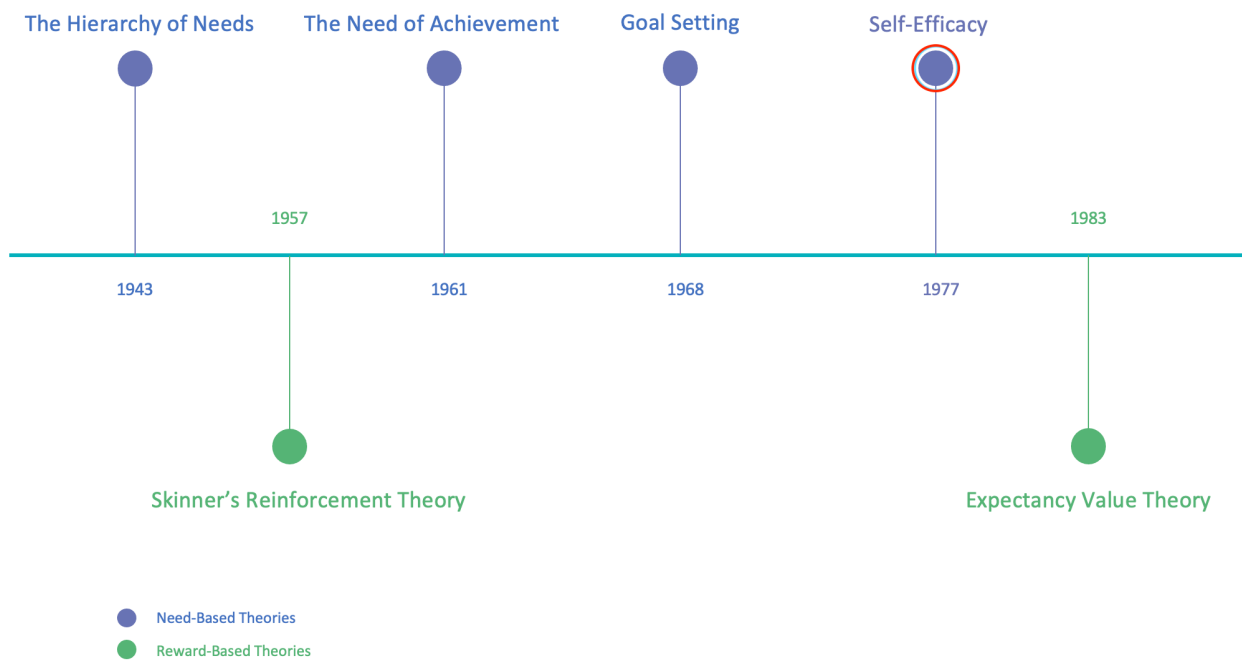


Figure 4.23: Motivation Theory Timeline

Table 4.13: Self-Efficacy

Self-Efficacy	
History	In 1977 Albert Bandura introduced his social-cognitive theory and self-efficacy theory, in which he proposed that self-efficacy and outcome expectancies are very important to behaviour initiation and maintenance (Bandura, 1977).
Key Deliverables	The author defines self-efficacy as perceived performance ability regarding a specific activity. The levels of self-efficacy enhance motivation (Reiners and Wood, 2015a). Furthermore, the author argues that individuals with higher self-efficacy usually perform more challenging tasks. An increase in effort and persistence is invested. Also when the individual fails, recovery occurs quicker and commitment to goals remains. Self-efficacy can be positively stimulated when tasks are divided into different levels of difficulty. Reiners and Wood (2015a) state that the more the players believe that they will be able to succeed in a task, the better they will perform in the specific task.
Applications	This theory has been widely utilized in health psychology to influence behaviour change in chronic disease management, smoking cessation, eating and exercise (Reiners and Wood, 2015a).
Shortcomings or Critique	When individuals have too high of self-efficacy and are overconfident they may set themselves up for failure (Reiners and Wood, 2015a). The lower your self-efficacy is the less willing you are to experiment with new ideas (Bandura, 1977).



Figure 4.24: Self-Efficacy, reproduced from Reiners and Wood (2015b)

Self-efficacy was the last theory that will be presented that falls under need-based theories. In the next subsection, reward-based theories will be introduced.

4.2.2 Reward-Based Theories

According to Reiners and Wood (2015a), extrinsic motivations are created through external factors, such as rewards, or incentives. Policymakers most often rely on financial consequences such as fines, taxes and subsidies to encourage pro-environmental behaviour as well as to discourage environmentally harmful behaviour. The reason for this is that financial consequences are much easier to administer on larger scales. Over the years monetary rewards, as well as penalties have proven to change behaviour for the better. However, Bolderdijk *et al.* (2018) feel that there are critical risks to this particular approach. Money can create a mindset in which the influence of moral obligations or personal norms is suppressed. Lindenberg and Steg (2007) argue that as soon as money enters the picture, individuals see the decision whether or not to act morally as a business approach, instead of an ethical issue. This onset of the business mindset can be prevented by positioning monetary rewards and penalties as support for the desired behaviour, rather than making it the ultimate goal. Secondly, attempts could be made to promote behaviour change through non-monetary consequences such as praise, toys, privileges or public recognition (Bolderdijk *et al.*, 2018).

In the following section, reward-based theories as defined by Reiners and Wood (2015a), are introduced as well as the theoretical base of incentives and rewards in gaming. The first theory mentioned in this section is the Expectancy Value Theory and secondly, Skinner's Reinforcement Theory. These two theories were chosen to be presented as they were identified to be most applicable to this research study.

4.2.2.1 Expectancy Value Theory

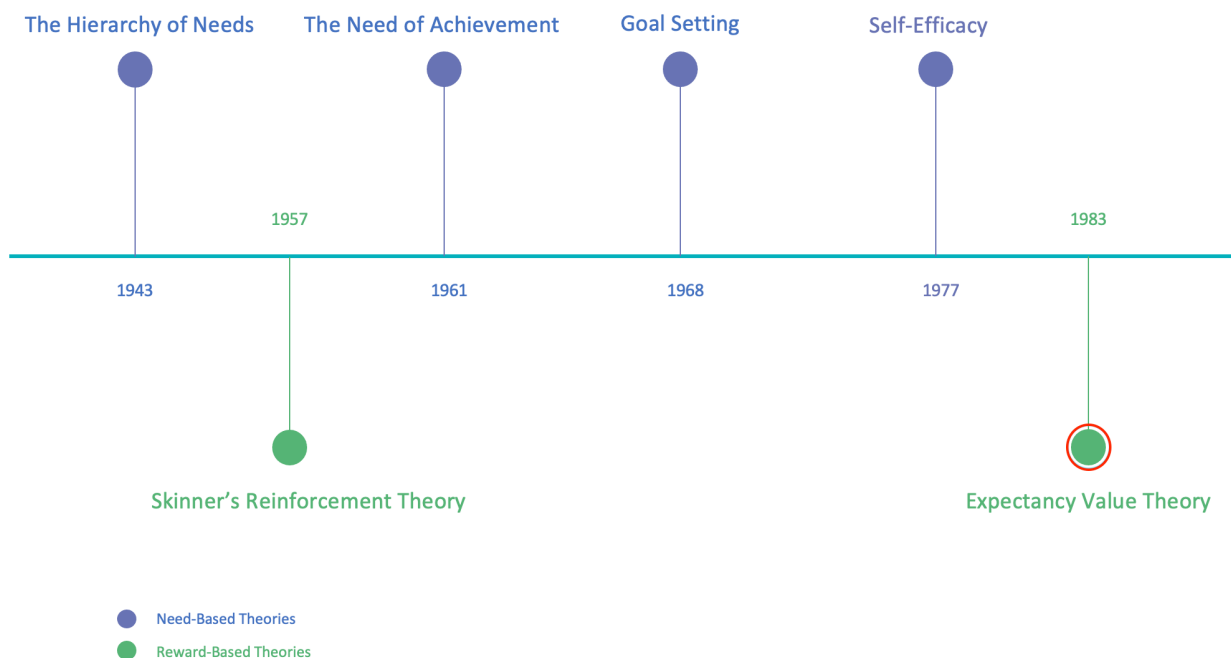


Figure 4.25: Motivation Theory Timeline

Table 4.14: Expectancy Value Theory

Expectancy Value Theory	
History	John William Atkinson developed the EVT in the 1950s and 1960s in an effort to understand the achievement motivation of individuals. In 1983, Jacquelynne Eccles expanded this research into the field of education (Leaper, 2011). This theory relates to the motivation strength which enables one to strive towards a certain goal, the expectations to attain the goal, and the incentive value of this specific goal.
Key Deliverables	EVT holds that goal-directed behaviour is a function of believing that your effort will lead to the performance needed to receive the rewards (Vansteenkiste et al., 2005). According to Reiners and Wood (2015a), the performance of the individual will determine the outcome of the task performed; and the value attached to achieving the outcome of the task. Reiners and Wood (2015a) also suggest that the values of rewards have an influence on achievements, choices, effort, persistence and performance.
Applications	The EVT has been developed in many different fields including education, health, communications, marketing and economics. Although the model differs in its meaning and implications for each field, the general idea is that there are expectations as well as values or beliefs that affect subsequent behaviour. (Reiners and Wood, 2015a).
Shortcomings or Critique	This theory doesn't consider that the individual's emotional state, personality, abilities, knowledge, skills, and past experiences. It is also seen as a perception-based model (Reiners and Wood, 2015a).

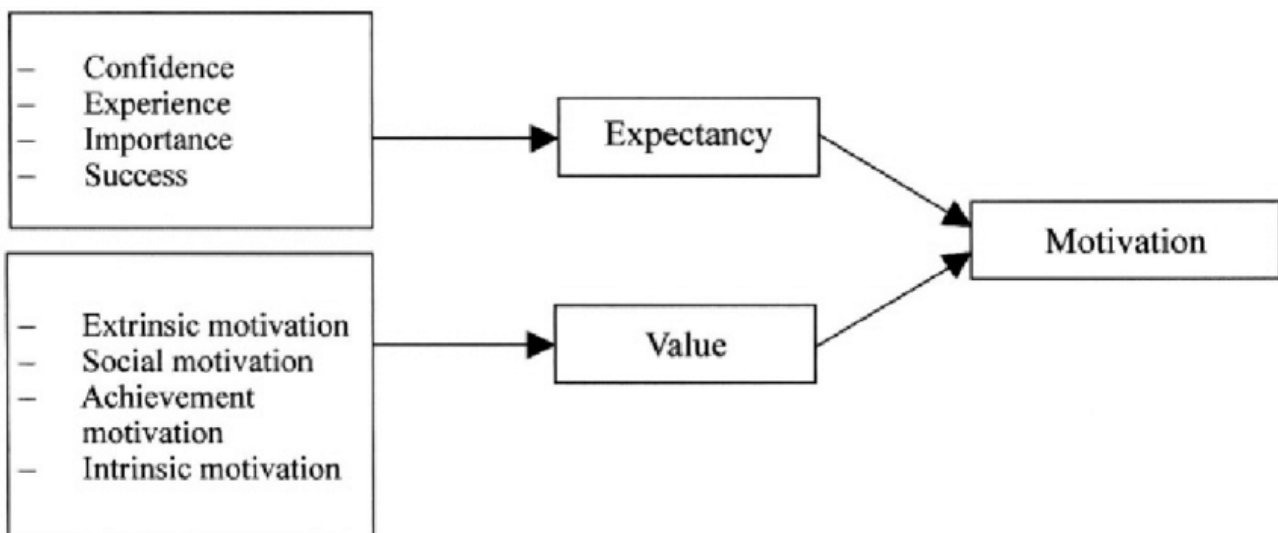


Figure 4.26: Expectancy Value Theory, reproduced from Goodyear and Jones (2004)

The following theory which will be presented is Skinner's Reinforcement Theory.

4.2.2.2 Skinner’s Reinforcement Theory

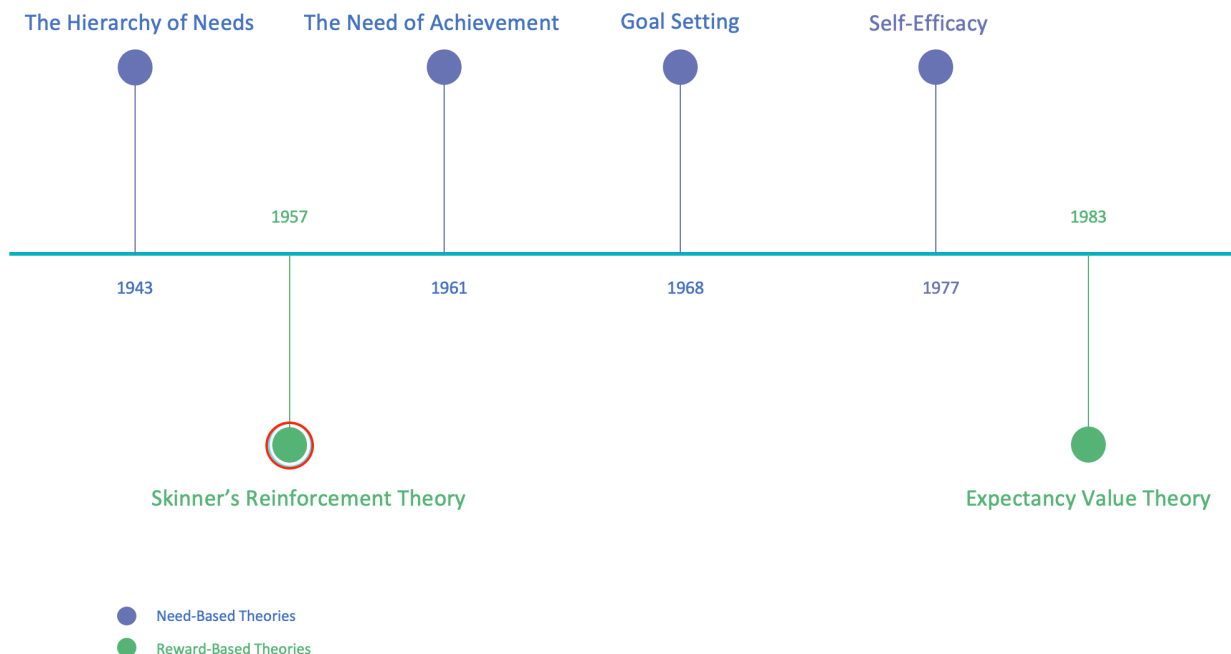


Figure 4.27: Motivation Theory Timeline

The second theory which will be discussed is Skinner’s Reinforcement Theory which focuses on human motivation.

Table 4.15: Skinner’s Reinforcement Theory

Skinner’s Reinforcement Theory	
History	This theory was published by an American social philosopher, psychologist and behaviourist Burrhus Frederic Skinner in 1957. Skinner (1979) mentions that his work is built on the assumption that behaviour is influenced by its consequences.
Key Deliverables	Reinforcement theory is the process of shaping behaviour by controlling the consequences of the behaviour. Reinforcement theory proposes that you can change someone’s behaviour by using reinforcement, extinction or punishment. Rewards are used to reinforce the behaviour you want and punishments are used to prevent the behaviour of the individual you do not want. Extinction is a means to stop someone from performing a habitual behaviour. Reinforcements can be defined as outcomes that strengthen the probability of a response. Reiners and Wood (2015a) argue that reinforcement creates desired behaviour faster than partial reinforcement. According to this theory, occasional reinforcement of behaviour leads to even more persistence to extinction than continuous reinforcements.
Applications	This theory has been implemented and used for educational and managerial purposes. It is used to manage learners or employees’ performance (Reiners and Wood, 2015a).
Shortcomings or Critique	The reinforcement theory only considers behaviour and consequences without considering processes of internal motivation or individual differences (Redmond, 2010). It is not equally reliable in all situations. Using it to impact behaviours involved in complicated task work can be problematic. It is easier to reinforce behaviour that applies to a simple task because positive and negative behaviours are easier to keep track of and modify (Redmond, 2010).

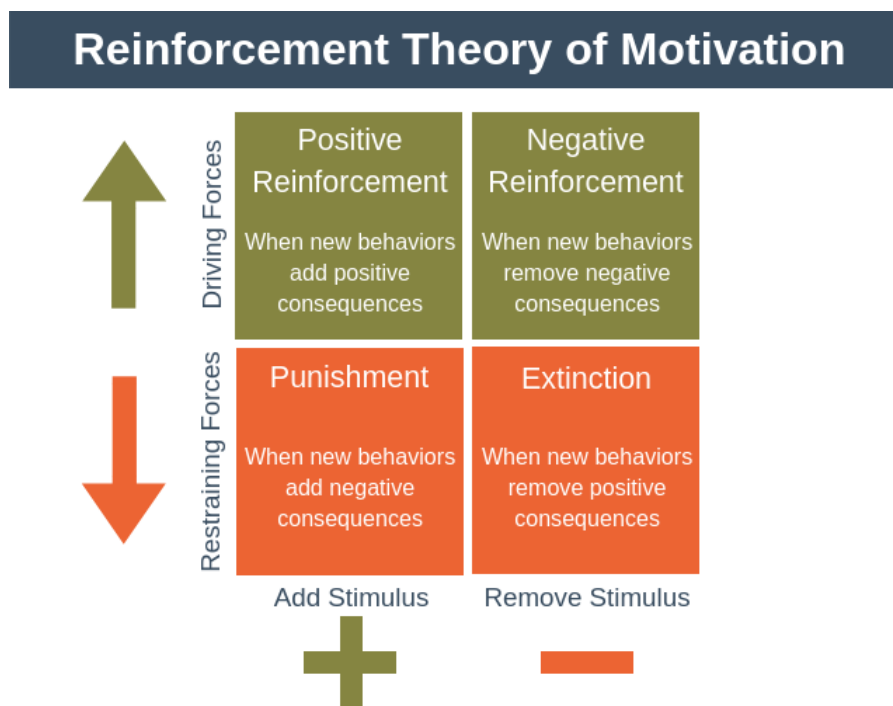


Figure 4.28: Reinforcement Theory, reproduced from EPM (2021)

This concludes the reward-based theories that will be presented in this chapter. In the next section gamification will be introduced.

4.3 Gamification

This section focuses on the intersection between two well-researched areas: game playing and motivation (Reiners and Wood, 2015b). Gamification is the link between intrinsic and extrinsic motivation. In this section gamification will be defined, following with the use of gamification elements. Section 4.3.2 gives more detail on how meaningful gamification can be created by using game design elements. Lastly, the potentials of gamification are presented.

4.3.1 Defining Gamification

The concept *gamification* is defined by Reiners and Wood (2015a) as the use of elements in non-gaming systems to improve user experience and user engagement, loyalty and fun. In the following table the main characteristics of gamification will be presented:

Table 4.16: Gamification

Gamification	
History	As a formalized and widely implemented strategy, gamification is a relatively new concept, only gaining traction in the 21st Century. However, gamification has existed for a significantly longer time. Nick Pelling, a game designer who had been tasked with developing a game-like interface for ATM and vending machines, created the term gamification in 2004 (Christians, 2018). However, the concept can be tracked all the way back to 1908 (Christians, 2018).
Key Deliverables	Gamification is a strategy that employs game mechanics, techniques, and theory in areas that traditionally do not function like a game (Karimi and Nickpayam, 2017). The main idea is to use the <i>building blocks</i> of games and then implement them in real-world situations, often with the aim of motivating behaviour change within the gamified situation. Seeing gamification as an innovative and promising concept that can be applied within a variety of contexts is popular among many authors.
Applications	Although it is still a relatively new term, gamification has strong roots in organization motivation, customer loyalty, and business development (Karimi and Nickpayam, 2017). More examples include crowdsourcing, data-collection, health, social networks, environmental protection and more. Within all the mentioned contexts, it is expected that gamification should foster the initiation of goal-directed behaviour using motivation.
Shortcomings or Critique	The concept of gamification is quite new. As a result, the utility of using gamification as a tool for behaviour change is still very limited.

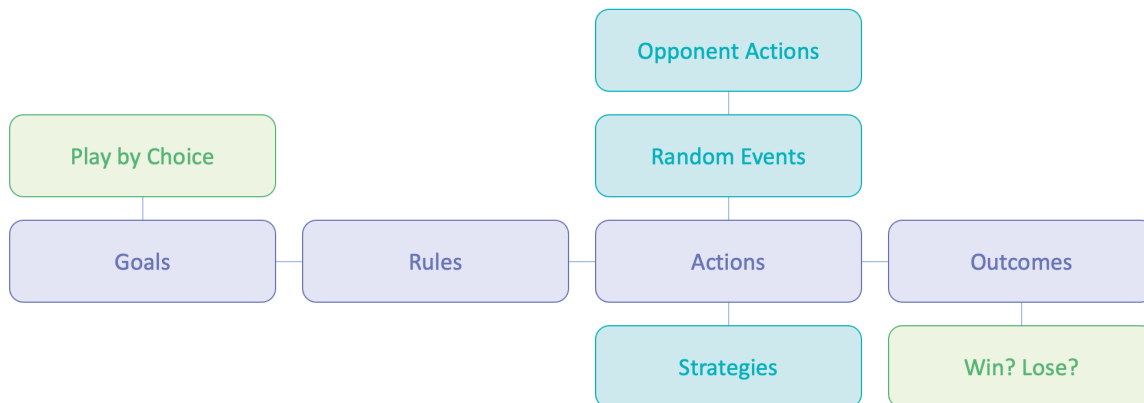


Figure 4.29: Miller’s Gamification Model, adapted from Rutkauskiene et al. (2016)

Gamification is a fairly new concept that is quickly gaining momentum. Reiners and Wood (2015a) mention that more than half of organisations use gamification in their innovation processes. It was emphasized that the need for the development of gamification systems that could create intrinsic motivations would result in a more positive outcome than the use of extrinsic rewards (Reiners and Wood, 2015a).

The authors, Reiners and Wood (2015a), comment on the similarities between gamification and serious games¹ such as PlayStation or computer games. Reiners and Wood (2015a) state that these two topics are related, because they both try to use aspects of games to achieve a goal that goes beyond playfulness. Serious games offer entertainment as well as a way to solve real-world problems. On the other hand, gamification is used in intelligent ways to promote a product or a business. The article suggests that players can earn badges, discounts and other rewards by *checking in* to mobile phone applications. Gamification attempts to use the motivation that was created through the game in order to promote achievement, participation and persistence.

Different studies have been done on motivation and acting on the motivation through Organizational Science, Educational and Social Psychology. These areas of study focus on motivation in specific environments. Reiners and Wood (2015a) attempt to link these theories with gamification. Games inherently possess a high level of motivational potential. Sailer *et al.* (2017) argue that given this potential, the idea of using the motivational power of video games for real-world applications is not a preposterous concept. This idea forms the root of all current discussions concerning the term gamification.

It was already mentioned in Section 4.2 that the two main aspects that play a role in determining the user's motivation, are intrinsic and extrinsic motivation. These two concepts are combined in gamification, as seen in Figure 4.30. Extrinsic rewards in gaming improve engagement and also raise feelings of autonomy as well as a sense of belonging. These extrinsic rewards could include points, badges and levels. Another aspect that is quite important is the social part that forms part of a game. This could include social interaction, competition and cooperation.

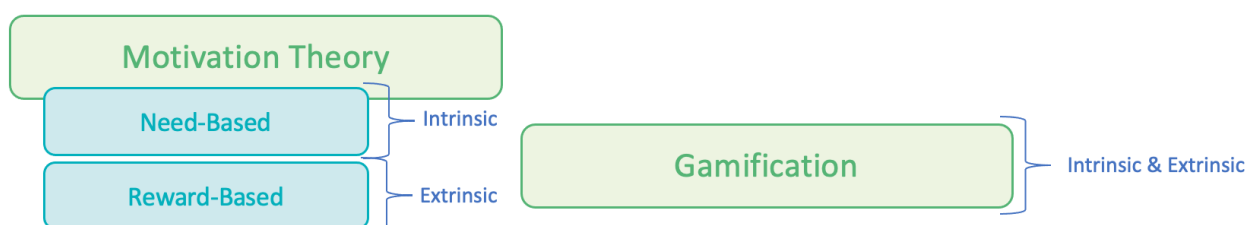


Figure 4.30: Extrinsic and Intrinsic Motivation in Gamification

The following sections will introduce: elements of game design, psychological need satisfaction, psychological needs and game design elements.

4.3.1.1 Elements of Game Design

Game designs can be seen as the basic *building blocks* of gamification applications and are very similar to game design patterns (Werbach, 2014). When specifically looking in the context of

¹Serious Games: A serious game or applied game is a game designed for a primary purpose other than pure entertainment. The "serious" adjective is generally prepended to refer to video games used by industries like defence, education, scientific exploration, health care, emergency management, city planning, engineering, and politics (Susi *et al.*, 2007).

gamification, many authors have proposed compilations of recurring design elements. Glanz *et al.* (2002) propose game elements, which includes a presentation of oneself through narrative text, feedback, teams, avatars, ranks and competition. Sailer *et al.* (2017) aim to investigate the effects of a selection of specific game design elements. Furthermore, the focus is mainly on selecting elements based on their visibility to the players and how strongly they can be expected to address motivational mechanisms. Sailer *et al.* (2017) explain in much detail each element that form part of the game surface, which can be implemented by game designers. This creates a way in which elements can be manipulated independently of one another, which enables their specific effects to be detected within empirical research. The elements of gamification according to Sailer *et al.* (2017) are:

1. *Points* are basic elements of a multitude of games or gamified applications. They serve to numerically represent the player's progress (Werbach, 2014). Points most important purpose is to provide feedback to the player and also act as a reward (Sailer *et al.*, 2017).
2. *Badges* are the visual representation of achievements that can be earned and collected. Earning a badge can be dependent on the number of points earned or on particular activities in the game (Werbach, 2014). Similar to points, badges also provide feedback as they give an indication of the player's performance. In general, the badges have no narrative meaning and isn't compulsory to collect. However, badges can influence players' behaviour, guiding them in selecting certain routes in order to earn the badges that are associated with them. Furthermore, badges symbolise membership of a group also, they can exert social influences on co-players (Sailer *et al.*, 2017).
3. *Leader boards* rank the players according to success and it measures them against certain criteria. Werbach (2014) regard leader boards as effective motivators if there are only a few points still to earn to move up to the next level, but as a demotivator, if the player is low on the leader board. Competition caused by leader boards creates social pressure that increases the player's level of engagement, and can as a result have a constructive effect on participation (Sailer *et al.*, 2017).
4. *Performance graphs* are often used in strategy games, they provide information about the players' performance compared to their previous performance. As a result, these performance graphs enhance improvement among the individual player (Sailer *et al.*, 2017).
5. *Avatars* are used as a visual representation of the player (Werbach, 2014). They can be chosen or uniquely created by the player. Avatars allow the player to create an identity in order to become part of a community (Werbach, 2014).
6. *Stories* are a game design element that does not relate to the player's performance. The narrative context of a game gives meaning beyond the mere quest to gain points. The narrative context can be oriented towards real, non-game contexts or act as analogies of real-world situations (Nicholson, 2015). Furthermore, the stories play a significant role in gamification, as they alter the meaning of real-world activities by adding a narrative overlay (Nicholson, 2015).
7. *Team members*, virtual non-players as well as real players, can induce conflict, cooperation or competition. Alternatively, if teams are introduced, it could result in players that work together towards a shared goal (Werbach, 2014).

The gamification elements, as mentioned by Sailer *et al.* (2017), are crucial for the purpose of this research study. These elements could be incorporated into developing a SLBCF.

Table 4.17: Gamification Elements and how they Contribute to the SLBCF

Gamification Elements And How It Contributes To The SLBCF	
Gamification Element	SLBCF Contribution
Points	Numerically represent sustainability progress
Badges	Act as achievement earned for behaviour and provide feedback on progress
Leader boards	Ranks individual according to sustainable performance
Avatars	Create identity to form part of the bigger community
Stories	Used as narrative overlay for the sustainability problem
Team members	Induce competition and cooperation

A broad variety of different gamification elements and aspects that are of importance were presented. Table 4.17, was created to point out how these elements can be used in a SLBCF. The following section discusses psychological need satisfaction.

4.3.1.2 Psychological Need Satisfaction

Sailer *et al.* (2017) used self-determination² theory to investigate the effects of the game design elements used in gamification. Their choice was based on the fact that the self-determination perspective includes a broad range of motivational mechanisms which partly overlaps with many other perspectives. Rigby and Przybylski (2009) have already successfully applied the perspective of self-determination in the context of games. Additionally, it also highlights the significance of the environment in fostering motivation. By enriching the environment with game design elements, as gamification does by definition, it directly modifies that environment. As a result, it potentially affects motivational and psychological user experiences (Sailer *et al.*, 2017).

The author further mentions that within self-determination theory, there are three basic psychological and intrinsic needs that are postulated. These include; the need for competence, the need for social relatedness and the need for autonomy (Deci and Ryan, 2002). These intrinsic psychological needs are motivational resources that can be created by modifying the environment. As a result, motivational behaviour patterns can be promoted to a significant degree by specifically addressing the human need for competence, social relatedness and autonomy (Sailer *et al.*, 2017). In the next section, it is explained how game design elements can be incorporated to satisfy psychological needs.

²Self-determination theory: Self-determination theory (SDT) is an empirically derived theory of human motivation and personality in social contexts that differentiates motivation in terms of being autonomous and controlled (Deci *et al.*, 2012)

4.3.1.3 Psychological Needs and Game Design Elements

Sailer *et al.* (2017) argue that game design elements can be used to modify non-game contexts. When trying to modify these modifications, the psychological need satisfaction theory can be incorporated. From a theoretical perspective, the question is then, which specific psychological needs can be addressed by which specific game design element. Considering the list of game design elements discussed earlier, it can be assumed that the need for competence can be addressed by performance graphs, points, badges and leader boards (Sailer *et al.*, 2017). All the game design elements give some sort of feedback. For example, points provide the player with granular feedback, that can be directly connected to the actions of the player. As a result, these feedback functions of these game design elements can evoke feelings of competence, where this communicates the success of a player's actions (Sailer *et al.*, 2017).

Experiences of decision freedom and experience of task meaningfulness are both aspects of the need for autonomy (Annetta, 2010). When looking at autonomy with regard to freedom of decision, avatars are relevant, because they offer the players freedom of choice (Annetta, 2010). Secondly, when looking at autonomy in regard to task meaningfulness, stories play a significant role. Stories can contribute to a player experiencing their own actions as meaningfully engaging, regardless of whether choices are available (Rigby and Przybylski, 2009). The need for social relatedness can also be influenced by a story if it offers a narrative perspective in which the player is given a meaningful role in the game. Together with teammates, a sense of relevance can be established by emphasizing the significance of the players' actions for the group's performance (Sailer *et al.*, 2017). In the case where a meaningful story is conveyed, there a shared goal can exist, which could cultivate experiences of social relatedness (Sailer *et al.*, 2017). The following section gives more detail on how meaningful gamification can be created by using game design elements.

4.3.2 Creating Meaningful Gamification

The goal of meaningful gamification, as developed by Nicholson (2015), is to help users find meaningful connections with the underlying non-game activities, and use rewards only when truly necessary. Nicholson (2015) further defines gamification by stating that meaningful gamification is the use of gameful and playful layers to help a user find personal connections that motivate engagement with a specific context for long-term change. When creating a gamification system, designers should first work with the organization to determine what outcomes they wish to achieve with the game. These outcomes should firstly focus on the benefits to the player. By developing a player-focused gamification system, designers are more likely to avoid short-term rewards, as the benefits of the system are in parallel to the benefits for the player. If the system is designed first to benefit an organization, then it could result in requiring more rewards and have a small long-term impact on the players. Nicholson (2015) mentions that by making the benefits for the players the first priority, the organization is more likely to gain long term participants who do not seek a continued string of increasing rewards in order to stay engaged with the game. It should be avoided to start with a system based on external rewards; if the outcomes are based on the player's needs, then the rewards will naturally form part of the project. Furthermore, it is important to ensure that there are numerous ways that the user can engage with the system. Consequently, Nicholson (2015) says that if there is only one path of engagement with a gamification system, then this will engage only one type of user.

It should be mentioned that reward-based gamification can be used as a very valuable tool. If the goal of the gamification doesn't result in long-term change, then offering a reward could be used to achieve short-term goals. Furthermore, if there are no player-based outcomes that can be created because of no intrinsic motivation for the player to engage with the real-world behaviours, then rewards could be used to get individuals engaged. This system is already implemented in the real world; money is a reward-based system that individuals use to change the behaviour of another individual (Nicholson, 2015). When the goal is to establish long-term change, their rewards must be used in moderation. If rewards are used from the start, they should be designed to be something that results in more meaningful engagement, and not a continuous way to bring people to the system. In conclusion, reward-based gamification can be of great value during the on-boarding experiences, but then those rewards need to be decreased so that the player will be challenged with tasks that ask of them to go outside the box. This results in meaningful gamification that is useful in helping the player to continue on their expedition of the desired context.

Both reward-based gamification, as well as meaningful gamification, can be used as tools to get an individual engaged in a context. However, this should only be the starting point. To create true long-term change, the whole gamification system should be specifically designed to come to an end for the individual player (Nicholson, 2015). Most gamification systems are designed to engage players on an ongoing basis and offers them more points, rewards and levels as they continue engaging with the real world. This result in, players that stay with the system until they grow tired of it, but if no transition element is built into the system, the player will most likely not make the switch to engage with the real world. Instead, the long-term goal should be to escort the player into a deeper engagement with the real-world context and then leave them there. Nicholson (2015) suggests that the gamification system should help the participant make connections with an authentic community of enthusiasts. Designers can then create systems that fade away and leave the player as a new member of this particular community. One direction the gamification journey should take is to address unmet needs and use a small reward-based layer as the tutorial to bring individuals into the system. These rewards should then be replaced with meaningful elements, such as a narrative, freedom to choose where to explore, fun activities, and opportunities to reflect. This will result in players engaging with the existing affinity groups that surround the context. The aim is then to remove the gamification layers completely. It is in this way that gamification should not be seen as a cycle, but rather as a journey to bring about lifelong change.

According to Deci and Ryan (2002), the potential of gamification is based on comprehensive motivational support and on invoking flow experiences. Mechanisms such as user satisfaction, meaning and social interaction, facilitate perceptions of control, autonomy, and fun that are central antecedents of flow experiences (Karimi and Nickpayam, 2017). Karimi and Nickpayam (2017) are of the opinion that flow can reinforce the voluntary use of a gamified service bundle and increase both performance and motivation of individuals. However, intrinsic motives and flow can be systematically activated by the use of extrinsic incentives. Thus, incentives do not only comply with the intrinsic motive of collecting but also with the extrinsic motive of social recognition. As a result, gamification allows for the design of persuasive incentive mechanisms that stretches far beyond financial incentives. Thus, Karimi and Nickpayam (2017) argue, gamification has a very high potential for changing behaviour. Gamification relates behavioural change to positive emotional feedback. In doing so, gamification may assist in the introduction of new behaviour patterns as well as the modification of habitual behaviour. Such behavioural patterns are usually automatized and

unconscious so that traditional incentive schemes frequently has low effectiveness. In providing positive emotions, gamification may separate existing habits, exchange them with new behaviours and support the stabilisation of new behaviours by continuously setting appropriate stimuli (Karimi and Nickpayam, 2017).

4.3.3 Examples of Gamification Frameworks

Management control is the act of ensuring that resources are obtained and used efficiently and effectively in the accomplishment of the organization's objectives (Anthony, 1965). This means that management control systems are the informal and formal mechanisms, processes and technologies used by organizations for monitoring, directing and adjusting behaviours and performance to pursue and implement strategies (McCarthy et al., 2019). McCarthy et al. (2019) suggest that the goals of gamification can be used to deliver highly engaged forms of management control.

In the following section, two gamification approaches will be presented namely, the MDE Framework and the Gamification+ Model. These approaches were chosen as their characteristics hold the value that could be incorporated when developing an SLBCF.

4.3.3.1 The MDE Framework

Table 4.18: MDE Framework

MDE Framework	
History	Robson et al. (2015) introduce and defines three gamification principles namely, mechanics, dynamics, and emotions. These gamification principles form the MDE framework which is used to describe the underlying aspects of a gamified experience.
Key Deliverables	By combining the designer's journey (the experience of designing a game) and the player's journey (the experience of playing a game) into an overall gamification framework, the MDE framework provides a useful lens for organizational decision-makers to understand how to design an engaging gamified experience that will lead to the intended behaviour changes by evoking desired emotions. Thus, Robson et al. (2015) propose that these gamification design principles can be used as a management control system to engage and direct the behaviours of individuals.
Applications	This framework has specifically been designed and implemented to enstrain strategic renewal with environmental velocity in organizations (Robson et al., 2015).
Shortcomings or Critique	Every individual has a unique set of motivational drivers, values and biases, and also different perspectives on what is reasonable, and therefore has to be motivated from within and won't always be motivated by player experience or rewards. Also, a common problem in organizations is that employees do not feel that the management cares about them and in turn blocking their natural motivation (Nicholson, 2015).

Figure 4.31 is a visual representation of the MDE framework:

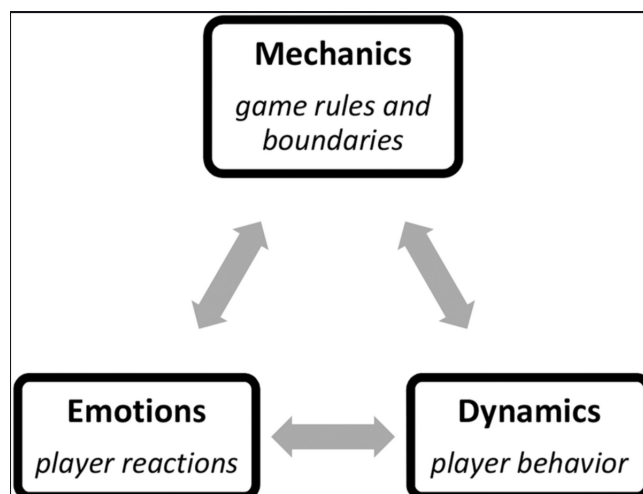


Figure 4.31: MDE Framework, reproduced from Robson *et al.* (2015)

According to Robson *et al.* (2015) gamification mechanics set up the rules of how behaviour change will be pursued. This could include different responsibilities and roles for different types of individuals and how success is measured. Every individual should follow the same mechanics. Robson *et al.* (2015) state that there are three categories of gamification mechanics, known as setup mechanics, rule mechanics, and progression mechanics. Setup mechanics indicate where, when, and how the gamified strategic behaviour change will occur. Rule mechanics dictate what the goals of the gamified strategic behaviour change process are and what actions players are allowed to take in their pursuit of these goals. Lastly, progression mechanics signal to players whether they are moving forward in their pursuit of the goal.

The dynamics are the types of player behaviours that emerge as individuals partake in any gamified behaviour change experience Robson *et al.* (2015). Contrary to mechanics that are decided by the designer, the gamification dynamics are produced by how players follow the mechanics chosen by the designers. As a result, the dynamics emerge from player interactions with other players and with the gamified experience; dynamics are the in-game behaviours, strategic actions, and interactions that happen during play.

Robson *et al.* (2015) define gamification emotions as the mental affective states evoked among individuals when they participate in a gamified experience. Emotions that occur during gamified experiences could be happiness, surprise or sadness. These emotions are a product of how individuals follow the mechanics and respond to the dynamics that develop. Emotions exert considerable influence on decision-making, disengage players, affect their decision to continue or abandon an experience and can deepen the player engagement (Robson *et al.*, 2015).

The MDE Framework helps clarify how designers and players perceive and follow different strategic behaviour change processes. As a result, understanding gamification mechanics, dynamics, and emotions, and how these principles relate to one another, is crucial for successfully gamifying and implementing a behaviour change process (Robson *et al.*, 2015).

The following approach that will be presented is the Gamification Design Model developed by a company called Gamification+.

4.3.3.2 Gamification Design Model by Gamification+

Table 4.19: Gamification Design model, adapted from Jenkins (2020)

Gamification Design Model	
History	The company was established by Pete Jenkins, first launched in August 2000 as E-advantage Solutions Ltd. The company’s intention was to provide enterprise level software to small businesses cost-effectively. In 2013 a shift took place in the company. the company’s name was changed to Gamification+ on 6th May 2015. Their goal is to achieve engagement using gamification strategies and frameworks. During this time the company released the gamification design model which is used when developing gamification frameworks for their clients (Jenkins, 2017).
Key Deliverables	Game design concepts and techniques are used to motivate and engage individuals to achieve better results in certain contexts. These result includes: creating long term customer loyalty, raising morale and increasing employee engagement, improving productivity and performance and creating behaviour change in your target audience(Jenkins, 2017).
Applications	This model has the scope to gamify any business issue. The gamification design model can be used as a tool to solve issues in any part of a company, including marketing, sales and human resource management (Jenkins, 2017).
Shortcomings or Critique	As this is a very new model and company, not many resources are available on shortcomings and critique regarding this model.

Figure 4.32 is a schematic illustration of the Gamification+ model.

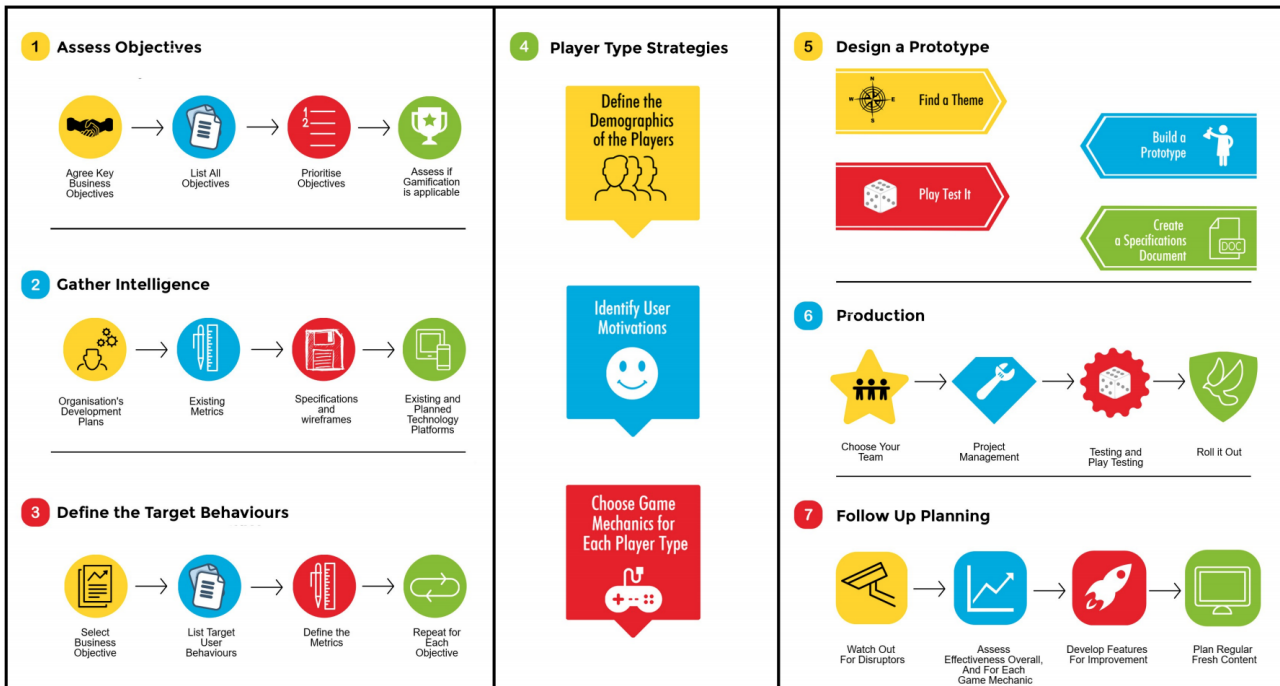


Figure 4.32: Gamification Design Model, reproduced from Jenkins (2020)

As seen in Figure 4.32, the first step gamification+ follows when designing a gamification framework, is to assess the objectives of the specific scenario. This can be done through listing and prioritising objectives. Secondly, intelligence and data are gathered. Following step 2, target behaviours need to be defined. Fourthly, the player type strategies are defined. This can be achieved by defining the demographics of the player, identifying a user and also by choosing game mechanics for each player type. The next step involves designing and building a unique prototype for the specific scenario. After the prototype is completed, production occurs. This involves choosing a team, project management, testing the model and then implementing the model. The last step involves following up and ensuring the model achieves the desired outcomes.

This model is significant for the purpose of this study as it gives a useful method in how to plan and design a new framework for a context where gamification models haven't really been implemented before.

4.4 Conclusion

The following section is the final section of this chapter. Firstly, a summary of all the previous sections will be presented. In Section 4.4.1, the candidate solution that will be used in the development of the SLBCF will be introduced. Lastly, the chapter concludes with Section 4.4.2.

The research proposed many different aspects that could be incorporated into the development of an SLBCF. Tables 4.20, 4.21 and 4.22 show by whom and in which year the framework was developed. The tables also highlight the applicable fields where the framework has been used. Lastly, the summaries indicate the main attribute of the framework as well as the elements which could contribute to the development of the SLBCF.

Table 4.20: Summary: Behaviour Change Frameworks

Summary of Behaviour Change Theories				
Individual Behaviour Change Theories				
Framework Title	Date Developed	Author	Applicable Field	SLBCF Contribution
Health Belief Model	1950s	Hochbaum, et al.	Healthcare Industry	Predict patterns of behaviour
Stages of Change	1977	Di Clemente, et al.	Addictive Behaviours	Similar problems could have similar solutions
Theory of Planned Behaviour	1985	Ajzen, et al.	Health Behaviour	Predict and analyse behaviour patterns
Social Theories of Behaviour Change				
Social Practice Theory	2004	Reckwitz	Energy Consumption	Determine human behaviour
Diffusion of Innovation	1962	Rogers	Economics	Adopting new behaviours
Integrated Frameworks of Behaviour Change				
MindSPACE Approach	2010	Dolan, et al.	Policy Making	Point out influences related to behaviour

Table 4.21: Summary: Motivation Theories

Summary of Motivation Theories				
Need-Based Theories				
Framework Title	Date Developed	Author	Applicable Field	SLBCF Contribution
Hierarchy of Needs	1943	Maslow	Motivation in workplace	Basic needs that influences human activity
Need of Achievement	1961	McClelland	Motivation in workplace	Achievement influences behaviour
Goal Setting	1968	Locke	Motivation in workplace	Goals create motivation
Self-Efficacy	1977	Bandura	Gaming	Self-efficacy influences behaviour maintenance
Reward-Based Theories				
Expectancy Value Theory	1983	Eccles	Education	Attain goal and incentive
Skinner's Reinforcement Theory	1957	Skinner	Education	Behaviour is influenced by consequences

Table 4.22: Summary: Gamification Frameworks

Summary of Gamification Frameworks				
Framework Title	Date Developed	Author	Applicable Field	SLBCF Contribution
MDE Framework	2015	Robson et al.	Establish behaviour change in organizations	Gives the designer insight in understanding how the user engages with the gamified experience
Gamification Design Model	2015	Gamification+ (Pete Jetkins)	Solve workplace related issues	Concepts can be used to motivate and engage individuals to achieve better results.

4.4.1 Candidate Solution

The primary objective of this chapter is to present a framework of the most prevalent and applicable findings of behaviour change theory to this study. However, not all the presented findings are necessarily applicable to the model that needs to be developed. Figure 4.33 explains the decision making process that was used to decide on whether the presented framework should be included in the candidate solution or not.

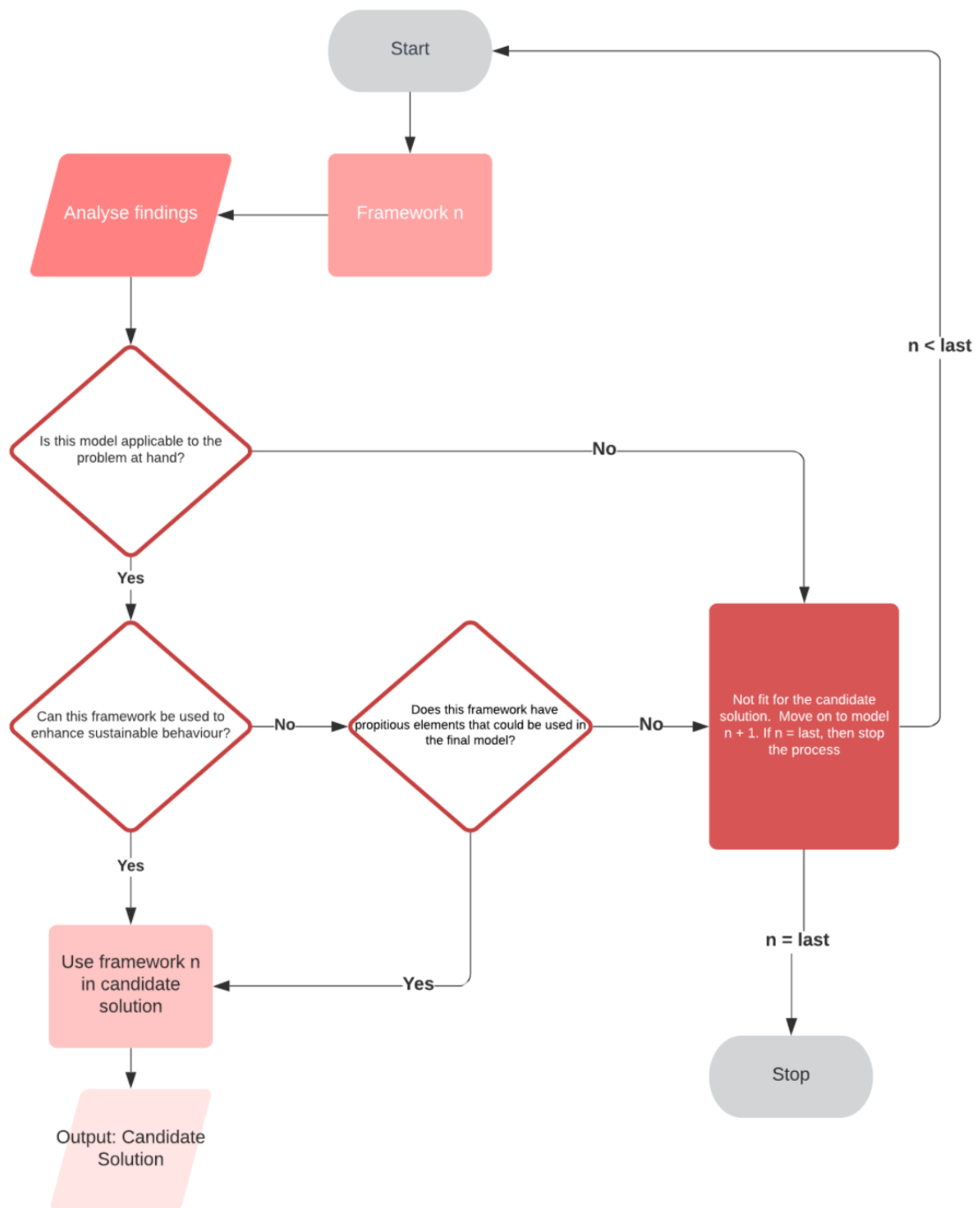


Figure 4.33: Decision Process Flow

As a result, it was decided that the following combination of frameworks will be used in the candidate solution:

Stages of Change is significant as it suggests that individuals in similar stages could be helped by the same type of solution. This could be used when implementing a model in a specific context to accommodate each individual in every stage. The six stages could also be used to classify the individuals on a scorecard to establish their level of readiness. Similar solutions could be applied to all individuals in a stage.

The **Diffusion of Innovation** theory makes use of five stages in the decision Innovation Process which could be implemented into the SLBCF. These stages could be used to describe the process from the beginning to the implementation stage of the model. It could specifically be used during the onboarding of individuals when implementing the model.

The concepts from the **Mindspace Approach** could be incorporated in the final model that would be implemented at a specific estate. These concepts could be used to define the unique characteristics of the identified estate where the SLBCF will be implemented. It could assist in the finer detail of the SLBCF.

Gamification frameworks can be designed for many different contexts. However, the one similarity which is included by all frameworks is motivation. Motivation is the key factor for the success of gamification frameworks. Gamification incorporates concepts and elements from many behaviour change theories as well as motivation theories. As a result, a solution that includes numerous concepts, that has proven to have an influence on behaviour change, is presented as a solution to design an SLBCF. What also stands out about the theory of gamification is that it uses both intrinsic and extrinsic motivation. Intrinsic motivation is addressed by intrinsic psychological needs as mentioned in Section 4.3.1.2. Extrinsic motivation is achieved by elements from gamification such as points and badges. It is proposed that reward-based gamification together with meaningful gamification should be incorporated into the SLBCF. As mentioned in Section 4.3.2, reward-based gamification can be of great value during the on-boarding experiences, but then those rewards need to be decreased in order to create meaningful gamification that will assist the individual to continue on their expedition of the desired context. The MDE Framework together with the use of gamification elements will support in clarifying how the SLBCF should be designed in order to clarify how the players will follow the behaviour change process. The steps as seen in the gamification design model developed by Gamification+ is proposed to be used when designing the SLBCF. This process will assist in ensuring that all desired objectives will be achieved. The model can also be used when implementing the SLBCF in a certain context.

The following section presents the conclusion of the chapter.

4.4.2 Chapter Conclusion

This chapter briefly investigated the history of behaviour change and how the relevant frameworks could be used to change sustainable behaviour. An extensive range of frameworks have been developed seeking to explain the processes underlying behaviour change for use in behaviour change frameworks. These frameworks were discussed and applicable elements were extracted and presented in a summary table to portray the findings in a more ambiguous way.

The primary objective of this chapter was to research and analyse the findings of current behaviour change theories. This assisted in determining which frameworks will be most appropriate to incorporate when developing an SLBCF. In pursuit of the primary objective, a number of aspects were addressed in this chapter. An overview of behaviour change theory and the evolution of these theories was first presented. Secondly, three individual behaviour change theories were presented. Thirdly, two social behaviour change theories were inspected and fourthly, an integrated theory of behaviour change. It was established that there are many different ways of approaching behaviour change. In the chapter, it was mentioned that motivation can be seen as a method to establish behaviour change. For this reason, the section presented theories of behaviour change as well as theories of motivation. There are also numerous ways in which an individual or a group can be motivated. One method included the use of rewards and incentives. Need-based theories and rewards-based theories are examples of motivation theories and were presented in Section 4.2.1 and Section 4.2.2. The chapter concluded with an in-depth discussion of gamification. Two gamification frameworks were presented namely, the MDE framework and the gamification design model. The research from this chapter resulted in a candidate solution that incorporates a number of frameworks discussed in this chapter. These include the Stages of Change Model, Diffusion of Innovation, the Mindspace Approach and Gamification. In Section 4.4.1 more detail was given on which aspects will be used when developing the SLBCF.

Chapter 5

Sustainable Living Behaviour Change Framework

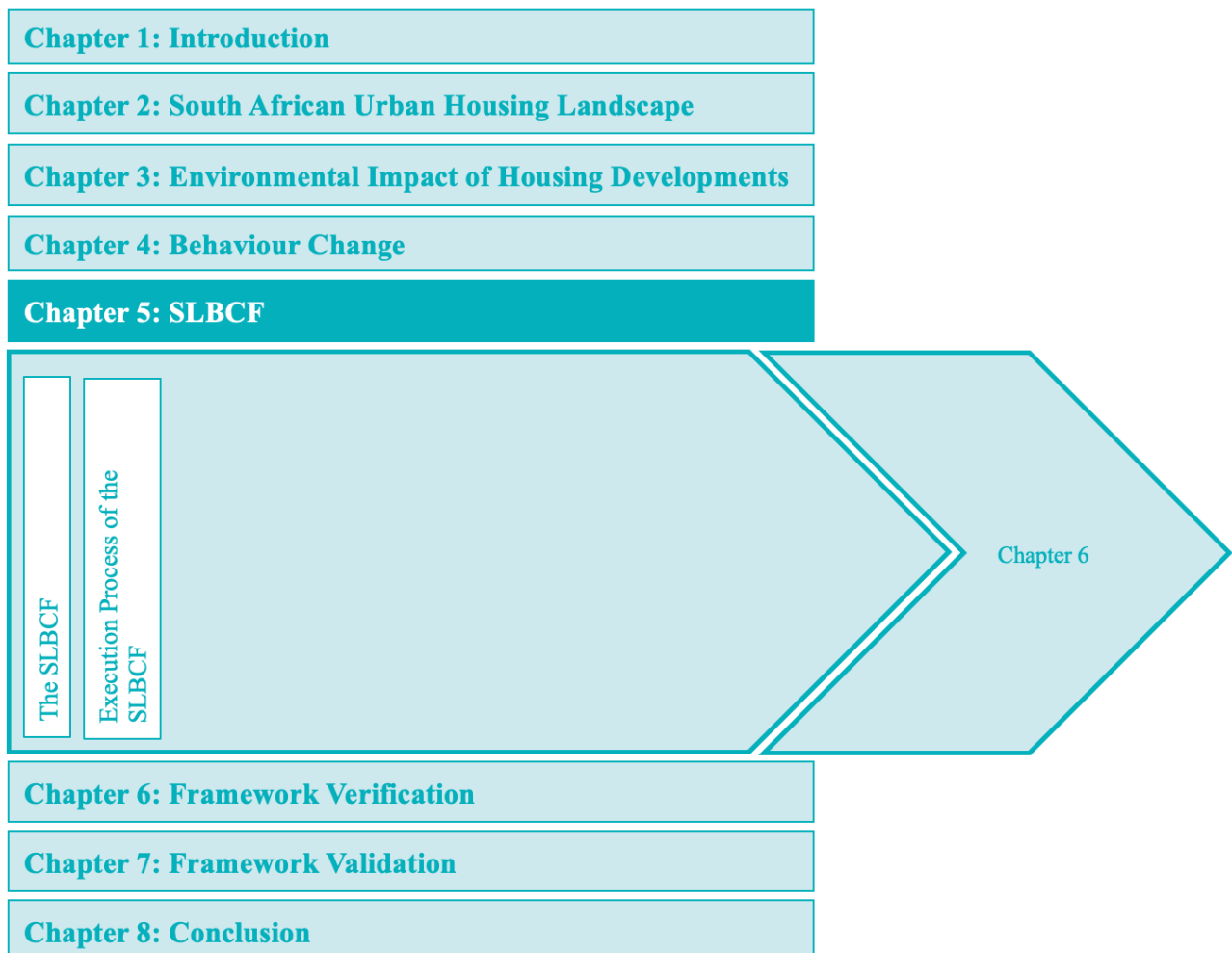


Figure 5.1: Chapter 5 Outline

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Table 5.1: Chapter 5: Research Objective Overview

Problem Statement	Objective Hierarchy	Sub Objectives	Research Question Structure	Doc Structure
The problem is that there is no efficient method available that could be used to change unsustainable behaviour within the context of institutionally owned rental estates. Thus, there is a need for the development of a Sustainable Living Behaviour Change Framework (SLBCF) to optimize sustainable living within the context of institutionally owned rental estates.	Present a Sustainable Living Behaviour Change Framework	Define the proposed SLBCF	What does the SLBCF consist of?	5.1
		Describe the SLBCF Execution Process	Which elements of Behaviour Change theories and debates will be incorporated?	5.2
			Which artefacts will be used in cooperation with the SLBCF?	

The objectives of this chapter are presented in Table 5.1. The primary objective of this chapter is to present a Sustainable Living Behaviour Change Framework (SLBCF) which will be used to optimize sustainable living within the context of institutionally owned rental estates. In light of the research done in Chapter 4, a combination of some of the frameworks presented seemed most fit for use in this study. In the first part of this chapter, the SLBCF will be introduced. Secondly, the different phases of the framework will be presented in more detail.

5.1 The SLBCF

In this section, a framework to assist all property stakeholders¹ with implementing sustainable behaviour will be presented. The mechanism will be referred to as the Sustainable Living Behaviour Change Framework. The SLBCF is illustrated in Figure 5.2.

The SLBCF consists of five iterative phases. The SLBCF is loosely based on the five stages of the Diffusion of Innovation (DOI) Process, which was discussed in Section 4.1.2.2. However, a combination of frameworks presented in Chapter 4 will be incorporated into the framework. The specific framework that is used in each phase will be indicated in Section 5.2. The phases of the SLBCF are titled as follow: Call to Action, Screening, Criticality Analysis, Campaign Development and Incremental Change. The phases, objectives, steps and artefacts involved in the use of the SLBCF are briefly introduced in Table 5.2. The execution process will be discussed in detail in sections 5.2.1 to 5.2.5. The original phases from the DOI process were reshaped and renamed so that the phase names of this specific framework will give more meaning to what exactly is needed to be done in each phase. However, the main concepts behind the phases of the DOI process will still be used in the SLBCF. The DOI process was developed within the context of new product or service adaptation within the context of a larger social system. The goal is thus not to support an individual through the adaptation process but rather a community. If each phase in the DOI process is understood, it enables a creative examination of how to influence people at each stage - during the final stage of confirmation, users begin to influence others in their purchasing or acceptance of the new products or

¹The SLBCF could be used and implemented by many different individuals that are in some way connected to institutionally owned rental estates. These individuals could be property owners, property developers, estate managers, landlords and more. For the purpose of this study these role-players will collectively be referred to as *stakeholders*.

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services.



Figure 5.2: SLBCF

5.2 Execution Process of the SLBCF

Table 5.2 presents the process flow of the SLBCF. The details of the objectives, steps and artefacts of each phase of the SLBCF is presented in more detail. The process flow is represented graphically in Figure 5.3.

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Table 5.2: Detailed process flow of the SLBCF

Phase	Objective	Steps	Artefact
Phase 1: Call to Action - an instruction to the audience designed to provoke an immediate response to do something in order to achieve an aim or deal with a problem.	The first objective is to bring awareness. Thereafter a decision needs to be made whether the estate will embark on this process or not.	<ul style="list-style-type: none"> • Constitute steering committee • Create awareness • Define specific goals 	Implementation Strategy
Phase 2: Screening - review of all behaviours and actions with the purpose of understanding the current condition of the individual/estate.	The objective of this phase is to establish the sustainability status of the individual/estate.	<ul style="list-style-type: none"> • Gather data - know and understand the individual • Evaluate sustainability status - scorecard • Interpret and present results 	Scorecard
Phase 3: Criticality Analysis - the process of assigning behaviours a criticality rating based on their potential risk or level of current performance.	The objective of this phase is to prioritize the burning platforms.	<ul style="list-style-type: none"> • Perform a criticality analysis • Prioritize burning platforms 	Criticality Analysis
Phase 4: Campaign Development - the design of an organized course of action to achieve a goal.	The objective is to develop the final version of the campaign.	<ul style="list-style-type: none"> • Develop campaign • Execute the plan • Target the message to ensure effectiveness -behaviour change tools • Enrol the tenants into the Game 	Behaviour Change Tools and the Game
Phase 5: Incremental Change - monitoring the gradual change taking place over a course of time.	The objective is to ensure sustainability and continuous incremental improvement and change.	<ul style="list-style-type: none"> • Data acquisition from the Game • Data analysis • Make adjustments where needed 	Implementation Strategy, Behaviour Change Tools and the Game

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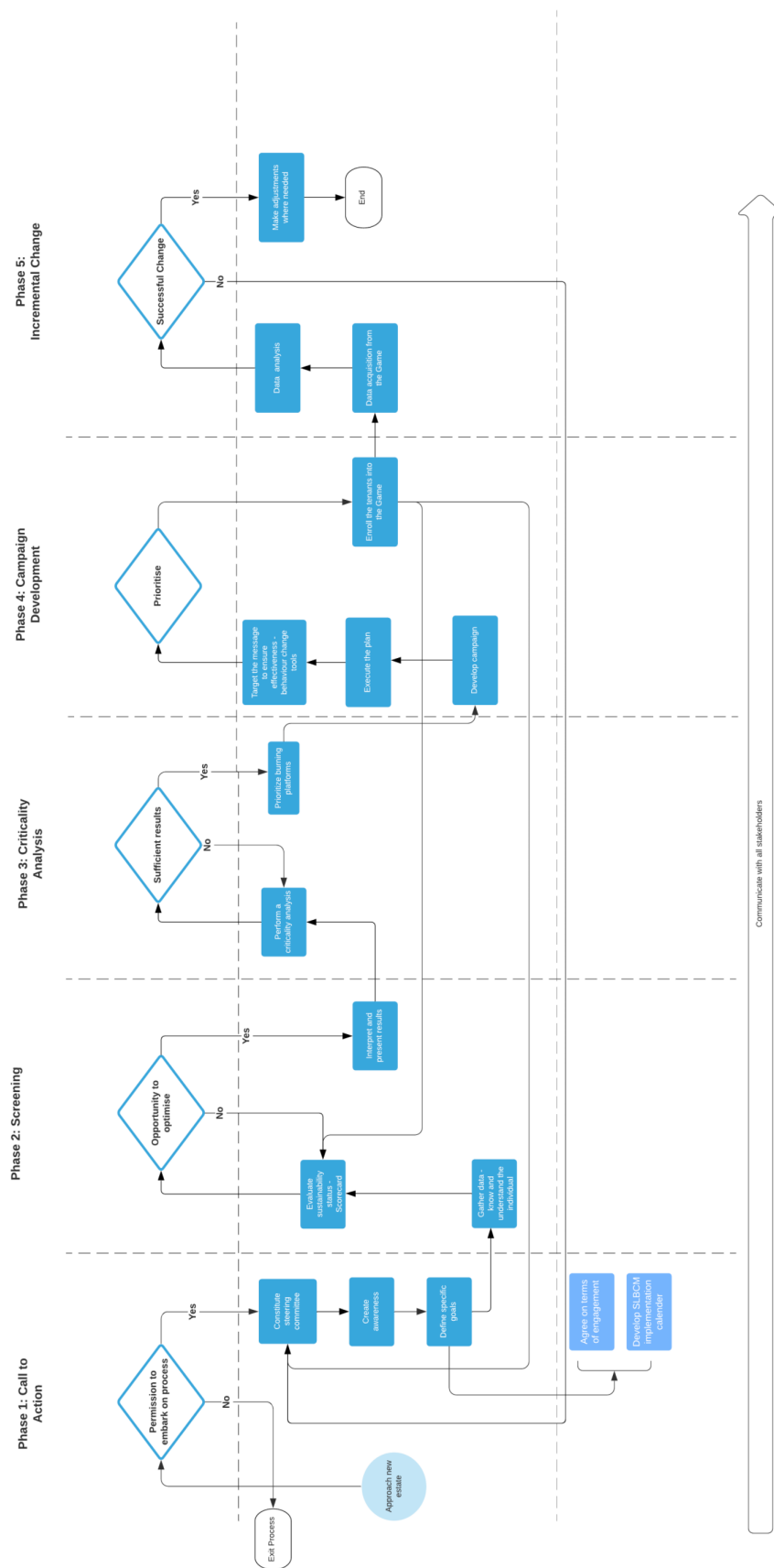


Figure 5.3: Visual Representation of SLBCF Process Flow

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In the next sections, the phases involved in the operationalization of the SLBCF will be introduced and contextualized in more detail. In an attempt to facilitate easy comparison and contextualisation, each one of the phases will be presented by using the following structure:

- The details of the phase will be presented;
- The theoretical grounding of the phase will be referenced;
- The artefacts incorporated into the phase will be listed;
- The responsible entity will be identified;
- The steps required to be completed during each phase will be presented.

5.2.1 Call to Action



Figure 5.4: SLBCF Phase 1

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Table 5.3: Phase 1: Call to Action

Phase 1: Call to Action	
Details	In the first phase namely, Call to Action, the goal is to create awareness and acceptance of the need to change, amongst individuals living in institutionally owned rental estates. It is also important to ensure that individuals are aware that with an increase in population growth and urban housing developments, the carbon footprint and damage to the environment will also increase if no changes are made. In addition to awareness, the individual should also accept the possibility that sustainability could be a major issue. These are the first steps that should be taken before implementing the SLBCF at a specific estate. A method that can be used to achieve the goals of the Call To Action phase could be by implementing awareness campaigns.
Theoretical Grounding	Diffusion of Innovation (DOI) - Section 4.1.2.2
Artefacts	A typical summary of the implementation strategy is presented in Figure 5.5. A similar approach, such as presented in Figure 5.5, should be used as a guide when making decisions and taking action steps. The detailed strategy, approach and tactics of the implementation strategy should be guided by using the four elements of the DOI theory namely, innovation, communication channels, time and social systems.
Responsible Entity	During this phase, a steering committee should be appointed. The steering committee will be responsible for the development and rollout of the campaign.
Steps	Phase 1 requires the completion of the following steps: <ul style="list-style-type: none"> • Constitute steering committee • Bring awareness • Define specific goals

Implementation Strategy

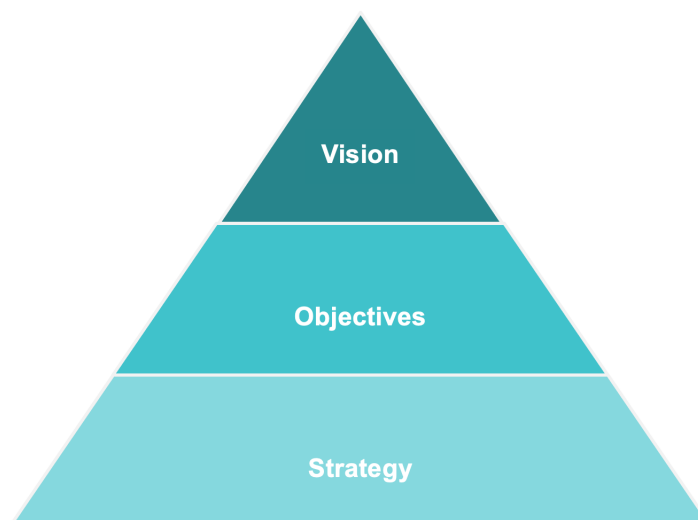


Figure 5.5: Implementation Strategy Model

Strategy implementation consists of putting plans in place by formulating a strategy to achieve the desired objectives. Numerous different frameworks for implementation strategies can be found in the literature. The goal of this study is not to present yet another framework, but rather follow a typical implementation strategy. A typical implementation strategy consists of the following elements:

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Vision, objectives and strategy. These elements ensure effectiveness when strategically planning. For the purpose of this study, we will use the framework that is presented in Figure 5.5. The elements of the Implementation Strategy for the SLBCF can be defined as follow:

- **Vision:** Reducing the carbon footprint, and encouraging overall better sustainable behaviour in every constitutionally owned rental estate.
- **Objectives:** Developing and implementing a framework that will be used to optimize sustainable living within the context of institutionally owned rental estates.
- **Strategy:** The table below indicates the key areas that were identified as the strategies that need to be focused on in order to achieve the vision. Table 5.4 indicates how much percentage increase needs to be obtained in each category for the next three years. The original target percentage will be determined for each category through the use of the scorecard that will be presented in Section 5.2.2.

Table 5.4: Strategies of the Implementation Strategy Model

Target Percentage Increase			
	2022	2023	2024
Recycling	29%	56%	62%
Energy Saving	28%	34%	42%
Fuel Efficiency	16%	25%	35%

The final version of the implementation strategy will be defined during the completion of all the phases of the SLBCF. The screening and criticality analysis phases can be used to establish the specific strategy and tactics of the implementation strategy. These elements will differ for each estate.

5.2.2 Screening

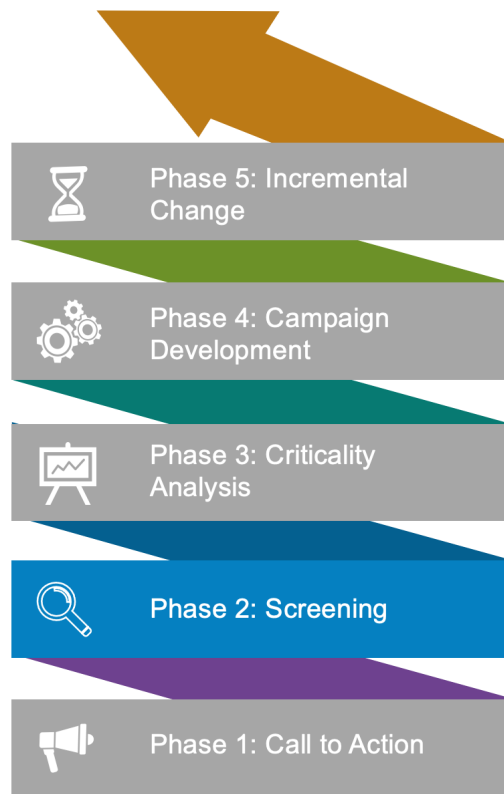


Figure 5.6: SLBCF Phase 2

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Table 5.5: Phase 2: Screening

Phase 2: Screening	
Details	The importance of screening cannot be overemphasized. During Phase 2 of the implementation of the SLBCF, the focus falls on screening the estate and individuals for the detection of factors that causes unsustainability. Data needs to be gathered to understand the practices performed by the individual and the estate. Through the use of a scorecard, the estate can be divided into segments. The scorecard that was developed by using the results from Section 3.1.2, will be used during Phase 2. The scorecard template is presented in this section. Additionally, a segmentation ² criteria can be set up. This could be used to better understand the individual and assist in knowing which method to use to address a specific burning platform. When the scorecard is completed, the results need to be analysed and presented to the stakeholder. The detailed screening audit mechanism to be used falls outside the scope of this study.
Theoretical Grounding	Stages of Change - Section 4.1.1.2
Artefacts	The author of the Stages of Change framework argues that individuals at the same stage could face similar problems and barriers, and thus can be helped by the same type of intervention. A scorecard was developed that can be used to classify people into levels of sustainability. Individuals that are categorized into different levels, could distinguish groups with similar issues from one another. Specific interventions can then be allocated to a specific group. When the SLBCF is configured for a certain estate, the framework should be implemented in a specific context to accommodate each individual in every stage.
Responsible Entity	It is recommended that an independent environmental health and safety practitioner should come to drive the operational aspects of the on-site screening audit.
Steps	Phase 2 requires the completion of the following steps: <ul style="list-style-type: none"> • Gather data - know and understand the individual • Evaluate sustainability status - scorecard • Interpret and present results

Scorecard

The main contributing factors of the operation stage which was introduced in Section 3.1.2, can be used to determine the sustainability of a household or a residential estate. This is used as an artefact in Phase 2 of the SLBCF. Thus, a scorecard was developed that can be used to evaluate all contributing factors in an integrated way. The scorecard consists out of two parts: the first part is used to analyse tenant behaviour and the second is used to analyse overall site behaviour and consumption. The scorecard results in categories that individuals or estates can be placed in. Figures 5.7 and 5.8 presents an abridged version of the scorecard.

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Sustainability Scorecard Part 1 - Determining the Sustainability of a Household				
	Codes of Sustainable Practise	Weight Factor	Target (%)	Total
E.g	Sustainable practise	3	20%	0.6
	Recycle plastic	7		
	Recycle glass	5		
	Recycles carton and paper	5		
Recycling	Use of recycled plastic bags	6		
	Use of recycled fabrics	3		
	Use of recycled glass	4		
	Use of recycled paper	4		
			Total	
			Category Weight Percentage	25%
	Switch geyser off when going away for long periods	6		
	Use of gas appliances	5		
Energy Saving	Use of energy saving appliances	4		
	Don't leave plugs and chargers in electrical outlet	2		
	Minimizing use of heaters/air conditioning	7		
	Switch light off after using	4		
			Total	
			Category Weight Percentage	40%
	Rather walk then drive	7		
	Car pool regularly	6		
	Avoid car idling	3		
Fuel Efficiency	Use cruise control on highways	5		
	Travel at a constant low speed	5		
	Drive fuel efficient car	6		
	Avoid rapid accelerations	1		
	Choose the closest destination	5		
			Total	
			Category Weight Percentage	35%

Figure 5.7: Scorecard Part 1 - Determining the Sustainability of a Household

Table 5.6: Scorecard Part 1 Status

Total Points	Status
< 8	Level 1
> 8	Level 2
> 17	Level 3
> 23	Level 4

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Sustainability Scorecard Part 2 - Determining the Sustainability of an Estate			
	Codes of Sustainable Practise	Weight Factor	Target (%) Total
Recycling	Recycling systems implemented	6	
			Total
		Category Weight Percentage	23%
Energy Saving	Heatpumps installed	6	
	Solar Geysers installed	7	
	Solar Panels installed at every unit	7	
	Motion sensor light installed on site	5	
	Energy management systems installed	6	
	Smart property technology installed	6	
			Total
		Category Weight Percentage	25%
Fuel Efficiency	Staff travel with public transport to the estate	6	
	Staff travel with a golf cart on site	6	
			Total
		Category Weight Percentage	25%
Green Building	Green building management systems installed	6	
	Use of sustainable building material	6	
	Building waste management	6	
	Green building certificate	7	
			Total
		Category Weight Percentage	27%

Figure 5.8: Scorecard Part 2 - Determining the Sustainability of an Estate

Table 5.7: Scorecard Part 2 Status

Total Points	Status
< 5	Level 1
> 5	Level 2
> 10	Level 3
> 15	Level 4

The sustainability status of a tenant and an institutionally owned rental estate is measured using the scorecard. The scorecard is based on three sustainable practices in line with the causal factors presented in Section 3.1.2, where each element has an assigned weighting (which correlates with the importance of that specific element) and a set target (percentage). A number of special contextual conditions might have an impact on the relative importance of each one of these causal factors. For this reason, the ability to weigh causal factors to indicate relative importance is considered to be an important feature of the scorecard. The final component of the scorecard is the results column. The score is determined through a relatively simple calculation. The more points an estate scores, the higher it's level of sustainability. If a particular target is exceeded, the estate can claim the full number of points allocated to it. A certain amount of points categorizes the individual or estate in a certain level of sustainability. Each category also has a factor weight assigned to it. As seen in Figure 5.6, the higher the points that are scored, the higher is the sustainability level.

The formulae for determining the level of sustainability will be explained by using an example of the scorecard Part 2. The example is illustrated in Figure 5.9.

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Example:

The percentages filled in to the table represents the target reached by the estate for the specific sustainable practise. As an example, this specific estate has some, but not significantly much of a recycling system installed, which gives them a score of 40%. The target percentage is then multiplied by the weight factor:

$$WeightFactor \times Target\% = Total$$

$$6 \times 40\% = 2.4$$

The totals are then summed together, which then results in the Category Total. The Category Total for Category 1 (Recycling) is 2.4.

Recycling	Recycling systems implemented	6	40%	2.4
			Total	2.4
			Category Weight Percentage	23%

Figure 5.9: Example using Scorecard Part 2

Let us assume following category totals:

- Category 2 (Energy Saving): Total 2 = 14.8
- Category 3 (Fuel Efficiency): Total 3 = 11.4
- Category 4 (Green Building): Total 4 = 10

The totals of each category is then multiplied by the Category Weight Percentage:

$$Total1 \times CategoryWeightPercentage = CategoryScore$$

$$2.4 \times 23\% = 0.552$$

$$Total2 \times CategoryWeightPercentage = CategoryScore$$

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$$14.8 \times 25\% = 3.7$$

$$Total3 \times CategoryWeightPercentage = CategoryScore$$

$$11.4 \times 25\% = 2.85$$

$$Total4 \times CategoryWeightPercentage = CategoryScore$$

$$10 \times 27\% = 2.7$$

The four different category points are then summed together:

$$CategoryScore1 + CategoryScore2 + CategoryScore3 + CategoryScore4 = TotalPoints$$

$$0.552 + 3.7 + 2.85 + 2.7 = 9.802$$

The total points scored would determine under which level the site will be categorized. In the case of this example, 9.802 points results in level 2.

If the sustainability level of an estate results in level 2, it means that the estate has a lot of room for improvement and innovation that could enhance sustainable behaviour. This estate will be a perfect candidate for the implementation of the SLBCF.

5.2.3 Criticality Analysis



Figure 5.10: SLBCF Phase 3

Table 5.8: Phase 3: Criticality Analysis

Phase 3: Criticality Analysis	
Details	The third phase in the SLBCF Execution Process is the Criticality Analysis phase. A criticality analysis needs to be done in order to assign certain actions a criticality rating based on their potential risk. This step is key in the method as it provides information to stakeholders to assist in prioritizing burning platforms. The information that is gathered during the criticality analysis can be used to contextualise the framework and as a result, a generic framework can be introduced.
Theoretical Grounding	Marquez and Parra (2020) presented a typical method on how to design a criticality analysis. This example was used to design the structure of the criticality analysis.
Artefacts	Criticality Analysis - Section 5.2.3
Responsible Entity	It is recommended that the steering committee of the SLBCF should drive the operational aspects of the criticality analysis of the site.
Steps	Phase 3 requires the completion of the following steps: <ul style="list-style-type: none"> • Perform a criticality analysis • Prioritize burning platforms

Criticality Analysis

Marquez and Parra (2020) define a criticality analysis as the following: It is a process that assists in determining the importance of potential events of a system within the operational context in which they perform. Marquez and Parra (2020) introduced a method for designing a criticality analysis that is based on a risk assessment process. The sustainable practices that are used in the scorecard - part 1 are also used in the criticality analysis. The goal of the scorecard was to categorise the estate and the residents into different categories. However, the goal of the criticality analysis is to determine the burning platforms that should be focused on during the campaign development. The criticality analysis lists many more behaviours and goes into more depth about unsustainable practices than the scorecard. The following figures represent the elements of the criticality analysis template that was developed for Phase 3 of the SLBCF.

		Score	Impact				
			Insignificant	Minor	Moderate	Major	Critical
Likelihood	Almost Certain	5	5	10	15	20	25
	Highly Likely	4	4	8	12	16	20
	Likely	3	3	6	9	12	15
	Unlikely	2	2	4	6	8	10
	Rare	1	1	2	3	4	5

Figure 5.11: Criticality Analysis Risk Score

Value	Overall Risk Assessment
1 - 4	Low Risk
5 - 9	Medium Risk
10 - 25	High Risk

Figure 5.12: Criticality Analysis Overall Risk Assessment

Figure 5.11 illustrates how the criticality rating is determined. The impact of an action can receive a score from one to five, where one is *insignificant* and five is *critical*. A similar approach is used to allocate a likelihood score. The action can receive a score of one to five, where one is *rare* and five is *almost certain*. The impact score is then multiplied by the likelihood score to determine what the criticality rating is. Figure 5.12 illustrates which criticality ratings are a low-, medium- or high risk. The high risks should be prioritized as burning platforms.

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Criticality Analysis			
Action	Impact	Likelihood	Criticality Rating
Energy Consumption Behaviour			
Forget to switch lights off	3	3	9
Leave appliances in electrical outlet	2	5	10
Using aircon/heaters	5	3	15
Boil kettle numerous times per day	3	5	15
Only use of electric appliances (no gas)	5	5	25
Geyser permanently switched on when away for periods	5	4	20
Washing clothes/dishes unnecessarily using appliances	4	3	12
Using hair dryer	3	2	6
Setting geyser's thermostat higher than 60°C	5	5	25
No solar installed	5	4	20
Using tumble dryer instead of air drying clothes	4	4	16
Waste Management			
Large use of plastic without recycling	3	4	12
Large use of paper without recycling	1	4	4
Large use of glass without recycling	2	3	6
No recycling system implemented at home	5	5	25
Do not clean plastic before recycling	5	5	25
Fuel Consumption			
Travel at high speeds	3	5	15
Not car pooling	2	2	4
Car idles for long time	2	2	4
No cruise control	1	3	3
Don't drive fuel efficient car	4	3	12
Often accelerates rapidly	3	5	15
Drive often and far distances	4	5	20
No public transport available to and from site	4	3	12
No access to golf cart/battery-powered car	4	5	20

Figure 5.13: Criticality Analysis Example

Figure 5.13 presents a completed example of the criticality analysis. Each action is given an impact score that describes the impact this action has on sustainability. A criticality analysis table similar to the example presented in Figure 5.12 should be given to a few randomly selected residents in the estate. The likelihood column should then be filled in by the steering committee after interviewing the residents on the actions listed in the criticality analysis. The criticality analysis is determined by multiplying the impact score with the likelihood score. The actions with the highest criticality rating should be prioritized as burning platforms when developing the campaign.

The completed example of the criticality analysis revealed a number of burning platforms with a criticality rating of 20 or higher, namely:

- Energy Consumption:
 - Only using electric appliances (no gas)
 - Geyser is permanently switched on when away for long periods
 - Setting geyser's thermostat higher than 60°C
 - No solar installed.
- Waste Management:
 - No recycling system implemented at home
 - Do not clean plastic before recycling

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- Fuel Consumption:
 - Drive often and far distances
 - No access to golf cart/battery-powered car

It is suggested the campaign should be developed around the actions with the highest criticality rating. For the purpose of this study, these actions will be referred to as burning platforms.

5.2.4 Campaign Development



Figure 5.14: SLBCF Phase 4

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Table 5.9: Phase 4: Campaign Development

Phase 4: Campaign Development	
Details	The fourth phase includes action planning and the development of the campaign, followed by the execution of the campaign. One of the goals of Phase 4 is to prioritize the action plans. The Screening and Criticality Analysis phases might reveal a number of potential burning platforms, it would be unfeasible and unrealistic to address all these factors at once. Thus, it is recommended that action plans are developed to address the specific burning platforms. The scorecard should be used to categorise residents and different estates into levels. When developing the campaign these levels should be used to determine each individual or estate's level of readiness. Additionally, the individuals in the different levels should be approached with similar interventions as suggested by the Stages of Change theory. Following the campaign development, the steering committee is responsible for presenting the framework to all stakeholders. During this phase, it is critical that all stakeholders are in agreement with the final framework. Lastly, action plans needs to be set-up and implemented by the steering committee.
Theoretical Grounding	The Mindspace Approach - Section 4.1.3, Gamification - Section 4.3.1.1
Artefacts	Behaviour Change Tools - Section 5.2.4.1, The Game - Section 5.2.4.2.
Responsible Entity	It is recommended that the steering committee of the SLBCF should drive the campaign development.
Steps	<p>Phase 4 requires the completion of the following steps:</p> <ul style="list-style-type: none"> • Develop campaign • Execute the plan • Target the message to ensure effectiveness - behaviour change tools • Enrol the tenants into the Game

In the following sections, the artefacts that are incorporated in Phase 4, will be presented in more detail. These artefacts should be incorporated according to the outcome of the scorecard. The scorecard categorizes estates and residents into different levels. The sustainability level gives an indication of the level of readiness according to the Stages of Change theory. Each level should be approached with the same intervention. Additionally, the criticality analysis will determine specific burning platforms which should be incorporated when using the artefacts.

5.2.4.1 Behaviour Change Tools

The behaviour change tools are based on the Mindspace Approach and Gamification, which was introduced in Section 4.1.3 and 4.3.1.1, respectively. These tools will be incorporated in the final framework that would be implemented at an estate. These tools could be used to define the unique characteristics of the estate where the SLBCF will be implemented. The characteristics will be unique for every estate. When the first generic framework is proposed it will consist of rewards and types of messages that are uniquely defined by the estate or specific resident. The following characteristics should be defined for each unique SLBCF:

- Norms: Sustainable behaviour should become the norm among peers. Encourage all individuals through specific mechanisms to participate in order to establish the norm.

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- **Messenger:** Who will communicate information, how will information be communicated (Through pamphlets, social media platforms, applications, website, scoreboard, meetings or more)?
- **Incentives:** Determine specific entity's incentives (Money, points to use at the clubhouse, credit for utilities or more).
- **Saliency:** Attention is drawn to what is relevant to the individual (inform how unsustainable behaviour directly influences the individual).
- **Affect:** Emotional associations shapes action. Ensure individual forms an emotional association with the sustainability campaign.

5.2.4.2 The Game

Gamification was first introduced in Section 4.3. The following gamification elements will be used in the generic framework of the SLBCF: Points, badges, leader board, avatar and a storyboard.

For this study, the following is proposed: Developing a platform that uses gamification elements to ensure long-term behaviour change toward sustainability. The platform could be anything such as a mobile application, website, and more. The platform could be used, for example, in residential settings where a community of people are all introduced to this platform on the move-in date. This platform can be implemented through each process of institutionally owned rental estates to address the sustainability problem.

The platform can consist of the following:

- Points could be allocated to keeping track of recycling records, rather using battery-operated golf-cart in the estate instead of a car or energy-saving through the use of solar energy, and more.
- Badges could be awarded to goals achieved on this application.
- Goals can be set up by the developer of the application or personal goals can be made on the application. An example of a goal could be to recycle a certain percentage of the weight of rubbish.
- Leader boards can be used to rank neighbours in the estate according to relative success. As a result, competition amongst neighbours arises, which results in more commitment towards the game as well as motivation to be ranked higher on the leader board.
- The application could allow for the design of personal avatars, that could be used to add identity to the application users and allow them to form part of the community.
- A meaningful story should be written to add context to the larger problem of sustainability that our world faces. The story could be used to enlighten and inform the users of the seriousness of the problem at hand and how they can play a meaningful role in this context.

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Physical incentives can be used as rewards for users who truly make a difference. These rewards can include a free meal at the estate's clubhouse, a discount on your utilities bill or even a discount on your monthly rent. These gamification elements should be designed based on the outcome of the criticality analysis. The focus should fall on the burning platforms. It is important to create meaningful gamification when designing this application and ensure that long-term change will be established. Through the example of the behaviour change framework by the use of a mobile application, it is evident that gamification can be a powerful solution to address motivational problems within any context. However, it is important to ensure that the framework is well designed and should be specifically designed to come to an end for the individual player. Furthermore, it is of great necessity to establish long-term behaviour change, and rather influence the player's mindset towards sustainability instead of just creating a meaningless framework that hands out rewards in the short-term. The end result should be a meaningful and long-term change. Incremental change should be documented to ensure that the framework is implemented successfully.

5.2.5 Incremental Change



Figure 5.15: SLBCF Phase 5

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Table 5.10: Phase 5: Incremental Change

Phase 5: Incremental Change	
Details	As mentioned in Section 5.2.4, strategies and action plans were designed and implemented as part of the SLBCF. Incremental change is a continuous process and should be measured and monitored regularly. Incremental change requires access to data. Data will need to be collected on the estate's sustainability status and practices on a regular basis. This could be done through the historic data and results from the Game. This data will need to be analysed and presented to the stakeholders to establish if a sustainable incremental change is taking place. Additionally, the steering committee should continuously be vigilant in the identification of signs that might indicate that incremental change for the better doesn't take place anymore. If this is the case, a fundamental rethink of the underlying objectives and principles needs to take place. Changes will then need to be made where necessary. These changes could result in changing the Implementation Strategy, the Behaviour Change Tools and The Game.
Theoretical Grounding	Diffusion of Innovation - Section 4.1.2.2, Behaviour Change Tools - Section 4.1.3, Gamification - Section 4.3.1.1
Artefacts	Implementation Strategy - Table 5.2, Behaviour Change Tools - Section 5.2.4.1, The Game - Section 5.2.4.2.
Responsible Entity	The steering committee should continuously be vigilant in the identification of signs that might indicate that incremental change for the better doesn't take place anymore.
Steps	Phase 5 requires the completion of the following steps: <ul style="list-style-type: none"> • Data acquisition from the Game • Data analysis • Make adjustments where needed

Incremental change might include continuous improvement. It is important to document behaviour change to ensure that the SLBCF is successful. Through documenting change, the framework can be adapted and changed to make the necessary improvements. In this way, not everything is changed at once, rather gradually. This allows for burning platforms to be addressed first, and then once a significant change is taking place, the framework can be adapted to address more of the other unsustainable behaviours.

5.3 Chapter Conclusion

The primary objective of this chapter is to present a Sustainable Living Behaviour Change Framework (SLBCF) which will be used to optimize sustainable living within the context of institutionally owned rental estates. This was achieved by defining the phases of the SLBCF. The theoretical grounding of the phases was presented, together with the artefacts, responsible entity and the steps that need to be followed during each phase.

Chapter 6

Framework Verification

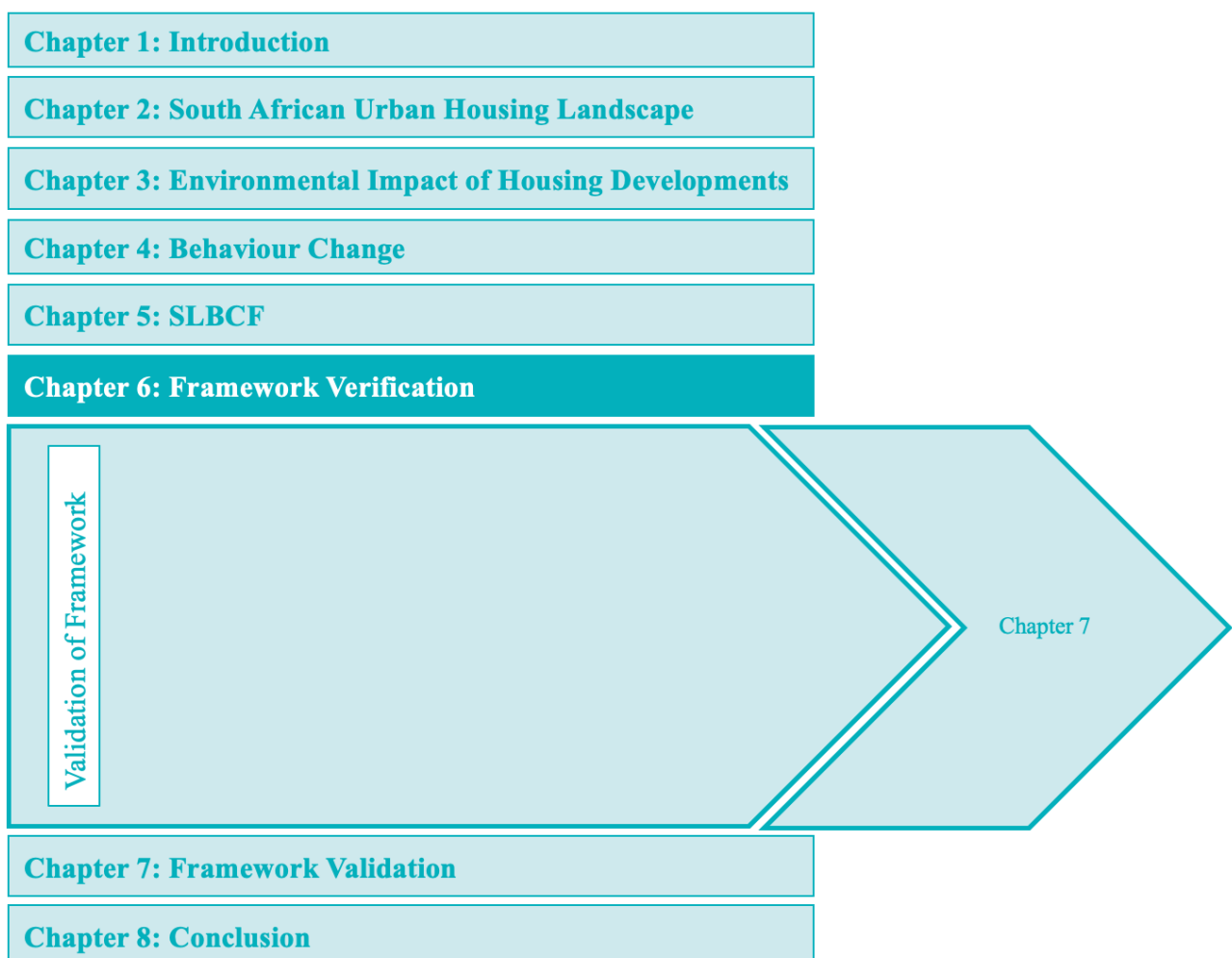


Figure 6.1: Chapter 6 Outline

The objective of this chapter is to verify that the candidate solution presented in Section 4.4.1 fulfils the requirements for the SLBCF. The requirements for the SLBCF was summarised and is presented in Table 6.1

Table 6.1: SLBCF Requirements

	Requirement	Comments
R1	A solution that could be used to address large groups of individuals with numerous different problems at once.	Efficiency and versatility of framework.
R2	A solution or elements thereof that could be used to influence behaviour.	The framework should be able to influence resident behaviour for the better.
R3	Concepts that can be used to motivate and engage individuals to achieve better results.	The framework should be inviting and encourage individuals to participate and work together towards a sustainable future.
R4	A framework that can be used as a guide for a strategy approach.	The framework should give guidance on how to onboard individuals when the framework is implemented.

These requirements were incorporated into the SLBCF as shown by Table 6.2.

Table 6.2: SLBCF Verification

	Framework	Section	Key Deliverables	Verification
R1	Stages of Change	4.1.1.2	The rationale behind a staged framework is that individuals at the same stage should face similar problems and barriers, and thus can be helped by the same type of framework.	✓
R2	Mindspace Approach	4.1.3	This framework introduces a few concepts that influences behaviour. These concepts could be used to define the unique characteristics of the identified estate where the SLBCF will be implemented and enhance motivation.	✓
R3	Gamification	4.3	Game design concepts and techniques are used to motivate and engage individuals to achieve better results in certain contexts. These result includes: creating long term customer loyalty, raise morale and increase employee engagement, improve productivity and performance and create behaviour change in your target audience.	✓
R4	Diffusion of Innovation	4.1.2.2	The framework makes use of five stages in the decision Innovation Process namely, knowledge, persuasion, decision, implementation, confirmation. These stages can assist with the onboarding of individuals when implementing the framework.	✓

Comparing Table 6.1 and Table 6.2, it can be concluded that the requirements of the SLBCF were fulfilled.

Chapter 7

Framework Validation

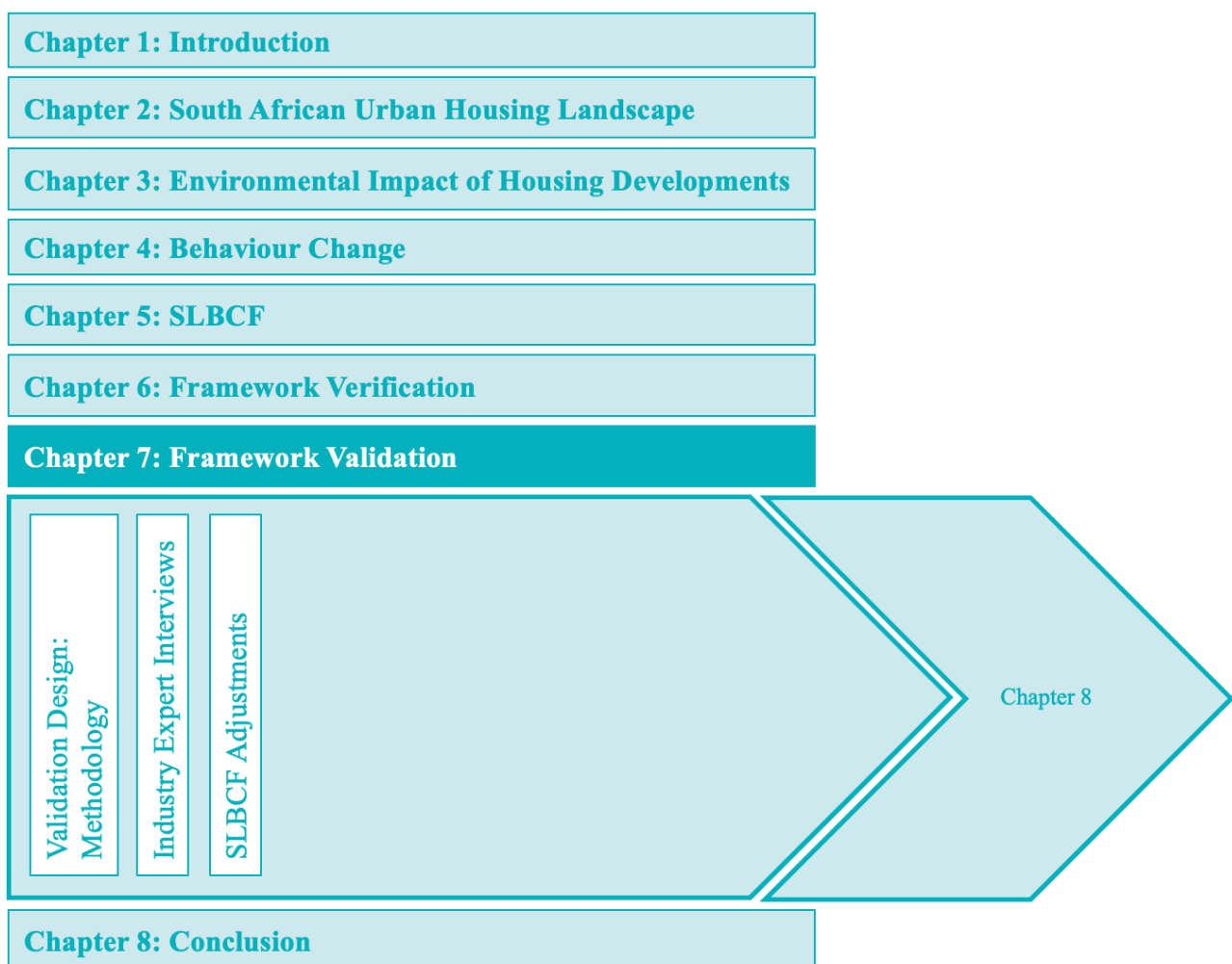


Figure 7.1: Chapter 7 Outline

Table 7.1: Chapter 7: Research Objective Overview

Problem Statement	Objective Hierarchy	Sub Objectives	Research Question Structure	Doc Structure
The problem is that there is no efficient method available that could be used to change unsustainable behaviour within the context of institutionally owned rental estates. Thus, there is a need for the development of a Sustainable Living Behaviour Change Framework (SLBCF) to optimize sustainable living within the context of institutionally owned rental estates.	The problem is that there is no efficient method available that could be used to change	Define the Validation Design Methodology	Which validation design methodology will be used?	7.1
	unsustainable behaviour within the context of institutionally owned rental estates. Thus, there is a need for the development of a Sustainable Living Behaviour Change Framework (SLBCF) to optimize sustainable living within the context of institutionally owned rental estates.	Get opinion of Industry Experts	Is the characteristics of the SLBCF realistic and applicable to the industry?	7.2
	Framework (SLBCF) to optimize sustainable living	Adjust SLBCF	How is the SLBCF affected after validation changes?	7.2

The objectives of this chapter are presented in Table 7.1. This chapter aims to validate the study through industry expert interviews. This chapter will first discuss the validation methodology where the validation process will be developed. Then the results from the validation process and industry expert interviews will be documented. Finally, the SLBCF will be updated with all the knowledge gained through the validation process.

7.1 Validation Design: Methodology

Validating conceptual frameworks are important for the advancement of both industry practice and theory. Bryman and Bell (2014) argue that validation adds to the integrity of the research conclusion and strengthens the link between the research purpose and the conclusion. Framework validation can be viewed as a specialised topic within the epistemology¹. Frey and Dym (2006) identify four important views on the justification of knowledge claims namely, foundationalism, naturalistic epistemology, relativism and epistemology of practice.

For the purpose of this study, the focus will fall on the validation methodologies used as part of the epistemology of practice. This view relies on the knowledge of skilled practitioners, that cannot be easily systemized, to validate new theories and frameworks. A detailed discussion on the history and development of the epistemology of practice falls outside the scope of this study. However, the following validation principles, methodologies and requirements are considered (Argyris, 1977):

- Internal consistency of the theory or framework;
- New theory or framework testability:
 - The specific situation where a framework or theory can be implemented needs to be defined;
 - The desired results of the application of the theory or the implementation of the framework, can be defined;

¹The theory of knowledge, especially with regard to its methods, validity, and scope, and the distinction between justified belief and opinion

- The way in which the impact of the theory or the application of the framework will be evaluated, can be described.
- Congruence between the new theory or framework and accompanying theory;
- Effectiveness of the new theory or framework - what will result in successful validation.

7.2 Industry Expert Interviews

This section presents the main points from interviews with experts in the industry. Firstly, in Section 7.2.1, the details of the industry experts and the interview protocol will be presented. Secondly, in Section 7.2.2, the feedback from the industry experts is presented.

7.2.1 Interview Protocol

Baker and Edwards (2012) conducted a study titled, "how many qualitative interviews is enough?". In this study the authors interviewed a few established academics and asked them "how many", to which all of them responded, "it depends". Hary Wolcott, one of the pioneering qualitative researchers, was among these academics that were questioned. He commented that for many qualitative studies one respondent is enough - the person of interest. However, Hary Wolcott elaborates and said that the general rule is to interview until a point of saturation is reached. Bowen (2008) defined the point of saturation as follow; Saturation is reached when the researcher gathers data to the point of diminishing returns, when nothing new is being added. The study concluded that the field and nature of the research will sometimes require more and sometimes fewer interviews to reach this point of saturation.

For this research study, the researcher determined the number of interviews that were needed before the completion of validation. This study is focused on a very specific field and saturation was reached after four interviews. The industry experts were interviewed and were asked to give input on specific sections of the framework that was developed. The first two individuals that were interviewed, both work full-time for a rental management company. Their day-to-day consists of working with the residents and the management of the residential property that is situated in Springs and Boksburg. The third individual works as an estate manager for a reward-winning retirement village. This retirement village forms part of South Africa's premier retirement lifestyle brands with a reputation for developing and operating exceptional retirement villages. Lastly, the fourth individual works as a project manager for a housing development company. This company has developed prestigious student accommodation in Woodstock and Observatory. For the purpose of this study, we will refer to the interviewees as Expert A, B, C and D. The real names of the interviewees will not be disclosed as they asked to stay anonymous. The details of the four industry experts are presented in Table 7.2. Interviews were not transcribed but an interview protocol was set up for each meeting. The interview protocol is presented in Table 7.3.

Table 7.2: List of Industry Experts

Expert	Position	Field of Expertise
Expert A	Rental Operations Manager	Rental Management; Resident Behaviour; Residential Industry; Property Development
Expert B	Rental Concierge	Resident Behaviour; Residential Industry
Expert C	Estate Manager	Resident Behaviour; Development and Management of Retirement Homes; Former Hotel Manager
Expert D	Property Development Project Manager	Resident Behaviour; Residential Industry; Construction Industry; Property Development

Table 7.3: Interview Protocol

Interview Protocol
Background
Ask interviewee about their job responsibilities, past projects and experiences, company background, etc.
Introduce SLBCF
<ul style="list-style-type: none"> • Give brief background on why the SLBCF was developed. • Give brief overview of behaviour change theory and existing frameworks. • Explain the phases and artefacts of the SLBCF. • Explain the implementation strategy. • Ask experts to confirm that the requirements is included at the correct phase according to their knowledge and experience.
Specific questions regarding the SLBCF
<ul style="list-style-type: none"> • Is the execution process of the SLBCF practical? • Lets consider each phase of the SLBCF, what changes would you make to these and why? • Lets consider the artefacts used in the SLBCF, what changes would you make to these and why?
Open conversation about the SLBCF
<ul style="list-style-type: none"> • Could the SLBCF successfully be implemented at any of your estates? • Do you think that the SLBCF would truly influence resident behaviour for the better? • What can you immediately see something that won't work? • What will you add to this framework to improve it?

All four of the industry experts are involved with residents and can observe their behaviour on a day-to-day basis. Expert A and B work for companies whose services include; estate development, managing rental contracts, managing tenants, managing property, and more. Expert C's is an estate manager and is responsible for the upkeep and day-to-day running of the estate. Expert C's average day consists of managing the operations of the estate, overseeing management, supervising staff

members and managing the budget. Expert D is a project manager that is employed at a company that has developed a number of student accommodations over the past few years. Expert D is responsible for the financing, approvals and design of infrastructure and affordable housing developments. All the experts work for companies that aim to create estates that are energy-smart and sustainable. All the estates are built according to energy efficiency regulations and the newer developments include solar geysers, as well as optional extras such as built-in grey-water systems, smart solar energy and full photovoltaic systems.

The industry experts were interviewed to give specific input on the feasibility of this framework and the implementation thereof. The intricate details of the SLBCF were presented and the experts were asked to comment and give feedback on where changes can be made in the framework. Lastly, the experts were questioned on whether they believe that the implementation of the SLBCF will truly influence tenant behaviour for the better.

The SLBCF incorporates sections from different backgrounds and finding industry experts with expertise in all the aspects of the framework would be difficult. Thus, the interviews were set up in a way that all the experts were interviewed on every section of the SLBCF.

7.2.2 Interview Feedback

The experts were interviewed and their significant contributions and feedback were recorded and is summarised below. The feedback was mostly very positive. However, the following questions and comments were raised:

Monitoring of Fuel Consumption

It would be quite tricky to monitor the fuel consumption of the resident. Especially when we look at options such as golf carts, etc. How would you know when the tenant drives with his or her golf cart instead of their car? It is a different situation if an estate rents out golf carts, then the tenant could get points for the hiring of the golf cart. An additional solution to this might be to do something similar to Discovery: The option to install drive sensors and tracking devices such as the DQ-Track of Discovery.

- Expert A

Monitoring of Waste Management

A well-thought-out waste management system should be implemented together with the framework. Residents could easily fill bags with anything that isn't just plastic. Together with ensuring that waste is properly separated and recycled, a system should be put in place to determine how waste management will be rewarded. Recycling will only be successful to monitor and reward if a system is designed and implemented where the waste of each individual can be checked and given a score.

- Expert B

Resident Readiness

It is important to not just consider the estate's sustainability level but also the tenant's readiness to embark on this process. During the phase of the framework, the tenants should be questioned on whether they will participate if this framework is implemented at the estate. It won't be worth implementing if only a few tenants are interested. This framework can only truly make a difference if the majority of the tenants are willing to embark on this journey. With only a few people participating, the competition won't be as strong and as a result the incremental change recorded will be insignificant.

- Expert A

The Financial Aspect of Implementing the SLBCF

As with everything, the cost is more important to any company rather than saving the planet. It will be difficult to implement this at an estate if funding isn't given to support this cause. Additionally, this can only be implemented once the government mandates it or creates significant tax benefits for sustainable development. I would also suggest asking a management fee to gain access to the application or platform. These funds can then be used to fund the rewards.

- Expert C

Implementing the SLBCF would have to offer a credit certification or green rating that is nationally recognised. At any company or business, one can always argue that there aren't enough finances, especially not for saving the planet. Many aspects will be prioritised before sustainability. This is why if the SLBCF can offer a nationally recognised certification, then it can be used as an attraction- or selling point to prospective residents. Additionally, incentives can be offered to the estate for implementing the SLBCF. However, it needs to be decided then who will be responsible for the costs involved of these incentives.

- Expert D

Technology for the Older Generations

Working at a retirement village, I am well aware of the struggle of trying to onboard the older generation to anything that involves new technology. Some older people struggle to send a message on their phone, it might be difficult to try and convince them to participate in sustainable practices if it means they have to use an application. It might be worth it to look into methods that could encourage older people to climb on board for this venture.

- Expert C

7.3 SLBCF Adjustments

From the interviews with industry experts, a few adjustments can be made with regard to the research in the study and the SLBCF. Section 7.3.1 summarises the changes to research done and assumptions made in the study as well as changes to the SLBCF. Section 7.3.2 presents the updated SLBCF.

7.3.1 Changes that will be made to the SLBCF

The following changes will be made to the SLBCF as suggested by the industry experts:

Monitoring of the main contributing factors:

For the purpose of this study, the SLBCF wasn't presented in so much detail that it disclosed the specifics of how fuel consumption would be monitored. This is mainly due to the time constraint on the study. However, after the industry expert interviews, it was deemed necessary to give additional information on how the three main contributing factors would be monitored. The following are examples of technology that could be implemented to monitor electricity and fuel consumption and waste management:

- **Energy Consumption:** Smart electricity meters could be used to measure consumption. Additionally, an application of reporting platform would need to be developed to display the consumption data.
- **Waste Management:** The estate could partner with companies such as *Waste Harmonics* that already have systems and technology developed to monitor waste. Waste Harmonics offers a web-based monitoring service, to track, measure and optimize waste and recycling processes. Alternatively, a unique system and technology could be developed that is implemented together with the SLBCF. Similar systems and technology that is used to track waste will assist in fairly rewarding each individual for their recycling.
- **Fuel Consumption:** A drive sensor could be installed on the resident's vehicle which will provide accurate and driver behaviour feedback. Additionally, an application will need to be developed that can report on fuel consumption and drive behaviour as measured by the sensor.

It is suggested that before implementation of the SLBCF, the necessary platform or application should be developed. It would be most optimal if *The Game*, which was introduced in Section 5.2.4.2, has a reporting system built in that can report on all consumption and recycling as well.

Readiness of the individuals:

Initially, during Phase 1 (Call to Action), the goal was to create awareness and acceptance of the need to change. This could be done through awareness campaigns. From the interviews with the industry experts it was decided that together with the awareness campaigns, surveys should be sent out to all the residents of an estate. This survey should be used to determine how many of the residents would consider participating if the framework is implemented at the estate where they live. This could be used to determine if it will be worthwhile to implement the framework at a specific estate.

SLBCF Financial Framework:

During the industry expert interviews, the uncertainties of the financial implications of the SLBCF were revealed. The scope of the study excluded the financial framework of implementing the SLBCF, which limited the depth of research done on certain technologies and features. From the

interviews it became apparent that everything in property management is determined by cost, as a result, aspects such as sustainable development are often overlooked to save cost. It can be concluded that a framework that investigates the financial impact of successfully implementing the SLBCF would be a valuable addition to the study.

It would be most beneficial to present this framework to the Green Building Council of South Africa². The certification processes governed by the GBCSA involve certification of buildings using the Green Star, Net Zero, EWP and EDGE rating tools. The rating systems and tools create a common language and standard of measurement for green buildings, promoting integrated, whole-building design. Agreed standards and independent benchmarks for green building allow investors to objectively assess the sustainability of a building or portfolio. This certification is a nationally recognised standard that could be used to attract prospective investors or residents to an estate. Thus, before the SLBCF is developed, a partnership needs to be created with the GBCSA.

Onboarding techniques for the older generations:

The company *Papa*³ are of the opinion that you are never too old to learn something new, even technology.

Papa suggests a few helpful ways that could assist in teaching a senior during the digital age. According to the feedback received from Expert C, it was decided that the following aspects, as suggested by Papa, would be built into Phase 1 of the SLBCF. These aspects include the following :

- Explain the value: Showing a senior how easy it is to video call a friend they haven't seen in years, or showing them photos of their grandchildren on Facebook, helps older adults see what technology has to offer them. These are just a few of the many benefits technology has to offer. In phase 1 of the SLBCF, it could be explained to the senior, that if they participate, they would not only secure a safe environment for their grandchildren, but they could also receive personal rewards by using the Game.
- Address security concerns: Most seniors are concerned about security and keeping their private information safe when they use the internet. The privacy settings of the platform or application will need to be discussed with them. Review privacy policies for the platform or application and show them that the benefits, in most cases, outweigh the security risks.
- Take it slow: As the different tasks are explained to seniors, encourage them to write down what they have been shown. A notebook needs to be provided where they can log passwords and usernames.
- Give them confidence: Small victories need to be prioritised. The positives need to be focused on.

²The Green Building Council SA (GBCSA) was formed in 2007 to lead the greening of South Africa's commercial property sector. They provide the tools, training, knowledge and networks to promote green building practices across the country and build a national movement that will change the way the world is built.

³Papa: The company pairs older adults and families with Papa Pals for companionship and assistance with everyday tasks. They offer programs to health plans, providers, employers, and consumers.

- Guide them to free resources: Set-up courses and material that could be used to assist not only the seniors but all residents on how the SLBCF would be implemented and used (Papa, 2018).

All the above-mentioned aspects are not only important to seniors, but to all individuals that will participate. These are practical guidelines that could be used during Phase 1 of the SLBCF.

7.3.2 The Updated SLBCF

With the adjustments made to the SLBCF that was presented in Section 7.3.1, the layout of the phases and the use of the artefacts of the final framework will stay unchanged. However, slight changes to the intricate details of phase 1 will be changed and an additional phase will be added which will be called Phase 0. Figure 7.2 presents the adjusted SLBCF phases including the new phase 1 titled Networking. Table 7.4 presents a summary of the intricate details of Phase 0.



Figure 7.2: Adjusted SLBCF

Table 7.4: Phase 0: Networking

Phase 0: Networking	
Details	<p>Phase 0 will be considered as a pre-phase of the SLBCF. During this phase, the main goal would be to attract investors and other parties that will form part of the execution of the SLBCF. For the purpose of this study, we will refer to these parties as the SLBCF network. The SLBCF network could include companies or individuals that would like to form part of the implementation of the framework. The network would most probably consist of groups of people or companies that provide the following services:</p> <ul style="list-style-type: none"> • Smart electricity metering • Waste monitoring • Driving sensors • Application developing • Green credit certification • Funding to implement a framework
Artefacts	The implementation strategy presented in Section 5.5 could be used to develop specific strategies for contacting and approaching the correct individuals that will form part of the network.
Responsible Entity	During this phase a main leader or manager needs to be appointed that is in charge of the steering committee. The manager will be responsible for appointing the steering committee and network providers. Additionally, the manager will need to decide which estates need to be targeted. Thereafter, the manager is in charge of approving the financial planning for the implementation of the SLBCF at each estate.
Steps	<p>Phase 0 requires the completion of the following step:</p> <ul style="list-style-type: none"> • Appoint network providers • Decide which estates need be targeted • Financial planning

Additions were also made to the intricate details of Phase 1 of the SLBCF. Only the additions and changes of Phase 1 will be presented in Table 7.5.

Table 7.5: Phase 1: Call to Action

Phase 1: Call to Action	
Details	In the first phase namely, Call to Action, the goal is to create awareness and acceptance of the need to change, amongst individuals living in institutionally owned rental estates. Information sessions for seniors at an estate will form part of this phase. Seniors need to be well informed on the details and benefits of the SLBCF as suggested in Section 7.3.1. An additional goal will be to establish the <i>readiness</i> of the residents at the specific estate. Surveys could be used to establish how many individuals will be interested to participate if the framework is implemented at the estate where they live.
Steps	Phase 1 requires the completion of the following steps: <ul style="list-style-type: none"> • Constitute steering committee • Bring awareness • Schedule information sessions for the seniors • Determine readiness of the estate • Define specific goals

7.4 Chapter Conclusion

In this chapter the validation of the SLBCF was presented. Firstly, a validation methodology was presented. Secondly, the results of the interviews conducted with the industry experts were presented. Finally, adjustments were made to the SLBCF according to the knowledge that was gained through the industry experts interviews.

Chapter 8

Conclusion

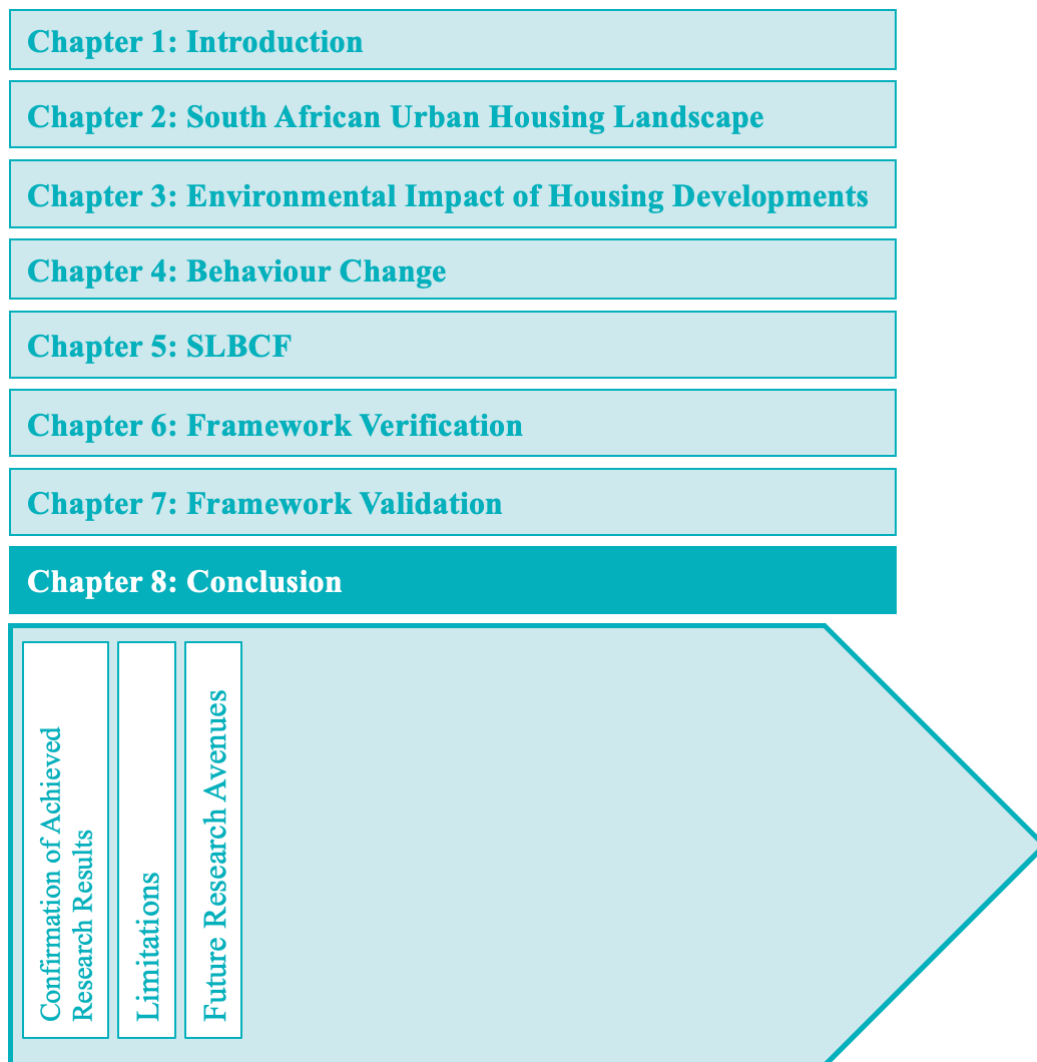


Figure 8.1: Chapter 8 Outline

This chapter concludes the study. The chapter will commence with a confirmation of achieved research results. Secondly, the limitations experienced during this study will be presented. The chapter will be concluded with a number of recommendations regarding possible future research.

8.1 Confirmation of Achieved Research Results

This study had a main objective and five primary objectives and twelve secondary objectives. The achievement of the main objective was dependant on the achievement of the primary and secondary objectives. The objectives are set out in Table 1.1 but for ease of reference, the objectives are summarised in Table 8.1.

The main objective of the study is:

With the great need for urban housing to be developed, it is also important to ensure that new developments will result in a sustainable future. How can the SLBCF be developed to optimize sustainable living within the context of institutionally owned rental estates?

Table 8.1: Summary of Research Objectives

Chapter	Number	Primary Objective
Two	1	Describe the scope of the South African urban housing landscape.
Three	2	Establish the environmental impact of housing developments.
Four	3	Present a framework of the most prevalent and applicable findings of behaviour change theory to this study.
Five	4	Present a Sustainable Living Behaviour Change Framework.
Seven	5	Validate the framework.

Objective 1: Describe the scope of the South African urban housing landscape.

Evidence: The purpose of Chapter 2 was to achieve the first objective of the study. In the pursuit of achieving this objective reference was made to the following two themes:

- South African Housing Landscape
- Urban Housing Requirements for 2030

In Section 2.1 the scope of the South African urban landscape was presented. Policies and interventions that are implemented addressing the sustainability issue in South Africa were also presented. The second section in Chapter 2 addressed the urban housing requirements for 2030.

Status: Achieved.

Objective 2: Establish the environmental impact of housing developments.

Evidence: In the pursuit of this objective Chapter 3 commenced with evaluating the residential building cycle. This evaluation revealed three main contributing factors of the operation stage. The impact these three contributing factors has on the environment was defined.

Status: Achieved.

Objective 3: Present a framework of the most prevalent and applicable findings of behaviour change theory to this study.

Evidence: Presenting the most prevalent findings of behaviour change theory proved to be more complicated than anticipated. Literature consists of a vast majority of theories and frameworks and it became a difficult and time-consuming task to cover the whole spectrum. However, the theories and models that were presented assisted with the development of the SLBCF. In pursuit of the primary objective, a number of aspects were addressed in this chapter. The following themes were presented:

- Behaviour Change Theory: Individual behaviour change, social theories of behaviour change and integrated frameworks of behaviour change.
- Motivation: Need-based theories and reward-based theories.
- Gamification: Defining gamification, creating meaningful gamification and examples of gamification frameworks.

Status: Achieved.

Objective 4: Present a SLBCF.

Evidence: Objective 4 is considered to be the primary study objective. In light of the research done in Chapter 4, a combination of some of the frameworks seemed most fit for the use of this study. Thus, in the first part of Chapter 5, the five phases of the SLBCF was presented. Secondly, the framework's artefacts were presented and discussed.

Status: Achieved.

Objective 5: Validate the framework.

Evidence: In Chapter 7 the SLBCF was validated through subject matter experts in the industry. Some adjustments were made to the framework and the changes are presented in Section 7.3.

Status: Achieved.

8.2 Limitations

With any scientific research, some form of limitation exists. It is very important to acknowledge these limitations since they can influence or restrict the research outcomes. This study had the following limitations:

- The available resources such as finances and time did not allow for a practical case study, thus the SLBCF was only presented to industry experts for validation. However, practical application will undoubtedly reveal unforeseen problems and challenges with the SLBCF;
- The scope of the study excluded the financial model of implementing the SLBCF. Implementing the SLBCF at an estate has costs involved, such as changes to recycling systems, management of utility systems and more. Without these systems and technology implemented, it becomes extremely difficult to successfully manage and monitor tenant behaviour.

The developed framework would work best and be most useful at estates where sustainability and green energy is already pursued to some extent. The process of implementing the SLBCF will be much easier at estates that already have smart utility meters and a recycling system installed. Without these systems and technology installed, it is almost impossible to monitor tenant behaviour, which makes it difficult to successfully use the Game presented in Section 5.2.4.2.

The ideal site will already have solar panels or heat pumps installed at each unit, together with smart electric meters. Additionally, a fully functioning recycling system needs to be implemented at the estate to ensure that waste is correctly recycled from the tenant's residence up until it is collected from recycling companies. Lastly, access to golf carts and public transport needs to be available to staff and tenants. This is why the screening phase presented in Section 5.2.2 is important; through the use of a scorecard the estate's level of sustainability is calculated. The results from the scorecard will give an indication if the estate is capable of implementing the SLBCF with the existing technology and systems implemented.

It is however possible to implement the needed equipment and systems to ensure that tenant behaviour can be monitored, but it has a cost involved. The conclusion is that the SLBCF will most successfully operate at an estate that is already equipped with the necessary technology and systems.

8.3 Future Research Avenues

This section proposes future research avenues. These avenues were either excluded from the scope of the study or discovered during research. Possible future research include:

- **Smart Technology in Estates:** With the digitalisation of residential industries, numerous smart building technologies have entered the market that are pioneering the way in which

people interact with and use indoor spaces. Examples of residential developments in South Africa is Balwin Properties' eco-friendly, top-quality Green Collection lifestyle estates.

- **Development of the Game:** The Game was introduced in Section 5.2.4.2. Future work could include the physical design and development of the application or online platform.
- **A Financial Model for the SLBCF:** During the industry expert interviews, the uncertainties of the financial implications of the SLBCF were revealed. A framework that investigates the financial impact of decisions and its influence on the return on investment would be a valuable addition to the framework developed in this document.

End.

Bibliography

- Ajzen, I. (2012). The theory of planned behaviour is alive and well, and not ready to retire. Health Psychology Review, vol. 9, no. 2, pp. 131–137. ISSN 17437202.
Available at: <http://dx.doi.org/10.1080/17437199.2014.883474>
- Anderson, L., Gold, J., Stewart, J., Thorpe, R., Saunders, M.N., Gray, D.E., Tosey, P. and Sadler-Smith, E. (2017). Concepts and theory building. A Guide to Professional Doctorates in Business and Management, pp. 35–56.
- Annetta, L.A. (2010). The "I's" Have It: A Framework for Serious Educational Game Design. Review of General Psychology, vol. 14, no. 2, pp. 105–112. ISSN 10892680.
- Ansah, S. and Ametepey, S. (2014). Impacts of construction activities on the environment. Journal of Construction Project Management and Innovation, vol. 4, no. 9, pp. 934–948. ISSN 1098-6596. arXiv:1011.1669v3.
- Ansari, S. (2017). The neo-liberal incentive structure and the absence of the developmental state in post-apartheid South Africa. African Affairs, vol. 116, no. 463, pp. 206–232. ISSN 14682621.
- Anthony, R. (1965). Planning and Control Systems: A Framework for Analysis.
Available at: <https://www.worldcat.org/title/planning-and-control-systems-a-framework-for-analysis/oclc/228994>
- Argyris, C. (1977). Double loop learning in organizations. Harvard business review, vol. 55, no. 5, pp. 115–125.
- Baker, S.E. and Edwards, R. (2012). How many qualitative interviews is enough ? National Centre for Research Methods Review Paper, pp. 1 – 42.
Available at: <http://eprints.ncrm.ac.uk/2273/>
- Bandura, A. (1977). Self-Efficacy: Toward a Unifying Theory of Behavioral Change. Psychological Review, vol. 84, no. 2, pp. 1–215.
- Bebbington, J., Unerman, J. and O'Dwyer, B. (2014). Sustainability Accounting and Accountability: Second Edition. ISBN 9781317906803.
- Bolderdijk, J.W., Lehman, P.K. and Geller, E.S. (2018). Encouraging Pro-Environmental Behaviour with Rewards and Penalties. Environmental Psychology, , no. January, pp. 273–282.
- Borowy, I. and Schmelzer, M. (2017). History of the Future of Economic Growth. ISBN 9781138685802.
- Bowen, G.A. (2008). Naturalistic inquiry and the saturation concept: A research note. Qualitative Research, vol. 8, no. 1, pp. 137–152. ISSN 14687941.
- Bozkurt, T., Bektas, F., Ahmed, M.J., Kola, V. and Yurtkoru, E.S. (2017). Application of goal setting theory. Pressacademia, vol. 3, no. 1, pp. 796–801. ISSN 2146-7943.

- Bryman, A. and Bell, E. (2014). Research methodology: Business and management contexts. Oxford University Press Southern Africa.
- C2ES (2021). Reducing Your Transportation Footprint.
Available at: <https://www.c2es.org/content/reducing-your-transportation-footprint/>
- Christians, G. (2018). The Origins and Future of Gamification. Scholar Commons, vol. 21, no. 2, pp. 127–148. ISSN 17438764.
- Clift, R. and Druckman, A. (2015). Taking Stock of Industrial Ecology. London. ISBN 9783319205717.
- Deci, E.L. and Ryan, R.M. (2002). Handbook of Self-Determination Research. vol. 23, no. 2, pp. 243–244.
Available at: <http://www.kopiloth.de/sdthb..pdf>
- Department of Environmental Affairs (2012). National Waste Information Baseline Report. Report, pp. 1–21.
Available at: https://www.greencape.co.za/assets/WASTE_MIR_20200331.pdf
- Dolan, P., Hallsworth, M., Halpern, D., King, D., Metcalfe, R. and Vlaev, I. (2012). Influencing behaviour: The mindspace way. Journal of Economic Psychology, vol. 33, no. 1, pp. 264–277. ISSN 01674870.
- Eisenhardt, K.M. and Graebner, M.E. (2007). Theory Building from Cases : Opportunities and Challenges
Linked references are available on JSTOR for this article : THEORY BUILDING FROM CASES : OPPORTUNITIES AND CHALLENGES. Organizational Research Methods, vol. 50, no. 1, pp. 25–32. ISSN 00132004. arXiv:1011.1669v3.
Available at: <http://doi.wiley.com/10.1111/j.1741-5446.2006.00241.x>
<https://www.academic-toolkit.com/downloads>
<http://www.ncbi.nlm.nih.gov/pubmed/19059132>
<http://dx.doi.org/10.1080/13562517.2013.795935>
- EPM (2021). Reinforcement Theory of Motivation.
- ETAP (2007). The Carbon Trust Helps UK Businesses Reduce their Environmental Impact. Science, vol. 1, no. 01, pp. 1–11. ISSN 03014215. 0208024.
Available at: https://ec.europa.eu/environment/etap/pdfs/jan07_carbon_trust_initiative.pdf
- Frey, D.D. and Dym, C.L. (2006). Validation of design methods: Lessons from medicine. Research in Engineering Design, vol. 17, no. 1, pp. 45–57. ISSN 09349839.
- Giusti, L. (2009). A review of waste management practices and their impact on human health. Waste Management, vol. 29, no. 8, pp. 2227–2239. ISSN 0956053X.
Available at: <http://dx.doi.org/10.1016/j.wasman.2009.03.028>
- Glanz, K., Rimer, B.k. and Viswanath, K. (2002). Health and Health. ISBN 9780787996147.
- Goodyear, P. and Jones, C. (2004). Advances in Research on Networked Learning. May 2014. ISBN 1402079095.
- GreenCape (2020). 2020: Market Intelligence Report: Waste. Waste, pp. 1–64.
Available at: https://www.greencape.co.za/assets/WASTE_MIR_20200331.pdf
- Hargreaves, T. (2011). Practice-ing behaviour change: Applying social practice theory to pro-environmental behaviour change. Journal of Consumer Culture, vol. 11, no. 1, pp. 79–99. ISSN 14695405.

- Haustein, K., Allen, M.R., Forster, P.M., Otto, F.E., Mitchell, D.M., Matthews, H.D. and Frame, D.J. (2017). A real-time Global Warming Index. Scientific Reports, vol. 7, no. 1, pp. 1–6. ISSN 20452322. Available at: <http://dx.doi.org/10.1038/s41598-017-14828-5>
- Imenda, S. (2014). Is There a Conceptual Difference between Theoretical and Conceptual Frameworks? Journal of Social Sciences, vol. 38, no. 2, pp. 185–195. ISSN 0971-8923.
- Jabareen, Y. (2009a). Building a Conceptual Framework: Philosophy, Definitions, and Procedure. International Journal of Qualitative Methods, vol. 8, no. 4, pp. 49–62. ISSN 1609-4069.
- Jabareen, Y. (2009b). Building a Conceptual Framework: Philosophy, Definitions, and Procedure. International Journal of Qualitative Methods, vol. 8, no. 4, pp. 49–62. ISSN 1609-4069.
- Jenkins, P. (2017). Big data games for productive employees.
- Jenkins, P. (2020). Gamification Project Process Workflow. Available at: <https://gamificationplus.uk/gamification-project-success-workflow/>
- Karimi, K. and Nickpayam, J. (2017). Gamification from the Viewpoint of Motivational Theory. vol. 1, no. 1, pp. 34–42.
- Kaur, A. (2013). Maslow 's Need Hierarchy Theory :. Maslow's Need Hierarchy Theory: Applications and Criticisms, vol. 3, no. 10, pp. 1061–1064. Available at: http://www.ripublication.com/gjmbs_spl/gjmbsv3n10_03.pdf
- Kushlin, A.V., Schillhorn van Veen, T.W. and Sutton, W. (2003). Kazakhstan: forest sector in transition: the resource, the users and sustainable use. World Bank Technical Paper, vol. 31883, p. 56.
- Laurencine, G. (2015). the Construction Industry and Climate Change - Teachers Guide. pp. 1–32. Available at: <http://www.s4seychelles.com/publications.html>
- Leeper, C. (2011). Expectancy-Value Theory: More Similarities than Differences in Contemporary Theories of social development?
- Lindenberg, S. and Steg, L. (2007). Normative, gain and hedonic goal frames guiding environmental behavior. Journal of Social Issues, vol. 63, no. 1, pp. 117–137. ISSN 00224537.
- Locke, E.A., Shaw, K.N., Saari, L.M. and Latham, G.P. (1981). Goal setting and task performance: 1969-1980. Psychological Bulletin, vol. 90, no. 1, pp. 125–152. ISSN 00332909.
- Marquez, A.C. and Parra, C. (2020). Criticality Analysis Methods. Based on the Risk Assessment Process. , no. June 2020.
- McCarthy, I.P., Plangger, K., Robson, K., Kietzmann, J. and Pitt, L. (2019). Dynamic Game Plans: Using Gamification to Entrain Strategic Renewal with Environmental Velocity. SSRN Electronic Journal, pp. 1–20. ISSN 1556-5068.
- Mckellar, K. and Sillence, E. (2020). Current Research on Sexual Health and Teenagers. Teenagers, Sexual Health Information and the Digital Age, pp. 5–23.
- Morelli, J. (2011). Environmental Sustainability: A Definition for Environmental Professionals. Journal of Environmental Sustainability, vol. 1, no. 1, pp. 1–10.

- Morris, J., Marzano, M., Dandy, N. and O'Brien, L. (2012). Theories and models of behaviour and behaviour change. Forestry, sustainable behaviours and behaviour change: Theories, pp. 1–27. ISSN 09528229.
- Ngwepe, L. and Aigbavboa, C. (2015). A Theoretical Review of Building Life Cycle Stages and Their Related Environmental Impacts. J. Civil Eng. Environ. Technol, vol. 2, no. 13, pp. 7–15.
- Nicholson, S. (2015). A recipe for meaningful gamification. Gamification in Education and Business, pp. 1–20.
- Nisbet, E.K. and Gick, M.L. (2008). Can health psychology help the planet? Applying theory and models of health behaviour to environmental actions. Canadian Psychology, vol. 49, no. 4, pp. 296–303. ISSN 07085591.
- Our World in Data (2020). Our World In Data.
Available at: <https://ourworldindata.org/emissions-by-sector>
- Papa (2018). How To Teach Technology To Seniorsite.
Available at: <https://www.joinpapa.com/how-to-teach-technology-to-seniors/>
- Reckwitz, A. (2004). Toward a theory of social practices: A development in culturalist theorizing. Practicing History: New Directions in Historical Writing after the Linguistic Turn, vol. 5, no. 2, pp. 245–263.
- Redmond (2010). A Review of Skinner's Reinforcement Theory of Motivation. International Journal of Research in Education Methodology, vol. 5, no. 3, p. 680. ISSN 2277-3061.
- Reiners, T. and Wood, L.C. (2015a). Gamification in education and business. Gamification in Education and Business, pp. 1–710.
- Reiners, T. and Wood, L.C. (2015b). Gamification in education and business. Gamification in Education and Business, pp. 1–710.
- Rigby, C.S. and Przybylski, A.K. (2009). Virtual worlds and the learner hero: How today's video games can inform tomorrow's digital learning environments. Theory and Research in Education, vol. 7, no. 2, pp. 214–223. ISSN 14778785.
- Robson, K., Plangger, K., Kietzmann, J.H., McCarthy, I. and Pitt, L. (2015). Is it all a game? Understanding the principles of gamification. Business Horizons, vol. 58, no. 4, pp. 411–420. ISSN 00076813.
Available at: <http://dx.doi.org/10.1016/j.bushor.2015.03.006>
- Rodgers, W. and Loitz, C. (2009). The role of motivation in behaviour change. ACSM's Health & Fitness Journal, vol. 1, no. 1, pp. 7–12.
- Rogers, E. (2003). Diffusion of Innovations. 5th edn. New York.
- Roux, A.L.E., Arnold, K., Khuluse-makhanya, S., Mans, G. and Wools, L. (2018). Highlighting the growth trajectory of South Africa's settlements. , no. October, p. 2018.
- Rutkauskiene, D., Gudoniene, D. and Maskeliunas, R. (2016). Smart Education and e-Learning 2016. vol. 59, no. June, pp. 291–301.
Available at: <http://link.springer.com/10.1007/978-3-319-39690-3>
- Sailer, M., Hense, J.U., Mayr, S.K. and Mandl, H. (2017). How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction. Computers in Human Behavior, vol. 69, no. January, pp. 371–380. ISSN 07475632.
Available at: <http://dx.doi.org/10.1016/j.chb.2016.12.033>

- Siang, A.C. and Rao, R.K. (2003). Theories of learning: A computer game perspective. Proceedings - IEEE 5th International Symposium on Multimedia Software Engineering, ISMSE 2003, pp. 239–245.
- Skinner, B. (1979). Contingencies of Reinforcement: A Theoretical Analysis. The shaping of a behaviorist. New York: Alfred A. Knopf, vol. 1, no. 1, pp. 372–390. ISSN 01454455.
- Sniehotta, F.F., Presseau, J. and Araújo-Soares, V. (2014). Time to retire the theory of planned behaviour. Health Psychology Review, vol. 8, no. 1, pp. 1–7. ISSN 17437199.
Available at: <http://dx.doi.org/10.1080/17437199.2013.869710>
- Stats SA (2017). Mid-year population estimate. Tech. Rep. 1, Pretoria.
- Stern, P.C. (2000). Toward a coherent theory of environmentally significant behavior. Journal of Social Issues, vol. 56, no. 3, pp. 407–424. ISSN 00224537.
- Stimie, J. (2018). Shaping the future of residential housing projects: Breakthrough in mindset and technology. Saaie29, , no. October, pp. 457–472.
- Strydom, W.F. (2018). Barriers to Household Waste Recycling : Empirical Evidence from South Africa.
- Susi, T., Johannesson, M. and Backlund, P. (2007). Serious Games - An Overview. Humanities and Informatics, vol. 1, pp. 488–491.
- Tae, S., Shin, S., Woo, J. and Roh, S. (2011). The development of apartment house life cycle CO2 simple assessment system using standard apartment houses of South Korea. Renewable and Sustainable Energy Reviews, vol. 15, no. 3, pp. 1454–1467. ISSN 13640321.
Available at: <http://dx.doi.org/10.1016/j.rser.2010.09.053>
- Vansteenkiste, M., Lens, W., De Witte, H. and Feather, N.T. (2005). Understanding unemployed people's job search behaviour, unemployment experience and well-being: A comparison of expectancy-value theory and self-determination theory. British Journal of Social Psychology, vol. 44, no. 2, pp. 269–287. ISSN 01446665.
- Vlek, C.A. and Steg, L. (2007). Human behavior and environmental sustainability: Problems, driving forces, and research topics. Journal of Social Issues, vol. 63, no. 1, pp. 1–19. ISSN 00224537.
- Welch, D. and Warde, A. (2015a). Theories of practice and sustainable consumption. Handbook of Research on Sustainable Consumption, pp. 84–100.
- Welch, D. and Warde, A. (2015b). Theories of practice and sustainable consumption. Handbook of Research on Sustainable Consumption, pp. 84–100.
- Werbach, K. (2014). (Re)Defining Gamification : A Process Approach Gamification as a Process. Springer International Publishing Switzerland, pp. 266–272.
- Williams, J.J. (2006). Community participation: Lessons from post-apartheid South Africa. Policy Studies, vol. 27, no. 3, pp. 197–217. ISSN 01442872.
- Williams, S.P., Thondhlana, G. and Kua, H.W. (2020). Electricity use behaviour in a high-income neighbourhood in Johannesburg, South Africa. Sustainability (Switzerland), vol. 12, no. 11, pp. 1–19. ISSN 20711050.
- Worldometer (). Population by Country.
Available at: <https://www.worldometers.info/world-population/population-by-country/>

BIBLIOGRAPHY

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Worldwatch Institute (2003). Sustainable facilities: building material selection. arXiv:1011.1669v3.
Available at: [/www.sustainablebusforum.org/bldgmat](http://www.sustainablebusforum.org/bldgmat)