

https://dspace.org/

nowledge and perceptions of add- on electrical geyser efficiency technologies held by contractors in Durban

Mzobe, Snothando Nosipho

2024

University of the Witwatersrand, Johannesburg

https://hdl.handle.net/10539/44333

Mzobe, Snothando Nosipho. (2024). nowledge and perceptions of add- on electrical geyser efficiency technologies held by contractors in Durban [Master's dissertation, University of the Witwatersrand, Johannesburg].WireDSpace.https://hdl.handle.net/10539/44333

Downloaded from a DSpace repository. https://dspace.org/

Knowledge and perceptions of add-on electrical geyser efficiency technologies held by contractors in Durban

Snothando Mzobe

A research report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Management in Energy Leadership

Johannesburg, 2024

ABSTRACT

Globally, energy losses take away as much as 40% of the primary energy during distribution. Recovering this lost energy by employing more energy efficient practices can make a significant difference to the available energy. In South Africa, the residential sector makes up approximately 17% - 35% of electricity demand during peak demand periods, primarily due to the large usage of household electric water heaters commonly known as geysers. Plumbing and electrical contractors who install and maintain electrical geysers are at a strategic position to act as intermediaries to influence households towards the adoption of more energy efficient practices. This paper, therefore, investigates the extent of knowledge and perceptions held by these contractors regarding the various add-on technologies that can be used to make geysers more energy efficient.

A non-experimental, quantitative research approach using questionnaires was used to, firstly, evaluate the factors that would influence the intention of contractors working in the Durban area to take up the aforementioned intermediary role. Secondly, this research sought to assess the extent of the knowledge held by contractors in the formal versus the informal sectors. Lastly, the research sought to evaluate the relationship between the contractors' knowledge of the various add-on technologies that can be used to make geysers more energy efficient and intention to take up an intermediary role to influence households towards the adoption of more energy efficient practices.

The results showed a positive correlation between social norms as well as perceived behavioural control with intention, while a correlation between personal norms as well as attitude with intention was not observed. It was also found that there is no difference in the levels of knowledge held by contractors in the formal and informal sectors, while knowledge was found to have a positive influence on intention.

It was recommended that in order to improve energy efficiency knowledge among contractors, the government ought to consider regulatory mechanisms

to encourage formal training and improve the quality of vocational education. To aid in this endeavour, government should also partner with businesses and industry-specific professional bodies. Lastly, government should implement quality feedback mechanisms to monitor the quality of work performed by contractors.

KEY WORDS: energy efficiency, intermediaries, contractors, formal, informal, knowledge, norms, attitude, perceived behavioural control, intention.

DECLARATION

I, Snothando Nosipho Mzobe_____, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Management in Energy Leadership ___at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Name: Snothando Mzobe Signature: 

Signed at …Tongaat……

On the ……15th…….. day of ……February…… 2024…..

DEDICATION

I dedicate this degree to my mother who never stopped encouraging me and liberally shared amusing but effective stories from her own educational journey right into her fifties. Secondly, I would like to dedicate this degree to the 22-year-old me who never thought I would find myself here; and lastly, to the 35-year-old me who wants to do a PhD but still scarred by the torturous journey of this degree. Just remember: One step at a time!

ACKNOWLEDGEMENTS

I would like to acknowledge Professor Gillian Finchilescu for being an amazing supervisor. Thank you for your support, encouragement, and empathy throughout this journey! I really could not have done this without you.

I would also like to thank Njabulo Ntuli for his assistance with data collection. Your dedication and energy were not lost on me.

TABLE OF CONTENTS

ABSTRACT ..... **ii**

DECLARATION ..... **iv**

DEDICATION ..... **v**

ACKNOWLEDGEMENTS ..... **vi**

LIST OF TABLES ..... **x**

LIST OF FIGURES ..... **xi**

LIST OF ACRONYMS and ABBREVIATIONS ..... **xii**

CHAPTER 1. INTRODUCTION **1**

1.1 PURPOSE OF THE STUDY 1
1.2 CONTEXT 1
1.3 RESEARCH PROBLEM 2
1.3.1 BACKGROUND 2
1.3.2 THE SOUTH AFRICAN CONTRACTORS' SECTOR: CONTEXT 6
1.3.3 THEORETICAL FRAMEWORK 9
1.4 RESEARCH QUESTIONS 13
1.5 SIGNIFICANCE OF THE STUDY 14
1.5.1 THE CASE FOR CONTRACTORS 14
1.5.2 BENEFIT TO STAKEHOLDERS 15
1.6 DELIMITATIONS OF THE STUDY 15
1.7 DEFINITION OF TERMS 16
1.8 ASSUMPTIONS 16
1.9 STRUCTURE OF THE REPORT 16

CHAPTER 2. LITERATURE REVIEW **18**

2.1 INTRODUCTION 18
2.2 DEFINITION OF TOPIC OR BACKGROUND DISCUSSION 18
2.2.1 DEFINING GEYSER EFFICIENCY AND GEYSER EFFICIENCY TECHNOLOGIES 18
2.3 FACTORS IN THE CADM PREDICTING INTENTIONS 20
2.3.1 PERSONAL NORMS 20
2.3.2 SOCIAL NORMS 22
2.3.3 ATTITUDES 29
2.3.4 PERCEIVED BEHAVIOUR CONTROL 30

2.4 LEVEL OF KNOWLEDGE HELD BY INTERMEDIARIES ABOUT GEYSER EFFICIENCY TECHNOLOGIES 35
2.4.1 THE ROLE OF KNOWLEDGE HELD BY THE INTERMEDIARY IN ENERGY EFFICIENCY INTERMEDIATION. 35
2.4.2 LEVEL OF CONTRACTOR KNOWLEDGE IN SOUTH AFRICA 37
2.4.3 ATTAINMENT OF ENERGY EFFICIENCY KNOWLEDGE 39
2.5 THE RELATIONSHIP BETWEEN KNOWLEDGE ON GEYSER EFFICIENCY TECHNOLOGIES AND INTENTIONS TO PROMOTE GEYSER EFFICIENCY TECHNOLOGIES? 41
2.6 CONCLUSION OF LITERATURE REVIEW 44

CHAPTER 3. RESEARCH METHODOLOGY 46

3.1 RESEARCH APPROACH 46
3.2 RESEARCH DESIGN 46
3.3 DATA COLLECTION METHODS 47
3.4 POPULATION AND SAMPLE 47
3.4.1 POPULATION 47
3.4.2 SAMPLE 48
3.5 THE RESEARCH INSTRUMENT 50
3.5.1 TESTING THE RECONFIGURED CADM AND EVALUATING THE SIGNIFICANCE OF THE FOUR FACTORS LINKED TO INTENTION 50
3.5.2 EVALUATING THE EXTENT OF TECHNICAL KNOWLEDGE 52
3.6 PROCEDURE FOR DATA COLLECTION 53
3.7 DATA ANALYSIS AND INTERPRETATION 53
3.7.1 RESEARCH QUESTION 1 53
3.7.2 RESEARCH QUESTION 2 55
3.7.3 RESEARCH QUESTION 3 55
3.8 LIMITATIONS OF THE STUDY 55
3.9 VALIDITY AND RELIABILITY 56
3.9.1 EXTERNAL VALIDITY 56
3.9.2 INTERNAL VALIDITY 56
3.9.3 RELIABILITY 57
3.9.4 OBJECTIVITY OR CONFORMABILITY 57
3.10 ETHICAL CONSIDERATIONS 57

CHAPTER 4. PRESENTATION OF RESULTS 59

4.1 INTRODUCTION 59
4.2 DATA SCREENING, ASSESSMENT OF VALIDITY AND RELIABILITY 59
4.2.1 DATA SCREENING AND IMPUTATION 59
4.2.2 DATA MEANING 60
4.3 RESULTS PERTAINING TO RESEARCH QUESTION 1 60
4.3.1 DESCRIPTIVE STATISTICS 60
4.3.2 CONFIRMATORY FACTOR ANALYSIS 62
4.3.3 RELIABILITY ASSESSMENT 67
4.3.4 PATH ANALYSIS 67
4.4 RESULTS PERTAINING TO RESEARCH QUESTIONS 2 & 3 70
4.4.1 DESCRIPTIVE STATISTICS 70

4.4.2 HYPOTHESIS 5 RESULTS 72
4.4.3 HYPOTHESIS 6 RESULTS 72

CHAPTER 5. DISCUSSION OF RESULTS 73

5.1 INTRODUCTION 73
5.2 DISCUSSION PERTAINING TO RESEARCH QUESTION 1 73
5.2.1 HYPOTHESES 1 73
5.2.2 HYPOTHESIS 2 76
5.2.3 HYPOTHESES 3 78
5.2.4 HYPOTHESES 4 80
5.3 DISCUSSION PERTAINING TO RESEARCH QUESTION 2 AND 3 81
5.3.1 HYPOTHESIS 5 82
5.3.2 HYPOTHESIS 6 86

CHAPTER 6. CONCLUSIONS & RECOMMENDATIONS 89

6.1 INTRODUCTION 89
6.2 CONCLUSIONS REGARDING RESEARCH QUESTION 1 89
6.3 CONCLUSIONS REGARDING RESEARCH QUESTION 2 91
6.4 CONCLUSIONS REGARDING RESEARCH QUESTION 3 92
6.5 RECOMMENDATIONS 92
6.5.1 CERTIFICATE OF COMPLIANCE OR OTHER QUALITY FEEDBACK MECHANISMS 92
6.5.2 INCREMENTAL APPROACH TO QUALIFICATIONS THROUGH PIECEWISE CERTIFICATIONS 92
6.5.3 INCLUDE GEYSER EFFICIENCY CONTENT IN TVET CURRICULUM 93
6.5.4 ENERGY LITERACY CAMPAIGNS AND PROGRAMS 93
6.5.5 PARTNERING WITH BUSINESSES AND PROFESSIONAL BODIES 94
6.6 SUGGESTIONS FOR FURTHER RESEARCH 95

REFERENCES 97

APPENDIX A: The Research Instrument (Participant information and Knowledge-based questionnaire) 104

APPENDIX B: Ethics Clearance 106

APPENDIX C: Participant Information Sheet 107

APPENDIX D: Participant Consent Form 108

LIST OF TABLES

Table 1: Principle of Operation of Various Geyser Efficiency Technologies..... 20

Table 2: Consistency Matrix: Research Questions and Hypotheses..... 44

Table 3: Profile of Respondents..... 49

Table 4: No. of Respondents in the Formal and Informal Sectors..... 50

Table 5: Likert-Scale Questions for Hypotheses 1 – 4 51

Table 6: Questions for Attitude..... 52

Table 7: Responses for Each Likert Scale Selection for Each Indicator by Percentage for Each Construct 61

Table 8: Statistics of The Composite Likert Scale Measures by Construct 62

Table 9: Factor Loadings or Standardised Regression Weights 65

Table 10: Squared Multiple Correlations for the Indicators 65

Table 11: Model Fit Results 66

Table 12: Cronbach Alpha Results..... 67

Table 13: Model Fit Indices for The Path Analysis Structural Model 69

Table 14: Hypotheses 1 to 4 Testing Results..... 69

Table 15: Descriptive Statistics for Scores..... 71

Table 16: Number of Respondents by Score 71

Table 17: Descriptive Statistics for Scores by Sector (Formal Vs Informal) 71

Table 18 : Participant information..... 104

Table 19 : Knowledge-Based Questions and Scoring..... 104

LIST OF FIGURES

Figure 1: Approximate Use of World Primary Energy Among Different Applications 2

Figure 2: Awareness Levels About Various Energy Efficiency Technologies 4

Figure 3: Level of Adoption of Various Energy Efficiency Technologies 4

Figure 4: National Plumbing Contractor Population 8

Figure 5: National Electrical Contractor Population 8

Figure 6: Comprehensive Action Determination *Model* 10

Figure 7: Reconfigured CADM 12

Figure 8: Simplified and Reconfigured *CADM* 12

Figure 9: Typical Energy Efficiency Label 24

Figure 10: Relevant Skills Required for A Range of Tasks and Intents 34

Figure 11: Plumber's Training Preferences 43

Figure 12: Training Preferences for Electrical Contractors 43

Figure 13: Simplified and Reconfigured CADM 48

Figure 14: CFA Model Computed on SPSS Amos 63

Figure 15: Path Analysis Structural Model Computed in SPSS AMOS 68

LIST OF ACRONYMS and ABBREVIATIONS

CADM	-	Comprehensive Action Determination model
ECA(SA)	-	Electrical Contractors Association of South Africa
EE	-	Energy Efficiency
IOPSA	-	Institute of Plumbing South Africa
LSM	-	Living Standard Measurement
MEPS	-	Minimum Energy Performance Standards
NCPC-SA	-	National Cleaner Production Centre of South Africa
NEES	-	National Energy Efficiency Strategy
PIRB	-	Plumbing Industry Registration Board
PBC	-	Perceived Behavioural Control
SAEEC	-	Southern African Energy Efficiency Confederation
SEM	-	Structural Equation Modelling
TVET	-	Technical and Vocational Education and Training

CHAPTER 1. INTRODUCTION

1.1 Purpose of the study

This research is a quantitative study to investigate plumbing and electrical contractors' knowledge and perceptions of household geyser efficiency technologies within the residential sector of Durban, as well as the factors that would influence their intentions to engage in an intermediary role to influence households to adopt them. It will also compare how the level of knowledge of geyser efficiency technologies differs among contractors in the formal and informal sectors.

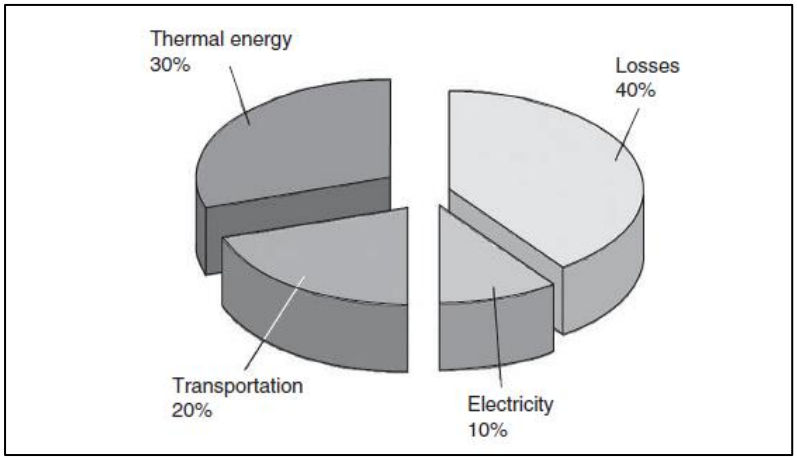
1.2 Context

Due to the country's heavy mining and energy-intensive industries, coupled with an electricity generation industry that is almost exclusively based on coal - with 88% of electricity generated from coal - the resulting CO_2 emissions earn South Africa a spot among the top 10 emitters of greenhouses gases in the world (British Petroleum, 2019). The energy industry alone contributes approximately 80% towards the country's greenhouse gas emissions (Department of Energy, 2019).

shows a general distribution of the uses of the world's primary energy sources. It can be seen that 40% of it goes to losses before even reaching the end-user (Ngo & Natowitz, 2009). The potential for energy efficiency activities to recover this lost energy is substantial. This also applies on the end-user side, where the efficiencies of many end-user applications, such as industrial equipment, automobile engines and household appliances result in further energy losses as only a fraction of the supplied energy is used to achieve the desired intent. On the end-user side, thermal energy such as heating and cooling of buildings and water account for 30% of primary energy- the second largest share after losses. Thus, losses of energy for thermal purposes ought to be viewed as a priority which should be investigated in order to reduce the consumption of fossil fuels (Ngo & Natowitz, 2009).

Figure 1

Approximate Use of World Primary Energy Among Different Applications



Note. Thermal energy is the second largest use of primary energy after losses.
From *Our Energy Future: Resources, Alternatives and The Environment,* by Ngo and Natowitz (2009, p. 17, adapted from B. Barre, Atlas des energies, Autrement, 2007)

In addition to environmental pressures, South Africa is currently facing an electricity generation crisis. For the past several years the primary and largest state-owned utility, Eskom, has been unable to consistently meet electricity demand. This has resulted in scheduled power outages throughout the country (Department of Energy, 2019). Energy efficiency can thus play an effective role in both reducing the country's CO_2 emissions, while also alleviating the demand pressure on the grid. Given that South Africa is a developing nation, it is expected that as the country develops further, even more energy will be required. This makes the imperative to find ways to use the available energy efficiently- that is, using less energy to achieve the same development - more critical.

1.3 Research problem

1.3.1 Background

In 2005, in response to the country's energy challenges combined with the commitment to reduce greenhouse emissions, the South African government implemented the NEES. This sought to increase energy efficiency in the major

sectors of the economy including mining and industry, commercial, transport and residential sectors (Department of Energy, 2015). The residential sector makes up approximately 17% of electricity demand during peak demand periods, which can sometimes rise up to 35%, primarily due to the large usage of household electric water heaters commonly known as geysers (ESKOM, n.d.). Geysers, thus present a prime domain of investigation to which Ngo and Natowitz (2009) allude.

Following the implementation of the NEES, a household energy survey was conducted as part of the process to determine the energy efficiency improvement in the residential sector (Department of Energy, 2015). To illustrate the significance of household electric geysers in the residential electricity demand, seven out of nine technologies in the survey pertained to improvements of electric geyser efficiencies. The results were linked to household wealth using the LSM. This showed varying levels of awareness and adoption rates of these technologies - lowest among lower LSM households and highest among higher LSM households, as shown in

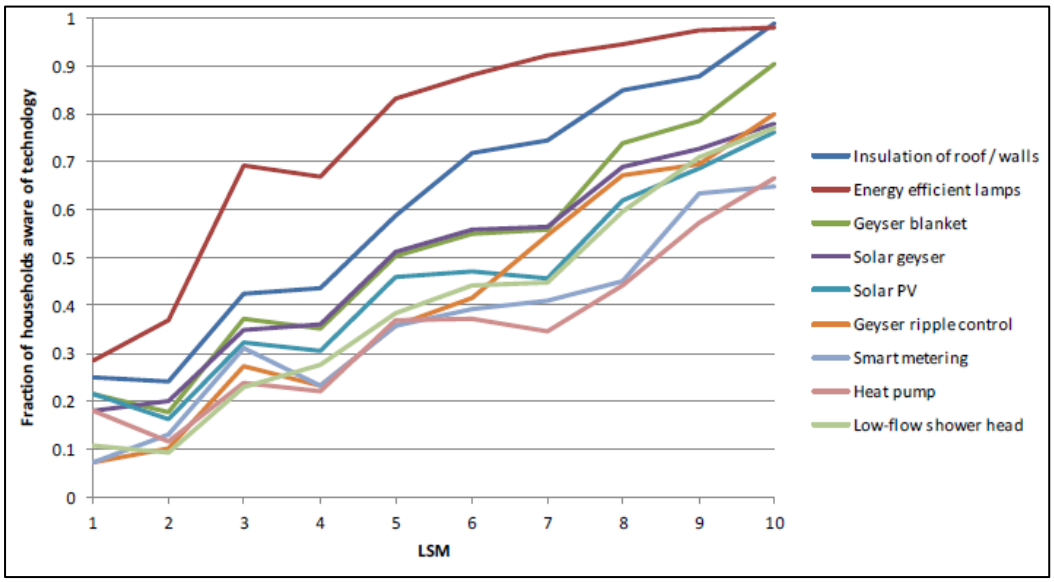
Figure 2 and

Figure 3. This leads to the question: what methods could be used to intervene by not only disseminating information effectively, but holistically steering the adoption of geyser energy efficiency technologies in the residential sector?

While geyser efficiency can be achieved by replacing inefficient geysers with more efficient ones or more efficient alternatives such as heat pumps - the capital costs of such new installations can be prohibitive for many households as evident with adoption rates only peaking amongst higher LSM groups. The cost of more capital intensive technologies has been similarly found to be a limiting factor to energy efficiency technology adoptions among lower income households in other parts of the world, including Finland and Belgium (Decuypere, Robaeyst, Hudders, Baccarne, & Van de Sompel, 2022; Hyysalo et al., 2022). Consequently, this study wishes to focus on the more economical add-on technologies that can be retrofitted to an existing electric geyser without having to change the entire geyser installation itself.

Figure 2

Awareness Levels About Various Energy Efficiency Technologies

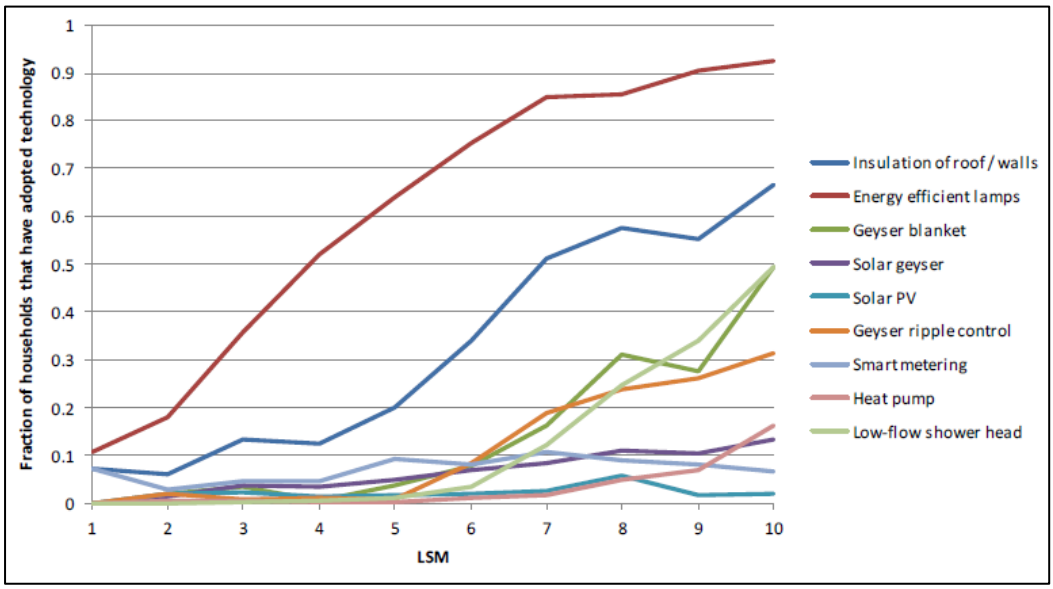


Note. Awareness levels of energy saving technologies increases from lower LSM households to higher LSM households. LSM- Living Standard Measurement.

From *South Africa's Energy Efficiency Targets: Second Annual Monitoring Report* by the Department of Energy, 2015, Pretoria, South Africa

Figure 3

Level of Adoption of Various Energy Efficiency Technologies



Note. Adoption rates of energy saving technologies increases from lower LSM households to higher LSM households. LSM - Living Standard Measurement.
From *South Africa's Energy Efficiency Targets: Second Annual Monitoring Report* by the Department of Energy, 2015, Pretoria, South Africa

Scharnigg and Sareen (2023) define intermediaries as “agents who link actors and practices by serving as go-betweens or mediators.” Intermediaries have varying modus operandi depending on their spheres of operation. These may be non-governmental organisations, municipalities, government driven programmes, large or small businesses or individuals acting in their professional capacities. Intermediaries operating at higher levels - involving larger groups and other organisations as their beneficiaries or stakeholders - may help with navigating government policies, lobbying government, building organisational capacities, empowering community stakeholders and providing direction for their stakeholders (Chun, 2023; Scharnigg & Sareen, 2023). At household level, intermediaries may deal with households individually or in groups and play an important role in the decisions of households to adopt energy efficient technologies (Decuypere et al., 2022).

There are several intermediaries globally in the energy domain focusing on a variety of activities, including the development and implementation of renewable energy projects, advocacy for sustainable and climate change friendly energy alternatives, energy poverty, and energy efficiency. Where energy efficiency is concerned, (Guibentif & Patel, 2023, p. 3) define EE programmes as “entities set up around EE incentive instruments … with the aim of improving the penetration of such instruments, i.e. creating a transition momentum towards EE solutions.” They describe intermediation to involve tasks performed by intermediary personnel for, in service of, and at times, in collaboration with the clients or end users.

When households need to make changes with technologies that affect energy usage, their decisions on what to install next or how to use it are generally influenced by the intermediaries, that is, contractors, architects, etc. (Owen & Mitchell, 2015). Contractors, who are at the coal face- physically working on installations, have the most direct contact with the households, and are in a strategic position to act as energy efficiency intermediaries and potential change agents due to their direct access to households. However, their roles have generally been neglected and are

relatively under-investigated in energy research (Wade, Hitchings, & Shipworth, 2016). Some studies even refer to them as an “unseen influence” (Owen & Mitchell, 2015) and “missing middlemen” (Wade, Hitchings, & Shipworth, 2016).

Contractors are in a unique position not only to influence knowledge and awareness of households, but to monitor progress, iron out teething issues in new installations and identify further opportunities for savings. Nevertheless, access alone isn’t enough and several other factors come into play in determining the extent to which interaction between contractors and households actually result in positive changes in terms of household energy savings (Wade, Murtagh, & Hitchings, 2018). However, before even getting into these factors - how do contractors come to get involved in such endeavours in the first place? Do contractors want to get involved with such endeavours? What are the factors that affect their willingness or resistance to get involved? Any attempt to take advantage of contractors’ strategic position relative to households needs to answer these questions first. Hence, this is, first and foremost, a question of which factors influence contractors’ behaviour. That is, what drives contractors to engage with household energy savings/efficiency matters in the first place? This is the problem that this paper seeks to answer.

1.3.2 The South African contractors’ sector: context

There are two types of contractors involved with the installation, operation, and maintenance of household electric geysers- plumbers and electricians. This study will focus on the city of Durban. Although the specific numbers for Durban are not known, in the province of Kwazulu-Natal where Durban is located, there are approximately 6700 plumbers and 4900 electricians with approximately 80% and 95% being informal plumbers and electricians, respectively (Skills Development for a Green Economy, 2019a, 2019b).

Both the plumbing and electrical sectors are characterised by higher proportions of informal businesses than formal as shown in Figure 4.

The Department of Statistics South Africa (2017), provides the following definition for informal businesses:

Informal sector: The informal sector has the following two components:

> *i) Employees working in establishments that employ less than five employees, who do not deduct income tax from their salaries/wages; and*
>
> *ii) Employers, own-account workers …who are not registered for either income tax or value-added tax.*

The informal sector is seen as a refuge for people who may have lost formal employment or those intending to make additional income over and above their formal employment. Based on the above definition, this clearly makes it possible for a qualified plumber and electrician to operate in the informal sector despite their qualifications. On the other hand, it is also possible for unqualified contractors to work in the formal sector, especially plumbers. This is made possible and exacerbated by the fact that for the plumbing industry, there isn't necessarily a law that prohibits one from working on plumbing installations without specific qualifications. In fact, the South African Standard Classification of Occupations (SASCO) classification of plumbers is based on self-reports which make it possible for someone who isn't a qualified plumber to be recognised as one in national statistics - just as long as they do plumbing-related work (Skills Development for a Green Economy, 2019c). The only formal regulatory body, the PIRB, allows qualified (trade-tested) plumbers to register as licensed plumbers by undergoing further written assessments. However, this title only grants a plumber the authority to audit plumbing work and issue a plumbing certificate of compliance (Institute of Plumbers South Africa, 2020) but does not prohibit unqualified personnel from working on plumbing installations

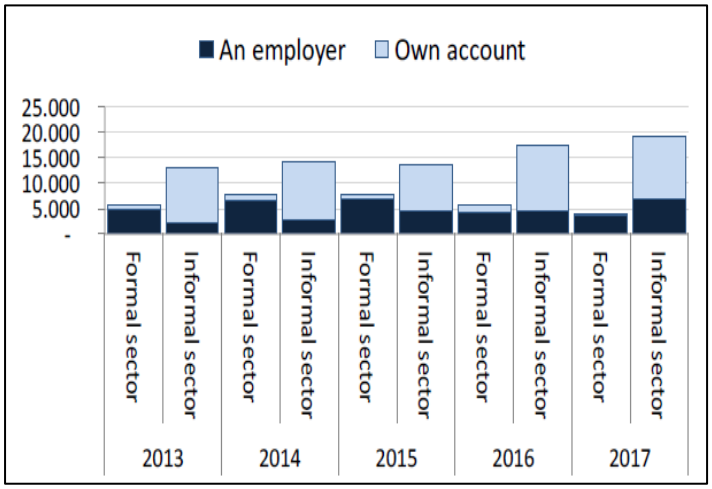
For the electrical trade, on the other hand, it is illegal for any person to work on electrical installations without the appropriate qualifications, and those who are qualified accordingly are required by law to register with the Department of Labour before they can work on any electrical infrastructure (Skills Development for a Green Economy, 2019c). This therefore makes operating informally more difficult for electrical contractors as enterprises cannot employ unqualified electricians without breaking the law. Contractors are required to register with the abovementioned entities to work on electrical infrastructure- otherwise, they too, break the law. Yet

contrary to this obstacle, the informal sector increased notably between 2013 and 2017 and formed a significant proportion of the electrical contracting landscape as shown in Figure 4 and

Figure 5. Hence, this research considers it imperative to analyse both sectors in order to formulate a more reflective and accurate picture of the perceptions of electrical and plumbing contractors in the residential sector.

Figure 4

National Plumbing Contractor Population



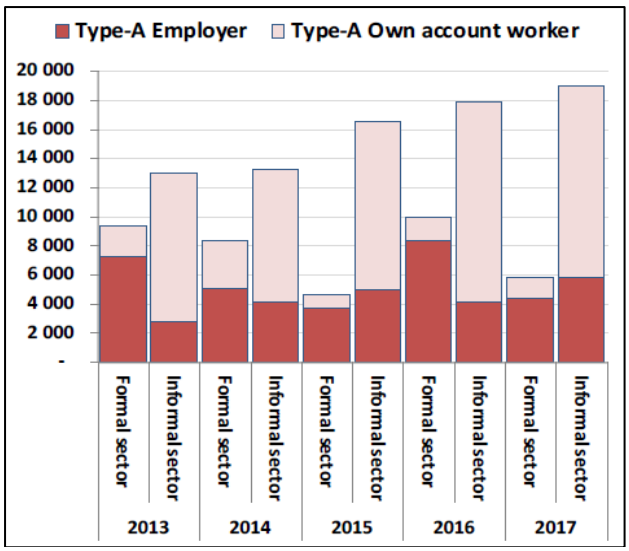
Note. An employer refers to small company employing other plumbing workers. Own account refers to plumbers who work in their own individual capacities.

The population of informal sector plumbers surpasses that of the formal sector and seems to be on an upward trend from 2013 to 2017.

From *High-level statistical analysis of the plumbing and electrical trades* by the Skills Development for a Green Economy, 2019a (p. 11) Pretoria, South Africa

Figure 5

National Electrical Contractor Population



Note. Type A employer refers to electricians who are involved in residential electrical work. Own account workers are those workers or business owners who have no other permanent employees under their employ while employer refers to plumbers/electricians who run larger businesses with people under their employ.

From *Industry Analysis of the Electrical Contracting Industry* by the Skills Development for a Green Economy, 2019b (p. 13) Pretoria, South Africa

1.3.3 Theoretical Framework

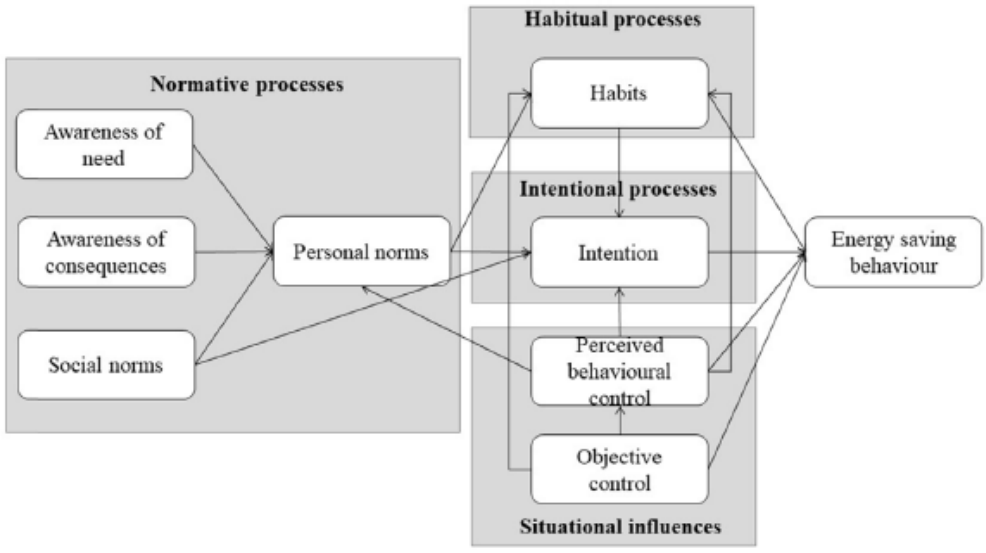
There are several theories in literature that attempt to explain how behaviour materialises, such as the Theory of Planned Behaviour (TPB); the Norm Activation Model (NAM); and the Habit Theory, Attitude-Behaviour gap theory. TPB postulates that behaviour is primarily determined by the individual's intention to perform the behaviour which is informed by a combination of three factors (1) one's attitudes towards the behaviour, (2) their perception of the social pressure to or not to perform the behaviour (social/subjective norms) and (3) their perceived behavioural control (Fishbein & Ajzen, 2011; Klöckner & Blöbaum, 2010). On the other hand, the NAM claims that the main driver of behaviour is the individual's personal norm or sense of moral obligation which is only triggered when three perquisites are satisfied (1) there is an awareness of need, (2) awareness of consequences and (3) a sense of behavioural control in the situation (Klöckner & Blöbaum, 2010). While the core of this model assumes that the behaviour clearly originates internally from the individual, it acknowledges that social norms are an important factor in formulating the personal norm, although it largely disregards behaviour as being planned or

intentional, but rather compelled once the social norm has been activated (Klöckner & Blöbaum, 2010).

With these two models, it is clear that a significant portion of their constructs overlap. However, it is also evident that both theories fail to take into account involuntary or external/objective environmental factors outside of the individual's control that may lead to or hinder behaviour, such as habits or regulatory and legal requirements. These are addressed by the Habit and Ipsative theories, respectively. Ultimately, while these varying theories have been seen to achieve varying degrees of success in explaining behaviour in different contexts, they are unable to adequately explain the overarching multi-dimensional nature of behaviour, as they overestimate or underestimate the role of factors identified in other models (Klöckner & Blöbaum, 2010). It was for precisely these reasons, that Klöckner and Blöbaum (2010) determined that combining these theories to make a single integrated model would result in a more useful model. In their view, the single model could "apply to *all* behavioural situations by describing all relevant factors influencing behaviour and their relative importance depending on the domain (p. 575)." This resulted in formulation of the Comprehensive Action Determination model, as shown in Figure 6 below.

Figure 6

Comprehensive Action Determination Model



Note. The CADM depicted from the study: *Drivers of Energy Saving Behaviour: The Relative Influence of Intentional, Normative, Situational and Habitual Processes* by van den Broek, K. L., Walker, I., & Klöckner, C. A. 2019, Energy Policy, 132, pp. 811-819

This integrated model has been applied more recently in the study of energy behaviour (van den Broek & Walker, 2019; van den Broek, Walker, & Klöckner, 2019), and even then, it has only been used to evaluate the behaviours of household end-users directly rather than those of the intermediaries wishing to influence those behaviours. In this study, only those constructs of the model that influence intention directly will be tested to evaluate the intermediaries' (contractors') behavioural intentions towards influencing households' geyser energy efficiency.

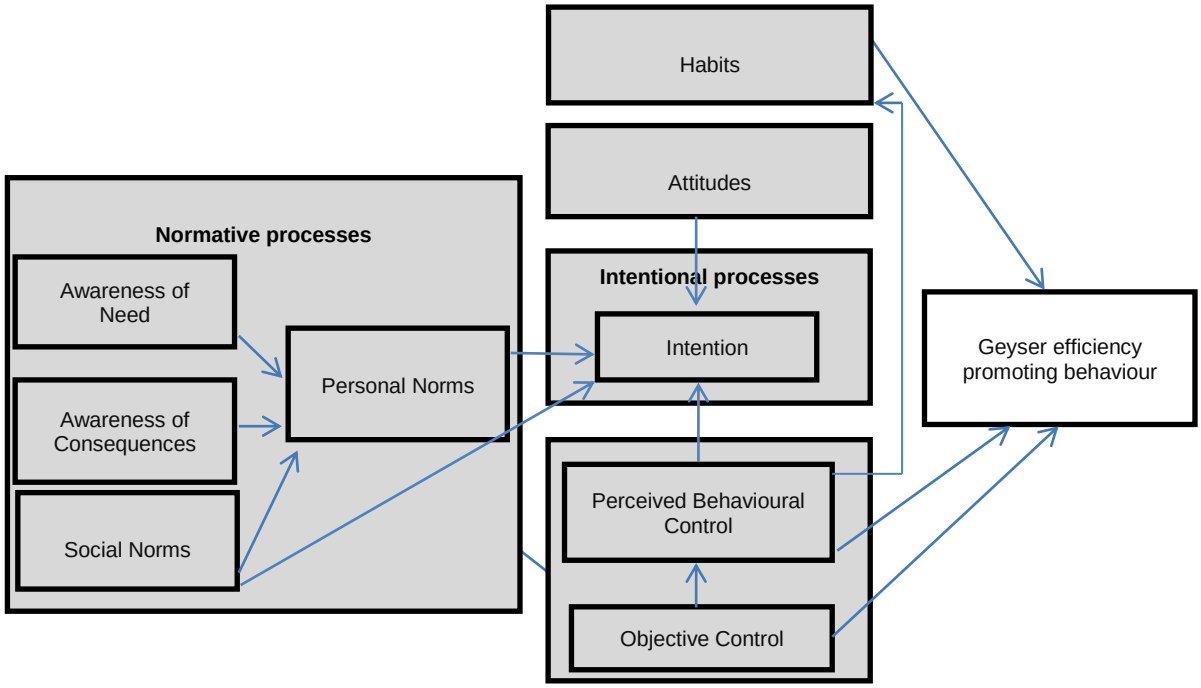
According to the CADM, situational influences, normative processes as well as habitual processes influence intentions. However, (Daae & Boks, 2015; Manstead, 1996) argue that habits can only influence behaviour directly and not through intentions because habits engage one in a particular action involuntarily or subconsciously while intention implies a voluntary and conscious decision to act. This seems at odds with the CADM theory that posits that habit influences intention – because, how can a construct that leads to involuntary and subconscious behaviour, at the same time, influence conscious and deliberate thought or intention to perform an action? – the two are diametrically opposite. In fact, in the paper where they developed the CADM, Klöckner and Blöbaum (2010, p. 578) themselves stated that "we expected that intentions would have a stronger relationship with behaviour when habits are weak." Following this, and for the purposes of this report, while habits' influence on behaviour are acknowledged, they are not seen as a valid influencer of intention.

On the other hand, the CADM left out the analysis of attitude - one of the three key factors in the Theory of Planned Behaviour - in its development, which Klöckner and Blöbaum (2010) acknowledge would have made a significant impact to the accuracy of their model had it been included. Taking attitudes into account and dissociating habits from intention thus leads to the reconfiguration of the CADM to as shown in Figure 7 below.

However, this research isn't so much concerned with their current behaviour where geyser efficiency is concerned, but rather their willingness to behave in a more pro-geyser-efficiency manner. Granted, it is possible that some contractors do already behave in a pro-geyser-efficiency manner while others don't. However, intentions are regarded as a key antecedent of any behaviour (Ajzen & Madden, 1986), and they are what this research will focus on. More broadly, this research seeks to explore the drivers that would cause contractors to want to or intend to behave in ways that are more pro-geyser-efficiency in relation to influencing their clients (households) to adopt them. That said, and in as far the CADM is concerned, the analysis of this paper will consider only the constructs shown to have a direct effect on intentions, i.e. attitudes, personal norms, social norms, and perceived behavioural control. Hence, the simplified model underpinning this study as shown in Figure 8.

Figure 7

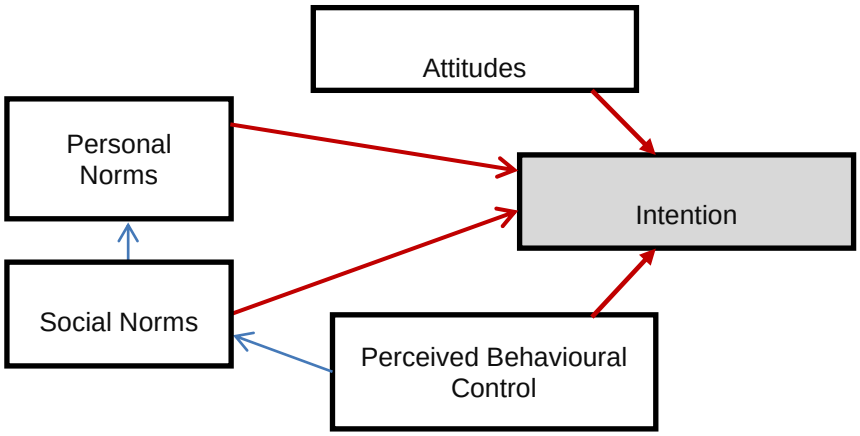
Reconfigured CADM



Note. The reconfigured CADM takes into account the influence of Attitudes on Intention and omits Habits as an influencer of Intention.

Figure 8

Simplified and Reconfigured CADM



Note. The simplified CADM tested in this research showing only the constructs that have a direct effect on intentions, i.e. attitudes, personal norms, social norms, and perceived behavioural control

1.4 Research questions

With reference to the reconfigured CADM as shown in Figure 8 above, there are four main classes of factors linked to intention that this research aims to explore, i.e. attitudes, personal norms, social norms, and perceived behavioural control. As such, the first research question is:

a) *How do personal norms, social norms, attitudes and perceived behavioural control affect contractor's intentions to promote the use of geyser efficiency technologies?*

The next two questions are sparked by the level of informality found within the residential electrical and plumbing sectors. Even though informality is defined on the basis of non-payment of taxes (Department of Statistics South Africa, 2017) it is also seen as a means to avoid other forms of formal compliance including attainment of certain qualifications and registering with the relevant professional bodies (Skills Development for a Green Economy, 2019a, 2019b, 2019c). Thus, it stands to reason that it is also inextricably linked to the level of knowledge, competence, and skill that the contractors possess.

The question of intermediaries' own level of knowledge about energy efficiency is a critical one. Although the core activities of the various types of intermediaries within the energy space may differ substantially depending on their domain of operation, scope of consideration and intended or desired outcomes, a common thread in most of their activities is the provision of technical knowledge to end users. Thus, there is the need for their own competencies to be of a high level (Decuypere et al., 2022; Guibentif & Patel, 2023; Page & Fuller, 2021; Scharnigg & Sareen, 2023; Zaunbrecher, Arning, Halbey, & Ziefle, 2021). The importance of knowledge cannot be overstated as in their paper, Willand, Torabi, and Horne (2023) argue that the limited understanding of energy efficiency in general is one of the prime causes of energy vulnerability amongst Australian households. In Europe, intermediaries such as Living Labs are set up in different locations around the region and work with local residents and other relevant stakeholders to reduce vulnerable households' energy costs and improve energy vulnerability through EE education and implementation of various EE measures or technologies (Bouzarovski et al., 2023).

With that said, the next two questions attempt to explore the impact that the prevailing level of formality or informality and subsequent knowledge or skills held by the contractors have on their intentions to promote geyser efficiency technologies, if any.

These are as follows:

b) *How does the knowledge about geyser efficiency technologies differ between formal and informal contractors?*
c) *How does the knowledge about geyser efficiency technologies influence intentions?*

1.5 Significance of the study

1.5.1 The case for contractors

While the mediating role of contractors in household energy efficiency has received growing attention particularly in the UK (Owen & Mitchell, 2015; Owen, Mitchell, & Gouldson, 2014; Wade, Hitchings, & Shipworth, 2016; Wade, Murtagh, & Hitchings,

2018; Wade, Shipworth, & Hitchings, 2017), and to a lesser extent in other countries including Belgium and Germany (Decuypere et al., 2022; Kivimaa, Bergek, Matschoss, & van Lente, 2020), this has not been the case in South Africa. Be that as it may, their role is even more pertinent in South Africa given the extent of misinformation regarding appropriate efficiency actions that prevails. For example, regarding switching geysers on and off, numerous web-based articles have been published citing Eskom as the source for the claim that switching on and off one's geyser does not lead to any energy savings (Home Insulations, n.d.; Isotherm Thermal Insulation, 2020; Powertime, 2015). This is not true and has been shown so in several research studies including Booysen, Engelbrecht, and Molinaro (2013), who demonstrated the effectiveness of this strategy through empirical experimental research and confirmed their findings through theoretical engineering concepts and calculations. In a more recent study Booysen, Engelbrecht, Ritchie, Apperley, and Cloete (2019) reviewed other research conducted between 1996 and 2019 on this strategy which also demonstrated an array of savings ranging between 4 and 39 percent. Furthermore, using geyser timers is now widely promoted by Eskom and many other pro-energy-efficiency campaigns in the media as one of the ways of saving electricity.

Electrical and plumbing contractors have technical backgrounds, and it is reasonable to assume that by virtue of this fact, they are less likely to be susceptible to misinterpreting misleading or technically ambiguous information. Since they enjoy an element of trust from households who view them as experts in their respective fields (Wade, Murtagh, & Hitchings, 2018), they are well positioned and can therefore be instrumental in correcting misinformation, and generally steering households towards EE technologies and behaviours.

1.5.2 Benefit to stakeholders

With superior knowledge and understanding, contractors can be identified as possible intermediaries and potential change agents that Government, Eskom, policymakers, energy efficiency advocacy organisations and technology suppliers can exploit through mutually beneficially collaborations that would work to advance the energy efficiency agenda in the residential sector and beyond. This study will

contribute to broadening existing knowledge in household energy efficiency interventions by providing insight that can be used for effectively engaging contractors to leverage their direct influence over households.

1.6 Delimitations of the study

i. This research will focus only on plumbing and electrical contractors in the Durban region. The research will be based on the private residential sector only.
ii. Contractors serving the commercial or public sectors will not be included. Those involved in both will be considered, although the analysis will be exclusively limited to their work that pertains to the private and residential sector.
iii. The research will include both formal and informal contractors as long as they operate within the above descriptions.
iv. An electric geyser consists of a large storage tank which contains electric resistive heating elements that are used to heat water. While there are newer, more modern in-line heating systems that heat water on demand, these will not be considered and only the traditional electrical geyser with a storage tank will be investigated in this research.

1.7 Definition of terms

Contractors	*Unless otherwise specified, the term "contractors" will be referring to both plumbers and electricians in general*
Geyser	*Electric water heaters commonly found in households used primarily for heating bathing water*
End-user	*Households with electric geyser installations*
Geyser efficiency technologies	*Devices or techniques that can be used to reduce the level of energy consumption by electric geysers, e.g. geyser blankets, timers, etc.*
Standing losses	*Heat lost from the hot water in the geyser through the natural process cooling down when no hot water is being drawn*

1.8 Assumptions

An assumption is that contractors are already technically inclined and should already have a better understanding of geyser efficiency technologies. If not, they can at least learn about them more readily than an ordinary person with no technical background at all. Another assumption of this research is that contractors do interact with end-users during periods of installations, maintenance, or upgrades of electric geysers in their households. With this, a follow-on assumption is that, with the correct incentive, they would be willing to explain what options are available to households to improve their geyser efficiencies and even teach them how the different technologies work.

1.9 Structure of the report

The report will begin with a literature review looking at literature that interrogates the constructs in the CADM within the context of energy and EE intermediation landscape in the next chapter. This will be followed by the outline of the research methodology in chapter 3. The research data and findings will be presented and statistically analysed in chapter 4 followed by a discussion in chapter 5. Lastly, in chapter 6, conclusions from the analysis will be drawn and combined with recommendations.

CHAPTER 2. LITERATURE REVIEW

2.1 Introduction

This study is rooted in the premise that contractors are in a strategic position to act as energy efficiency intermediaries and potential change agents due to their direct access to households. This section will review literature and critically analyse the factors that shape their perceptions of their roles in steering household energy efficiency behaviour, particularly geyser efficiency technologies.

The first research question explores the factors outlined in the CADM to affect one's intentions to perform a given behaviour. The factors include personal norms that provoke one to follow through on a given behaviour, social norms exerted by external influences that pressure one to perform or not perform the behaviour, their attitude towards the behaviour and their perceived behavioural control to enact the behaviour successfully. The next two research questions will explore the influence of the extent of formality of contractors' participation in the industry on their knowledge about geyser efficiency technologies and whether whatever knowledge or skill they possess actually has any impact on their intention to promote household geyser efficiency technologies.

2.2 Definition of topic or background discussion

2.2.1 Defining geyser efficiency and geyser efficiency technologies

The domestic geyser tank sizes are typically made from 100l, 150l and 250l storage tanks - with the 150l being the most common size in South African households (McNeil, Covary, & Vermeulen, 2014). Thermodynamically, geysers have approximately 100% efficiency and this is because 100% of the electricity supplied to the heating element causing it to become hot is transferred entirely to the water due the element being completely submerged in the water

(Johnson, Lutz, McNeil, & Covary, 2013). However, once the water becomes hotter than the air surrounding the geyser, natural convection driven by this temperature difference begins to take place, which sees heat being transferred from the water to this surrounding environment. It is this heat lost due to natural convection that introduces the concept of inefficiency for geysers. The more heat is transferred from the water to the surrounding environment, the more inefficient the geyser is considered to be. This heat loss causes the water inside the geyser to gradually lose temperature over time, thereby triggering the heating element to come on periodically to reheat the water back to the desired set temperature (Booysen, Engelbrecht, & Molinaro, 2013; Catherine, Wheeler, Wikinson, & Jager, 2012; McNeil, Covary, & Vermeulen, 2014). This electricity used to reheat the water when it hasn't been used (standing) by the end-user is essentially wasted, hence the majority of geyser efficiency technologies are designed to minimise the heat loss and resultant electricity wastage.

The geyser is fitted with a thermostat that regulates the temperature of the water inside the tank by switching the electric elements off when the temperature reaches a pre-set, temperature limit and back on when the water temperature inside the tank drops below another pre-set, lower temperature. Every time the elements come on; electricity is used.

There are two causes for the temperature of the water inside the geyser to drop and thus trigger the elements to come on: (1) when the end user draws the hot water from the geyser which gets replaced by cold water that lowers the overall temperature of water remaining in the geyser, and (2) when the hot water in the geyser and along the pipelines losses heat to the colder environment through a natural process of heat convection described above, i.e. standing losses.

In this study, geyser efficiency technologies refer to any means that can be employed to reduce these standing losses while ensuring that households have access to the amount of hot water they need. This may refer to physical methods in the form of new devices or retrofits to existing geyser installations, such as pipe insulation, geyser blankets, programmable timers or ripple control, circulating pumps or heat traps. It may also refer to manipulation of end-users' energy behaviours through smart metering; or changing control parameters

such as adjusting thermostat settings up and down. Standing losses can be minimised through different methods, as shown in Table 1.

Table 1

Principle of Operation of Various Geyser Efficiency Technologies

Technology	*Principle of operation*
Geyser blankets and pipe insulation	*Increase thickness of geyser and pipes and use special heat transfer-resistant materials to effectively reduce heat that can permeate over a given period of time resulting in lower standing losses.*
Circulating pump	*Installed on outlet pipe and pumps hot water left in the pipe back into the geyser (rate of heat loss is higher in the pipes than in the geyser)*
Heat traps	*Installed on both inlet and outlet pipes just before and after geyser and prevents further heat from geyser transferring to the water in the pipes*
Lowering thermostat setpoints	*Lower thermostat setpoint means lower temperature inside geyser resulting in smaller temperature difference between the geyser and the surrounding environment resulting in lower a heat transfer rate, hence lower standing losses*
Programmable timers or ripple control	*Automatically turns the geyser on and off. When the geyser is off, the heating elements cannot come on to replace lost heat by heating the water back to the set temperature.*
Smart metering	*Allows end-users to see geyser usage in real time and hopefully encourages them to adjust usage to save energy*
Low flow shower head	*Does not reduce standby losses but reduces the amount of hot water flow from the geyser during a shower hence allows more showers to be taken with the same amount of hot water.*

Note. All the considered geyser efficiency technologies, except low flow shower heads, deal with the prevention or reduction of standing losses.

2.3 Factors in the CADM predicting intentions

2.3.1 Personal Norms

The Norm Activation Model (NAM) states that intention towards a behaviour is driven by a sense of moral obligation which occurs when an awareness of need for and consequences of a particular action, triggers a sense of personal responsibility and a moral obligation to act (Klöckner & Blöbaum, 2010; van der Werff & Steg, 2015). This is combined with a sense of behavioural control or belief that one's actions would yield the desired outcome (outcome efficacy or expectancy). This phenomenon describes the impact of personal norms in influencing a person's intentions towards a particular behaviour.

Bordass and Leaman (2013) argue that contractors have a responsibility from a sustainability perspective to care about what happens in the households they work in after they leave. They argue that contractors have individual responsibilities and also share in the collective responsibility to use their professional independence and judgement to ensure greater public good by practicing sustainability in their own roles. However, to assert what a group of people should be responsible for and do is entirely different to them (1) being aware of that responsibility and (2) actually owning it.

Dolšak (2023)'s study that investigated the determinants of energy efficiency retrofits globally, reviewed 1198 documents published between 1993 and 2022 and found that the number of publications increased rapidly post 2004. They concluded that this rapid growth has been spurred by the policy changes made within this period to alter people's views and behaviours concerning environmental issues. However, from 2020 onwards - likely driven by the recent global economic crisis - energy savings and the need for energy efficiency retrofits also emerged as leading factors that influence policy development.

These studies further identified economic factors, including the energy costs, anticipated cost savings, and information and policy-related factors as the main determinants for energy efficiency adoption. For instance, Frankowski and Herrero (2021)'s study reiterated that environmental and climate change concerns were not the primary drivers for Poland households to switch from using coal stoves to electricity, and that many households first asked: "What's in it for me?", before deciding on whether to adopt the proposed technology change.

In a UK domestic heating study, Wade, Murtagh, and Hitchings (2018) observed that some contractors were simply indifferent to energy efficiency in their work. One architect quelled the topic even when a client had brought it up, and stated they would only pursue it if the client was specifically insistent. Some research have explained such seemingly indifferent behaviour as being due to fear of working with unfamiliar technologies or risk of reputational damage should the new technology fail (Wade, Hitchings, & Shipworth, 2016). These, however, provide no insight into whether the sense of personal responsibility had been

activated or not. In fact, it is possible that the sense of personal responsibility was activated yet unable to be acted upon due to other considerations being more compelling- perceived behavioural control being one of them as alluded to above in relation to potential failure.

Nevertheless, in the event of moral obligation and a sense of personal responsibility being activated, yet overpowered by other factors, it may be a clear indication as to why a desired behaviour may not be achieved even when opportunities for such behaviour present themselves. This predicament aligns with the "value action gap" phenomenon which describes how people with pro-environmental attitudes and values may not behave in a manner that demonstrates those values (Owen, Mitchell, & Gouldson, 2014).

2.3.2 Social norms

Social norms refer to one's belief about the social pressure that a certain reference group that is important to that individual, exerts on him or her to behave in a certain way in relation to a particular issue (Manstead, 1996). According to the CADM, these social norms can influence the formulation of what one considers to be their personal, individual norms as discussed previously, and can also directly influence their intention to engage in a particular action whether or not they have been internalised or personalised first (Klöckner & Blöbaum, 2010). The theory of planned behaviour posits that social norms are comprised of two constructs (1) a person's belief of the expectations or pressures exerted by the said reference group and (2) their motivations to comply with such expectations or not (Manstead, 1996).

2.3.2.1 Expectation or pressure from significant reference group

While neither the lack of expectations, the belief in them nor the motivations to comply can be confirmed from any publicly available research concerning the South African plumbers and electricians, it remains difficult to assert if this is because it does not exist at all. Nevertheless, formal reference groups such as government, institutions, lobby groups, etc.- can also influence social norms to manipulate the desired behaviour of their subjects through carefully crafted

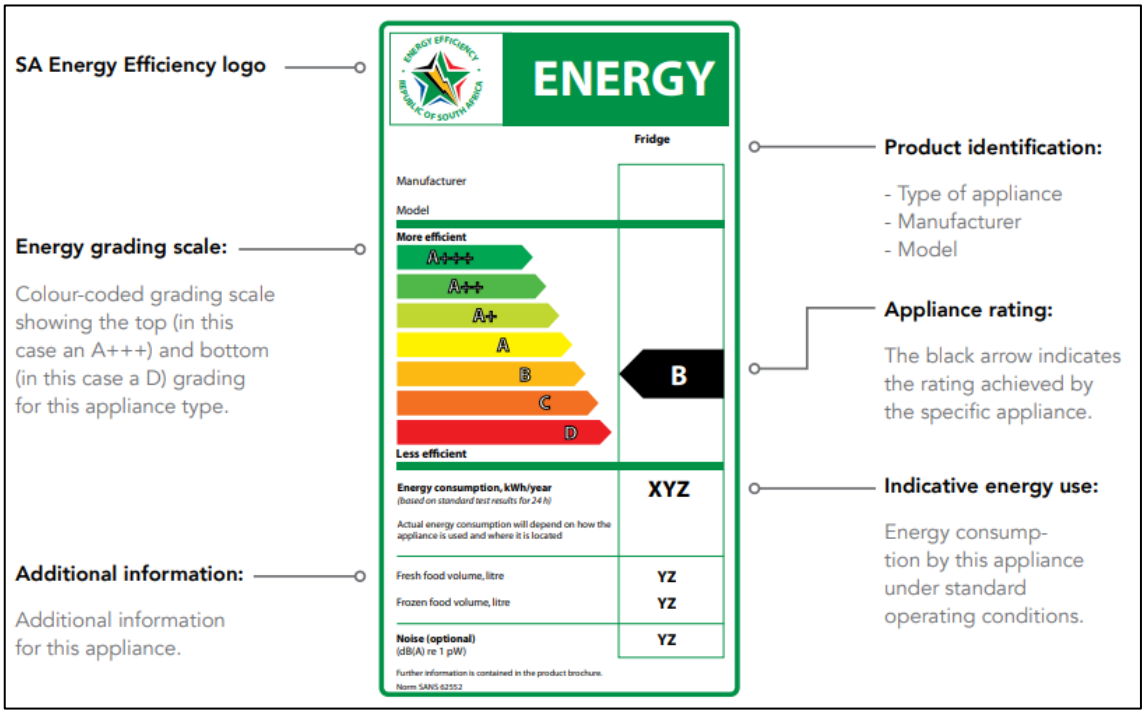
intervention programmes and regulatory mechanisms (Yamin, Fei, Lahlou, & Levy, 2019). In South Africa, some headway has been made to use regulatory standards to influence norms where geyser efficiency is concerned. For example, the SANS 204:2011: *Energy Efficiency in Buildings* standard does make provision for geyser energy specifications, particularly with regards to insulation (South African Bureau of Standards, 2011).

Other regulatory frameworks directed at geyser efficiency are the MEPS which prohibit manufactures from selling geysers that have standing losses exceeding some predefined limit for different size geysers within a 24-hour period (Johnson et al., 2013), and the 2016 amendment of VC 9006 which requires all sold geysers to have a minimum rating of Class B (Department of Mineral Resources and Energy, 2023). These invariably reduce the level of pressure placed on households or contractors to act in a more energy efficient behaviour, as the efficiency is enforced before the geyser even enters the market. However, the South African efficiency label that indicates a geyser's energy efficiency class, the standing losses over a period of 24 hours and its rated capacity remains a regulatory lever that operates in their domain of influence and seeks to force them to make a purchasing decision having taken energy information into consideration. An example of the efficiency label is shown in

Figure 9**Error! Reference source not found.** below.

Figure 9

Typical Energy Efficiency Label



Note. This type of label is also used on geysers to encourage more energy-efficiency-conscious purchasing decisions. The "B" symbol indicates the relative efficiency of a particular equipment relative to similar equipment. From *A User Guide to Mandatory Minimum Energy Performance Standards (MEPS) and Compulsory Energy Efficiency Labelling* Retrieved from https://www.savingenergy.org.za/Guidelines/Guidelines/artworkfiles/SA%20MEPS%20and%20EE%20labeling%20Guideline%202022.pdf

2.3.2.2 Subsidies

Two decades ago, du Plessis, Irurah, and Scholes (2003) predicted that while pressure to reduce greenhouse gas emissions existed, it would not likely be strong enough to make serious impact on the residential landscape given the dire mass of competing needs that face South African households. They foresaw that the dire social-economic circumstances would make it unlikely for energy efficiency considerations to be a norm for many South African households. This is supported by a study by Winkler, Fecher, Tyani, and Matibe (2002) that modelled *Cost-benefit analysis of energy efficiency in urban low-cost housing*. This study found that many households do not have spare funds to invest upfront in energy efficiency. It argued that subsidies are essential for

making such investments possible as they provide the necessary incentive or motivation households need to even consider it.

This is supported by the findings of the Department of Energy's 2015 household energy survey that revealed that most likely due to the high capital costs of the majority of energy efficiency technologies, adoption rates were lowest among low income households and moderately peaked among middle income to high income households as shown previously in

Figure 3, suggesting that without some sort of subsidy, adoption of more energy efficiency technologies likely remains hampered by the high capital investment requirements. However, the capital-intensive technologies referred to in these reports included solar geysers and heat pump technologies whose costs are in the thousands of Rands, while the add-on geyser efficiency technologies considered in this study cost a few hundred Rands.

Nevertheless, subsidisation remains a powerful driver in the adoption of energy efficiency technologies as it provides not only the financial means to implement costly energy efficiency technologies, but also an incentive (Dolšak, 2023). In Poland, subsidies have been found to have accelerated the transition from coal based energy fuels to other energy technologies (Frankowski & Herrero, 2021). In Germany, the current regulatory framework which provides for solar PV subsidies has promoted the diffusion of this technology and is believed to become one of the most important tools in the German power generation mix in the future (Aniello & Bertsch, 2023), while in Chile, the government initiated mortgage linked incentive programs to deal with this issue (Schueftan, Aravena, & Reyes, 2021).

2.3.2.3 Regulation and legal compliance

In Germany, tradesmen raised the lack of consistency in the legal framework for energy related services to be a barrier and found those regulations that are in force to be relatively prescriptive and limiting creativity- thereby causing them to merely do the bare minimum, at the lowest possible cost to ensure compliance (Zaunbrecher et al., 2021). In Denmark, households reported the various energy related policies to be overly complex and have difficulty grasping their

purpose, value, or relevance to them. Furthermore, they felt that policies were contradictory in that they promoted green transitioning but made no provisions for making the transitioning technologies affordable (Mogensen & Gram-Hanssen, 2023).

In addition, existing regulation and policy measures in other parts of the world have been found to either be too prescriptive or target end-users directly – bypassing contractors (Bordass & Leaman, 2013). This is also observed in the South African context with various household energy efficiency initiatives targeting households. With regards to prescriptiveness, while standards such as SANS 204 (2011): *Energy Efficiency in Buildings* (South African Bureau of Standards, 2011) can be viewed as prescriptive, policies such as MEPS have been seen to be very lenient in South Africa compared to other countries. For example, a study conducted by Johnson et al. (2013) comparing the MEPS requirements adopted by 5 different countries (South Africa, India, China, US and EU) for a 200l geyser revealed that South Africa's MEPS was the most lenient. The study revealed that the South African MEPS had among the highest permissible standing losses at approximately 3KWh per day.

It has also been highlighted that the manner in which new regulations are communicated in general can be unclear, contradictory and confusing, thereby, inadvertently cause households to see contractors who refer to them as untrustworthy (Decuypere et al., 2022). In Chile, the government's incentives that are linked to mortgages have been found to contradict household's preferences who do not favour such long-term investments, but instead prefer to opt for personal savings followed by short to medium term credit (Schueftan, Aravena, & Reyes, 2021). Such mismatches in policies and regulations lead to them being altogether perceived as useless (Mogensen & Gram-Hanssen, 2023) .

To add on to the weaknesses in the content of the standards themselves, it has also been cited that some standards are inadequately regulated in that no audits are done to ensure compliance and no penalties or punitive measures are stipulated in case of non-compliance (Chandel, Sharma, & Marwaha, 2016). The leniency combined with the lack of enforcement capacity in existing geyser

efficiency standards is likely to reduce the motivation for contractors to comply with these and act in in a more energy efficient manner. This is echoed by some participants in the (Decuypere et al., 2022) study in Belgium who felt that the regulations relating to energy efficiency in buildings are insufficient and should be stricter - with clearer, more specific, and unambiguous technical specifications.

Whether too lenient or too prescriptive, (Sohre & Schubert, 2022) argue that these types of command-and-control policies are only partially suitable for advancing the energy efficiency adoption cause anyway. They argue that because energy efficiency or consumption behaviours are only practised privately in households- they are largely hidden from the regulatory arm of policy or direct regulation. Alternatively, more focus ought to be placed on the "bottom-up" softer methods such as information, labelling, nudging, advising, and feedback instruments driven primarily by civil society, NGOs, science communities, localised businesses or divisions thereof, and lower level, localised government actors.

In addition, while contractors who operate at the coal face with households directly may possess significant power and influence over household's final decisions, there is a view that the bulk of the responsibility to educate and disseminate information to end users, and any necessary efficiency or savings calculations should lie with government (Decuypere et al., 2022).

Hyysalo et al. (2022) investigated the cause of the slow uptake of readily available renewable and energy efficiency technologies in Finland and identified rapid changes in technologies coupled with inadequate information to end-users to be some of the main challenges. They concluded that the lack of systematic information sharing mechanisms results in situations whereby end users struggle to make decisions about the best technologies to adopt as they predominantly rely on self- education and the intervention of intermediary actors. Furthermore, the wide variation and complexity of some of the technologies requires intermediaries to have competency over a wide spectrum of technologies which is not financially viable for many businesses, and consequently, they refrain from entering the market. This highlights the

importance of the role of government in making information available so that intermediaries such as contractors do not have to bear the full burden of educating households on their own.

In Europe, energy advising is already being used as a policy instrument to ensure systematic energy efficiency education for end users and is enforced through the Renewable Energy Directive and the Energy Performance of Buildings Directive which require all members of the European Union to provide their citizens with sufficient relevant advice on renewable and energy efficiency information (Mignon & Winberg, 2023). Several European countries including Austria, Belgium, Denmark, France, Germany, Greece, Portugal and Sweden already have this in place with dedicated government funded energy advisers or agencies whose core duties include addressing this very need through the organisation of workshops, seminars, hotlines, household visits, energy audits, one-on-one consultations, etc. usually at no cost to the households (Guibentif & Patel, 2023; Mignon & Winberg, 2023; Scharnigg & Sareen, 2023). Some interventions include the provision of procedural guidance in implementing more large scale energy projects (Chun, 2023). Over and above employing individual energy advisors, some countries have established fully-fledged standalone institutions to concentrate on improving energy efficiency in the residential sector, including the Energy Agency and ABGnova in Germany (Laborgne, 2023).

2.3.2.4 Incentives

Ultimately, merely creating opportunities for energy efficient technology adoption through policy that targets the implementation of some energy efficiency measure and leaving it to the households and contractors to make it happen on their own is simply not enough (Owen, Mitchell, & Gouldson, 2014). The result of slack regulation, lack of incentives and/or enforcement mechanisms means that the degree of engagement between contractors and end-users rests squarely at the discretion and goodwill of the contractors themselves (Gram-Hanssen, Heidenstrøm, Vittersø, Madsen, & Jacobsen, 2017). However, it is unlikely that the contractors' own sense of personal responsibility will provide the necessary motivation for him or her to see the

required behaviour through, as Risholt and Berker (2013) claim that the lack of contractor incentives isn't just a hindrance to the household energy efficiency quest, but an outright barrier.

2.3.3 Attitudes

A generally accepted definition for attitude in literature is one that describes attitude as a "relatively enduring tendency" to respond to an attitude object in a way that reflects a negative or positive evaluation of it (Manstead, 1996, p. 3), that is, have a favourable or unfavourable response towards it. Such attitudes can be expressed through cognitive, affective and behavioural responses and can be either verbal or non-verbal (Manstead, 1996). These include held beliefs, expressions of feelings or behavioural responses towards the attitude object. The Theory of Planned behaviour postulates that attitude is determined by two constructs (1) behavioural belief – one's beliefs about what the consequences of performing a given behaviour will be, and (2) outcome evaluation – one's evaluation of those consequences as being either favourable or not and whether they approve or disapprove of them (Manstead, 1996).

It is believed that contractors' behavioural beliefs concerning household energy efficiency mediation is linked to their beliefs of what households want (Owen, Mitchell, & Gouldson, 2014; Wade, Hitchings, & Shipworth, 2016). In a UK study, Wade, Murtagh, and Hitchings (2018) found that contractors felt that sharing detailed technical information with clients was unnecessary and would be construed as a bother. On the other hand, it has been found that sometimes contractors are not confident working with unfamiliar technologies and fear that pursuing energy efficiency technologies might fail or not live up to their intended objectives or promise (Wade, Hitchings, & Shipworth, 2016).

Furthermore, some contractors believe that engaging in energy efficiency pursuits does not align with their business priorities and motivations, such as business stability and employment security rather view it as an economic growth agenda (Owen, Mitchell, & Gouldson, 2014) or even possibly an environmental conservation one. In fact, they see the process as unnecessary

bureaucratic and administrative hassles that yield little benefit for their businesses.

While there is no specific literature found that has rendered insight into the beliefs of South African contractors, it is possible that some may have experiences with households that have shaped their beliefs. For instance, several energy saving activities require active and continuous engagement from the end-user to sustain, such as turning the geyser on and off; adjusting thermostat settings, or monitoring the smart metering displays (Booysen et al., 2019; Booysen, Nel, & van der Merwe, 2016; Chiu, Kuo, & Liao, 2020; Siegel, Das, Sun, & Pratt, 2020). Although households may demonstrate willingness to reduce their energy usage, this intensive engagement is one of the reasons participants in one study expressed unwillingness to adopt a geyser management strategy as it was perceived to inconvenience their lifestyles (Booysen, Nel, & van der Merwe, 2016). In fact, this inconvenience factor is among the main reasons why a lot of research is presently dedicated to developing tools that can remotely and automatically implement schedules based on end-user's unique usage patterns to either, turn the geyser on and off or adjust the thermostat set temperature, etc. (Booysen et al., 2019; Catherine, 2009; Catherine et al., 2012; Kepplinger, Huber, & Petrasch, 2016; Siegel et al., 2020). So, in the event that a contractor might be aware of this inconvenience predicament, it is possible that their behavioural belief may be affected negatively as they may assume upfront that households would automatically reject their proposals because of it.

2.3.4 Perceived behaviour Control

Perceived behavioural control is defined as one's belief of how easy or difficult the performance of a particular behaviour is likely to be (Ajzen & Madden, 1986). Due to the lack of a single definition of what exactly constitutes perceived behavioural control (Zolait, 2014), several researchers have presented variations of its constructs and meaning. van der Werff and Steg (2015) talk about outcome efficacy (the feeling that one can solve a problem by changing their behaviour) while Klöckner and Blöbaum (2010, p. 2) talk about

perceived behavioural control explicitly describing it as “a person’s experience of having total control of a situation, or being, at least partly, controlled by other people or situational conditions.” In other studies, perceived behavioural control is considered to stem from the extent to which one feels that the performance of a particular behaviour is wholly under their voluntary control and “perceived difficulty” (the extent to which one considers a behaviour to be easy or difficult) Trafimow, Sheeran, Conner, and Finlay (2002); perceived control and self-efficacy (Terry & O'Leary, 1995); and self-efficacy and facilitating conditions (Zolait, 2014).

While the terminology used to describe these constructs varies from researcher to researcher, they remain strongly interrelated. Fundamentally, the core message as viewed by this paper is their analysis of whether it is ultimately within their control to attain the desired outcome, or not.

The plumbing license competency test and on-site inspections reveal high failure rates (Plumbing Industry Registration Board, 2017); high installation non-compliance (Van Zyl, Lobanga, Lugoma, & Ilemobade, 2008) and high client dissatisfaction with quality of residential construction in general (Construction Industry Development Board, 2011). One would expect that these would be seen as negative outcomes and therefore quell contractors’ participation behaviour or intentions (Bandura, 1997; Maddux, Norton, & Stoltenberg, 1986; Williams, 2010). Yet, the opposite is true. The number of Plumbing and electrical contractors entering the sector has been climbing persistently between 2013 and 2017 (Skills Development for a Green Economy, 2019b).

Could it be that the standards by which contractors measure their expected outcomes against are different to those applied by professional bodies- and therefore, make it possible for contractors to maintain positive outcome expectancies? This is a plausible case because South African legislation is not well-enforced (Van Zyl et al., 2008). The fact that defects are not always immediately apparent (Van Zyl et al., 2008) eliminates uninformed and unsuspecting end-users from identifying substandard work and accepting all work positively- thus confirming contractors’ positive outcome expectancies. This acceptance from uninformed end-users is a false confirmation of outcome

achievement, and is likely the primary factor for contractors' positive participation as behaviour is influenced and reinforced by its consequences (Bandura & McClelland, 1977; Maddux, Norton, & Stoltenberg, 1986) - consequences which are, in this case, positive as no red flags are immediately apparent. In fact, "Responses that cause unrewarding or punishing effects tend to be discarded, whereas those that produce rewarding outcomes are retained and strengthened" (Bandura & McClelland, 1977, p. 149).

In the context of this study, the expected desired outcomes are that households adopt geyser efficiency technologies promoted by contractors. This implies that contractors would have to display several skills outlined by Owen, Mitchell, and Gouldson (2014): (1) technical competency, (2) adaptive capacity to tailor design solutions for different households; (3) social and interpersonal skills; (4) motivations for the doing the said work; and (5) be willing to offer follow-up or after-care support as households may be unfamiliar with the new technologies in question.

However, in a context where the confidence of the majority of South African contractors may already be rooted in false positive outcomes granted by uninformed end-users who do not notice the poor workmanship as generally these don't come to light until much later (Van Zyl et al., 2008) – it is possible that some contractors may refrain from this role. Engaging with households may expose their actual inadequacies, which would not only result in failure in persuading the households, but also reduce their sense of self-efficacy as efficacy beliefs can be eroded by failure or disconfirming experiences (Bandura, 1997). The risk of failure may lead contractors to refrain from engaging in new energy efficiency pursuits with households in order to avoid reputational damage and loss of confidence from their clients (Wade, Hitchings, & Shipworth, 2016) - a heuristic of risk and acceptability according to Owen, Mitchell, and Gouldson (2014).

In Germany, however, tradesmen expressed high optimism about the impact of their adopted energy efficiency recommendations despite admitting to it being difficult to evaluate it as they usually do not see the households again after the consultation (Zaunbrecher et al., 2021). This confidence could be due to some

of their confessions that they do not recommend anything to their clients that they would not implement in their own houses or haven't had prior experience with. It was also noted that their high confidence was not limited to the effectiveness of their recommended measures only, but it is also on their general perception of their influence on the households' decisions to adopt their recommended measure or abandon what they condemn. This perception of their power to influence was also observed with contractors in Belgium (Decuypere et al., 2022).

On a more extreme end, some contractors altogether dissuade households who from installing measures that they are not familiar with or have personal convictions against (Zaunbrecher et al., 2021). Furthermore, because of the perception that households do not want to be bothered in the Wade, Murtagh, and Hitchings (2018) study, (or possibly not interested in the inconvenience of such technologies (Booysen, Nel, & van der Merwe, 2016)) - contractors viewed the consequence of pursuing this behaviour negatively. Hence, they withdrew from it, rather preferring to get on with their work silently and merely display their technical professional expertise through action.

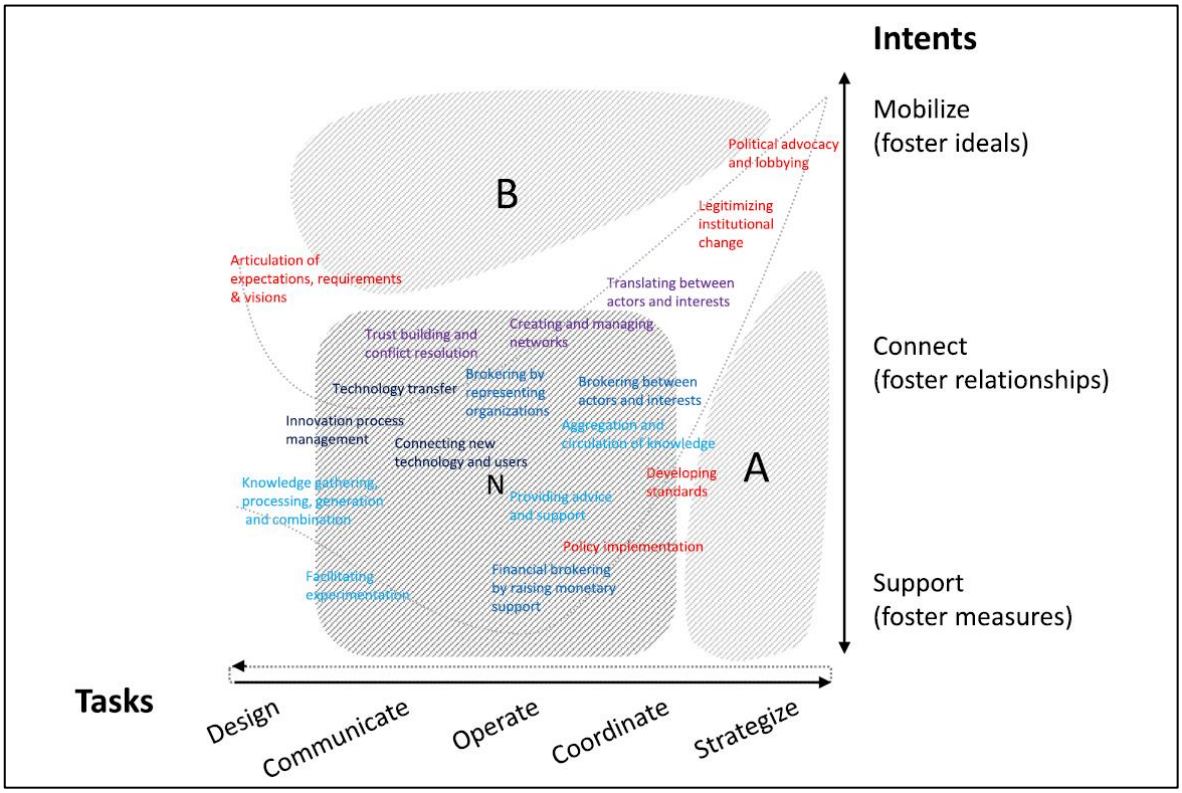
Nevertheless, the reality of the existence of a positive perception of behavioural control of contractors towards energy efficiency intermediation regardless of the accompanying technical competence suggests that technical knowledge alone isn't the only factor that creates it. Figure 10 paints a picture of the interrelatedness and cross-linking nature of the intermediation functions that are necessary to bring about a holistic and sustainable EE programme (Guibentif & Patel, 2023).

In this study, (Guibentif & Patel, 2023) followed the work of an intermediary organisation in Switzerland and noted how they focused the bulk of their skills and efforts on the practical work on the ground as depicted in region "N". These are the technical, engineering oriented day-to-day tasks to deliver an energy efficiency solution involving design, communication, and coordination at an operational level. However, they noted that this intermediary does not pay enough attention to strategic endeavours such as the necessary next steps for the intermediary to keep itself sustainable, as depicted in "A". This entails

phasing out activities, integrating a range of existing solutions and coordinating feedback. Lastly, depicted in area B is another area of oversight where this intermediary fails to activate stakeholder involvement and get buy in to the vision ahead of the implementation of specific, incremental EE solutions. These (A and B) require more soft skills such as persuasion, networking, stakeholder mobilisation, etc. compared to the more technical skills used in implementing individual technical solutions.

Figure 10

Relevant Skills Required for A Range of Tasks and Intents



Note. The above image is an illustration of different intermediary functions used to accomplish specific tasks (on the axis) versus intents (depicted on the y-axis). Regions A and B depict soft skills such as persuasion, networking, stakeholder mobilisation, etc. while region N captures the more technical skills used in implementing individual technical solutions.

From *Do intermediaries have blind spots? Mapping the activity lifecycle of an energy efficiency programme*, by Guibentif, T. M., & Patel, M. K. (2023), *Energy Research & Social Science, 101*, 103141

While this example relates to the more sophisticated work of institutionalised energy efficiency intermediation, the overarching importance of the soft skills in the pursuit of the intents of the programmes extends beyond. With individual contractors in their own small-scale, intermediary corners, soft skills such as

persuasion, communication, coordinating, and strategizing remain critical skills over and above technical expertise.

However, in addition to the technical and soft skills, Bobrova, Papachristos, Chiu, Tikhomirova, and Coon (2024), state that any attempt at successful persuasion of households should also understand and leverage the emotional motivations that households hold when making energy efficiency decisions. They claim that household's drivers for embarking on energy efficiency retrofitting are not only cognitive, but also emotional – driven by the meanings they attach to their homes and what impact a retrofit might have on those meanings. For example, will it add more comfort, reduce inconvenience, or afford them a particular social status among their peers? Biswas, Fuentes, McCord, Rackley, and Antonopoulos (2024) echo this, suggesting that energy efficiency retrofits can be seen as an extension of the home improvement experience that integrates tastes, routines, social aspirations and influences. In other words, in addition to saving energy and costs, retrofits may add to households' feelings of happiness, belonging, safety and security. As such, government and intermediary efforts ought to go beyond technological and economic levers, to socio-cultural ones in crafting their strategies to win households into adopting energy efficiency technologies.

2.4 Level of knowledge held by intermediaries about geyser efficiency technologies

2.4.1 The role of knowledge held by the intermediary in energy efficiency intermediation.

The role of energy education is considered to be a crucial step in the quest for energy efficiency diffusion. Renewable and energy efficiency adoption is reliant on well informed end users who must, in the face of widely varying and ever-changing technologies, make decisions about the best solutions to implement (Hyysalo et al., 2022).

However, finding correct and accurate information can be time consuming and requires a lot of effort on the part of the households or end-users, and therefore, contractors become key in bringing this information and influencing households (Decuypere et al., 2022). Zaunbrecher et al. (2021) argue that the technical complexity of energy efficiency combined with the low levels of knowledge about it among households puts intermediaries in a position whereby they are the gatekeepers of energy efficiency awareness, and consequent adoption. While Decuypere et al. (2022) also highlight the role of the general lack of knowledge, they also claim the existence of an element of ignorance about the importance of energy efficiency technologies amongst households.

Whether out of ignorance or a genuine lack of awareness, the lack of knowledge leads to lack of investment in energy efficiency measures and the forfeiture of the corresponding savings and economic gains, thereby resulting in the so-called energy efficiency gap (Dolšak, 2023; Schueftan, Aravena, & Reyes, 2021). Zaunbrecher et al. (2021) state that this knowledge deficit makes intermediaries such as contractors, gatekeepers of not just information, but the processes that lead to the final outcome of whether an energy efficiency decision is taken or not. They argue that contractors' decisions on what technologies they choose to be part of their business portfolio or offering (and therefore willing to install), and what advice or interaction they have with a potential adopter are the two levers they pull to open or close the gates into a successful energy efficiency adoption decision.

While any advice given by the intermediary may be sufficient for some households who see contractors as knowledgeable professionals and trust them (Decuypere et al., 2022), some households may need more convincing and require some level of technical demonstration or calculation to back the proposed energy efficiency measure before they consider installing it. This highlights the importance of strong technical knowledge within the intermediaries themselves or internally within their organisations.

While some intermediaries, especially those of larger scale programmes have the human capacity built into their core functions to do detailed analysis and calculate potential savings for end-users or beneficiaries (Guibentif & Patel,

2023) independent contractors working on their own find it difficult to do this (Zaunbrecher et al., 2021). In a Belgium study, it was noted that contractors found it not only difficult to calculate the energy efficiency savings correctly due to missing or unknown technical specifications, but also time consuming due to the fluctuating electricity prices (Decuypere et al., 2022). Whatever the reason for not being able to produce the energy savings analysis, they noted it to be counterproductive to their efforts of convincing households to adopt more energy efficiency technologies.

However, in their paper, Guibentif and Patel (2023) explore the functions of an EE programme in Switzerland and describe some of the pitfalls or blind spots that they fall into. They highlight how the narrow focus of the programme in recruiting individuals with technical expertise (which is crucial for ensuring credibility with their targeted beneficiaries), inadvertently disadvantages the programmes. That is, purely technical teams often do not possess the other necessary soft skills of being able to collaborate and coordinate with other stakeholders. They also experience difficulties connecting with and mobilising the beneficiaries towards the desired changes and outcomes.

In addition, Mogensen and Gram-Hanssen (2023) also highlighted that the saving potential of energy efficiency measures can be overly complex for households to grasp. Further to the that, the outcome itself may be quite uncertain. All the above highlight the complexity of energy efficiency intermediary work and the need for active, well-informed, and empowered communities.

2.4.2 Level of contractor knowledge in South Africa

While no known energy efficiency study specific to contractors has been published in South Africa, the Department of Energy (2013) did conduct a country-wide survey of the general residential sector's energy related behaviours and perceptions. This study found that education played a critical role in determining awareness levels amongst end users and that people with a tertiary education were nearly three times more likely to be aware of energy saving strategies/technologies in comparison to people with no formal

education. In fact, a subsequent survey conducted by the Department of Energy (2015) revealed energy efficiency technology adoption rates of less than 50% among participants, with the vast majority of adopters being from higher income households.

That said, it stands to reason that as a consequence of the majority of contractors being informal players with low education levels (Skills Development for a Green Economy, 2019c), two possibilities which impact their knowledge levels arise: Firstly, drawing from the aforementioned Department of Energy surveys, they too are likely to have low awareness about energy efficiency technologies. Secondly, they fall within the low to middle income brackets and may actually not be using geysers in their owns homes to the extent that higher income households do. They, therefore, are unlikely to have any significant awareness of such geyser efficiency technologies themselves as they would derive little to no benefit from them due to the high cost of running them. To this point, the Department of Energy (2013) survey revealed that less than 10% of low to middle income households use electric geysers for heating water.

In the USA, Chun (2023) found that low-income households prioritised activities that seemingly had more immediate outcomes such as household energy upgrades (like electrifying a piece of infrastructure they may have previously not been electrified) as opposed to long term goals such as clean energy or building sustainable energy projects. Scharnigg and Sareen (2023) corroborated this in that they found that in Norway, people form middle class neighbourhoods were more available for potential energy community projects while the poor neighbourhoods seemingly had too many competing priorities that surpassed energy efficiency.

In addition, Booysen, Nel, and van der Merwe (2016) conducted a study to evaluate end user behaviour and understanding of electric geysers. They found that the majority of participants lacked the basic theoretical and technical knowledge that underpins the concept of standing losses in electrical geysers. Although neither the public surveys (Department of Energy, 2013, 2015) nor the Booysen, Nel, and van der Merwe (2016) studies were specific to contractors, they provide a useful snapshot of what could be the status quo with contractors

in the residential sector. Judging by the low levels of formal education acquisition and poor quality of the formal institutions of learning for vocational training in South Africa (Skills Development for a Green Economy, 2019a, 2019b; Windapo, 2016), it is highly probable that contractors are well represented among the participants with poor knowledge discussed in these studies.

In 2017, the Plumbing Industry Registration Board (2017) observed a 63% failure rate in the open book, multiple-choice competency assessment for plumber licensing and registration. An average mark of 22% was observed even though the assessments were entirely based on regulatory standards that plumbers ought to be applying in their daily jobs, with 83% of on-site inspections resulting in rudimentary failures and re-fixes. In fact, more recently, they found that 67% of the assessed 725 geyser installations on a national geyser installation audit were non-compliant (Plumbing Industry Registration Board, 2023). Furthermore, Windapo (2016) found that the general quality of workmanship in the industry was very poor even though contractors who had obtained their formal qualifications produced work of relatively higher quality than those who had not. Nevertheless, if this is the prevailing status quo with fundamental day-to-day tasks, then it is even more likely that energy efficiency knowledge and competence lags even further behind.

2.4.3 Attainment of energy efficiency knowledge

Where formal education is acquired, Windapo (2016) argued that the skills taught in the TVET institutions fail to live up to the specialised skills required by industry. Consequently, the primary industry professional body for plumbers, the Institute of Plumbing South Africa (IOPSA) only recognises 10 TVET colleges throughout the country (Skills Development for a Green Economy, 2019a).

The plumbing curriculum for instance, lightly touches on energy - looking at energy efficiency legislation applicable to plumbing and how it impacts the work activities on a plumbing project/site, as well as energy saving, although it does not specify what this legislation is or what energy savings areas ought to be covered (Institute of Plumbers South Africa & Quality Council for Traders and

Occupations, n.d.). This generalisation has the potential to open up the curriculum to interpretation and training institutions can choose what aspects of legislation or energy savings to cover or leave out, and to what degree - thus leading to variations in content delivered.

Furthermore, TVET colleges are generally believed to be fraught with challenges such as poor institutional management, incompatible curriculum and lack of resources (Makole, Moeti, & Ntshangase, 2023; Nkambule & Ngubane, 2023) Under these prevailing conditions, the state of TVET college education denies its recipients superior knowledge and skills. As a result, it is likely that there is negligible difference between the levels of knowledge between formal and informal contractors. In fact, some sentiments from some participants in the Windapo (2016) study were against and spoke harshly about TVET education.

So, while the formal TVET education may appear to be inadequate as a source of energy efficiency awareness and training in South Africa, there are other means to develop this knowledge in which intermediaries around the world use to stay abreast of new energy efficiency technologies or measures. These include trainings from professional bodies, reading trade or specialist journals, participating in webinars and workshops, attending trade fairs and manufacturer-offered trainings, legal standards and regulations, learning from fellow professionals or tradesmen, and receiving training, coaching and advise from other governmental, business or non-profit intermediary institutions or programmes (Decuypere et al., 2022; Dolšak, 2023; Guibentif & Patel, 2023; Laborgne, 2023; Page & Fuller, 2021; Sohre & Schubert, 2022; Zaunbrecher et al., 2021). These are generally regarded as continuous development mechanisms, some of which are also used in South Africa by the plumbing and electrical professional organisations including the PIRB and ECA(SA).

Nevertheless, even these alternatives are not perfect, and the issue of low energy efficiency knowledge seems to persist. Scharnigg and Sareen (2023)’s study which focused on the role of institutionalised intermediaries including municipalities, non-profit organisations and businesses in expanding solar energy in Portugal communities identified one of the failures in this endeavour as the lack of such facilitated knowledge sharing. On the other hand,

Zaunbrecher et al. (2021) and Decuypere et al. (2022) found that many tradesmen admitted to finding it difficult to prioritise continuous training due to cost and time constraints, and saw the time spent on training as lost time that they could have spent attending to their work and earning an income. They also highlighted that the general pace of changes in technologies in the market is something they find difficult to keep up with and found it easier to just stick with old practices they are familiar with.

2.5 The relationship between knowledge on geyser efficiency technologies and intentions to promote geyser efficiency technologies?

As noted in the previous section, there is no known literature that can give insight into the knowledge of geyser efficiency technologies specifically held by contractors in South Africa. However, some insight can be gleaned by looking at other available information such as the type of training and development they receive which would directly impact their level of knowledge, competence and skills. Knowledge and competency are one of the core elements of self-efficacy which is a strong motivator of intention to engage in a given behaviour (Bandura, 1997; Bandura & Schunk, 1981; Williams, 2010).

Figure 11 and

Figure 12 show the results of a survey from a group of plumbing and electrical contractors, respectively. In both cases, the highest frequency of training preference is in house-training with a notable portion claiming no training activity at all (Skills Development for a Green Economy, 2019a, 2019b). For in-house training, Skills Development for a Green Economy (2019b) noted that it was most common amongst those businesses that have been operating for more than 20 years and therefore likely to rely on the years of experience among their older staff members. Evidently, contractors' confidence that they can train each other in-house or don't need to be sent for training at all for general plumbing and electrical work persists despite any formal process of skill acquisition or competency achievement. The question, however is: "why?"

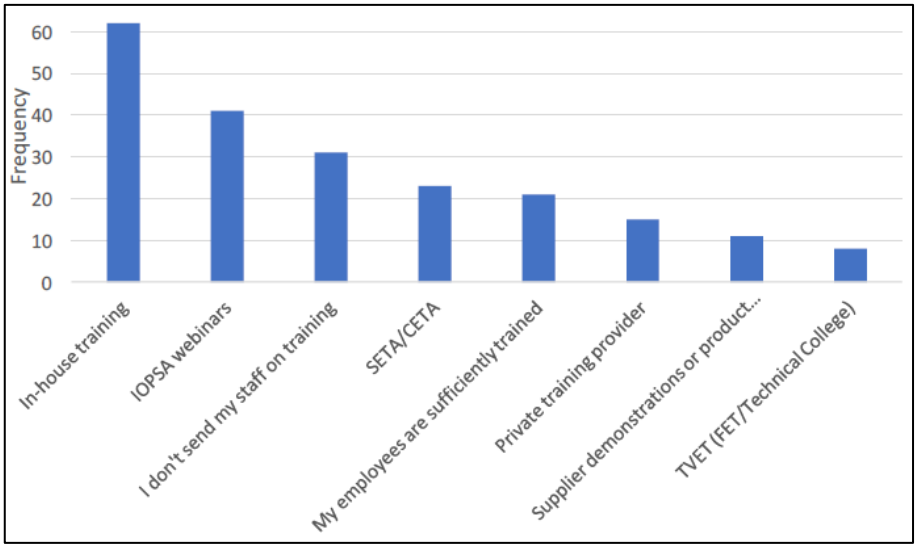
It may seem baffling that contractors who supposedly are not skilful or knowledgeable enough to be performing the tasks they are performing, continue to do so undeterred, and one might argue, confidently too. This is nothing out of the ordinary as Bandura (1997) confirms that high self-efficacy can be observed even when there is little or no underlying competency confirmation. In such a case, competency may clearly not be the most important factor for success and other factors not necessarily explored in this study may exist and have a stronger influence on self-efficacy or intention directly. With this in mind, it is possible that contractors may feel the same sense of self-efficacy and positive intentions towards promoting geyser efficiency technologies whether or not they actually possess the backing knowledge and competence.

Be that as it may, there remains a body of literature that suggests that knowledge remains one of the core elements that ultimately lead to the formulation of intention to engage in a particular behaviour (Acikgoz, Filieri, & Yan, 2023; Bandura, 1997; Bandura & Schunk, 1981; Tassiello & Tillotson, 2020; Williams, 2010). Hence, regardless of scenarios where self-efficacy or intention may exist even without the necessary knowledge or skills, where knowledge does actually exist, intention is likely to have developed as well. In other words, the higher the knowledge that a subject has, their level of intention

is likely to be higher as well (driven by that knowledge) compared to a subject with lower knowledge (whose intention may or may not be high, driven by different factors).

Figure 11

Plumber's Training Preferences



Note. Plumbers training preferences is predominantly geared towards informal training methods such as in-house training and webinars, with a large proportion showing no interest in training at all. TVET colleges are the least favoured.

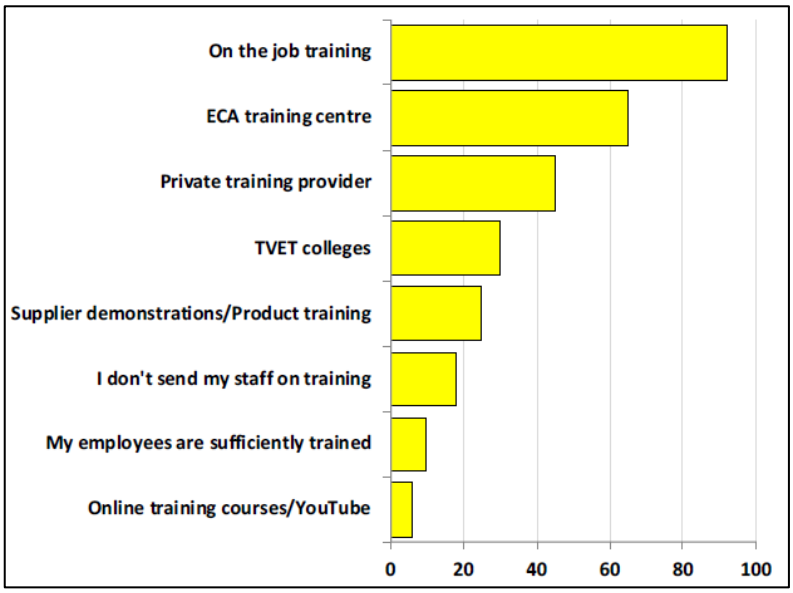
SETA – Sector Education and Training Authority

CETA – Construction Education & Training Authority

From *High-level statistical analysis of the plumbing and electrical trades* by the Skills Development for a Green Economy, 2019a (p. 19) Pretoria, South Africa

Figure 12

Training Preferences for Electrical Contractors



Note. Similar to plumbers, electrical workers prefer in-house training. However, the proportion that expressed no need for training is less and TVET colleges rank higher up on the scale. This is likely due to the stricter regulations governing the electrical trade.

ECA - Electrical Contractors Association (same as ECA(SA))

From *Industry Analysis of the Electrical Contracting Industry* by the Skills Development for a Green Economy, 2019b (p. 23) Pretoria, South Africa

2.6 Conclusion of Literature Review

Looking at the different constructs that affect intention, the literature reviewed above has revealed some valuable insights on how each of these factors may play out amongst contractors. The CADM suggests that there is a causal relationship between personal norms, social norms, attitudes and perceived behavioural control on contractor's intention towards a specific behaviour; hence the existence of such a relationship would also be accompanied by a positive correlation between each of these constructs and intention. Hence, it is hypothesised that each of these factors will have a positive correlation with intention. In as far as exploring the extent of and role of knowledge in driving intention, it hypothesised that the level of knowledge will be higher among formal sector contractors versus informal sector; and knowledge will have a positive correlation with intention. These hypotheses are summarised in

Table 2 below.

Table 2

Consistency Matrix: Research Questions and Hypotheses

RQ #	*Research Question*	*Hyp #*	*Hypotheses*
1	*How do attitudes, personal norms, social norms and perceived behavioural control affect contractor's intention to promote the use of geyser efficiency technology?*		
1.1	*How do personal norms influence contractors' perceptions of their roles in household geyser efficiency?*	*1*	*There is a positive correlation between personal norms and intentions to promote household geyser efficiency*

RQ #	*Research Question*	*Hyp #*	*Hypotheses*
1.2	*How do social norms influence contractors' intentions to promote household geyser efficiency?*	*2*	*There is a positive correlation between social norms and contractors' intentions to promote household geyser efficiency*
1.3	*How do contractors' attitudes towards an intermediary role for household geyser efficiency affect their intention?*	*3*	*There is a positive correlation between contractors' attitudes and intentions to engage in a mediating role with household geyser efficiency technologies*
1.4	*How do contractors' perceptions of their behavioural control to influence households successfully influence their intentions?*	*4*	*There is a positive correlation between contractors' sense of personal responsibility and their intention influence households to adopt more energy efficient geyser technologies*
2	*How does the knowledge about geyser efficiency technologies differ between formal and informal contractors?*	*5*	*There is no difference between the levels of knowledge held by formal contractors compared to informal contractors*
3	*How does the knowledge about geyser efficiency technologies influence intentions?*	*6*	*There is a correlation between contractors' knowledge or competence and their intentions to promote household energy efficiency technologies.*

CHAPTER 3. RESEARCH METHODOLOGY

3.1 Research approach

This research took the form of a quantitative, non-experimental, cross sectional approach. It seeks to test the reconfigured CADM model as shown in Figure 7, i.e. explore the factors that affect contractors' intentions to pursue and promote more energy efficient geyser technologies in their work in the residential sector. It also evaluated the level of knowledge on geyser efficiency between formal and informal contractors and whether the extent of that knowledge held by contractors actually impacts their intentions promote more energy efficient geyser technologies.

3.2 Research design

According to Creswell (2012, p. 545), the strength of this design is that quantitative data provides for generalizability. In line with this, the intention of this study is to evaluate the general perceptions held by contractors towards household geyser efficiency interventions. Its aim is to obtain broader insights into contractors' perceptions and knowledge of add-on geyser efficiency technologies and a sense of their inclination to act as of energy efficiency intermediaries. This does not warrant the focused probing that would be obtained from a qualitative design which focuses on fewer subjects and attempts to get as rich and in-depth an understanding as possible regarding a particular topic of research. While for this research generalisation may be weak due to the limitations of convenience of snowballing sampling employed as described in 3.4.2. below, quantitative design still provides that broader insight of what could be happening on much a higher level by seeking out a higher number of participants, than what qualitative design could ever be able to provide.

3.3 Data collection methods

An online survey was used to collect the data which was all collected electronically through the use of a survey application (i.e. Survey Monkey). Participants were sought through their respective professional bodies including the Ethekwini Municipality database, internet searches, word of mouth or referrals and setting up a stall outside agreeable hardware's/plumbing outlets. Surveys were distributed via WhatsApp, emails and where physical interactions took place, links copied directly onto participants' electronic devices from a display chart were used - rendering all survey responses electronic.

Surveys distributed via email received virtually no responses despite having called the individuals beforehand and having them agree to participate. Surveys distributed via WhatsApp were just as difficult receiving no more than 10 respondents out of approximately 50 people reached out to. The most effective and time-consuming method was setting up a stall outside one of the largest plumbing chain stores in Durban. Several other stores approached refused to have a stall outside their store, fearing any solicitation of their customers would be received as a bother. Others, simply didn't have enough plumbers or electricians frequenting the stores, and those that did, not being open to even hearing about the survey. It took collectively 2-3 weeks, consisting of different occasions of setting up the stall at the agreeable plumbing store where either the researcher or the data collection assistant was present.

3.4 Population and sample

3.4.1 Population

The provincial population for Kwazulu-Natal is approximately 6700 plumbers and 4900 electricians with approximately 80-20% and 95- 5% between the informal and formal sectors for plumbers and electricians, respectively (Skills Development for a Green Economy, 2019a, 2019b). The exact population data for Durban, the target population, is not known, although as the largest

metropolitan in the province, it most likely makes up the largest share of the provincial population.

3.4.2 Sample

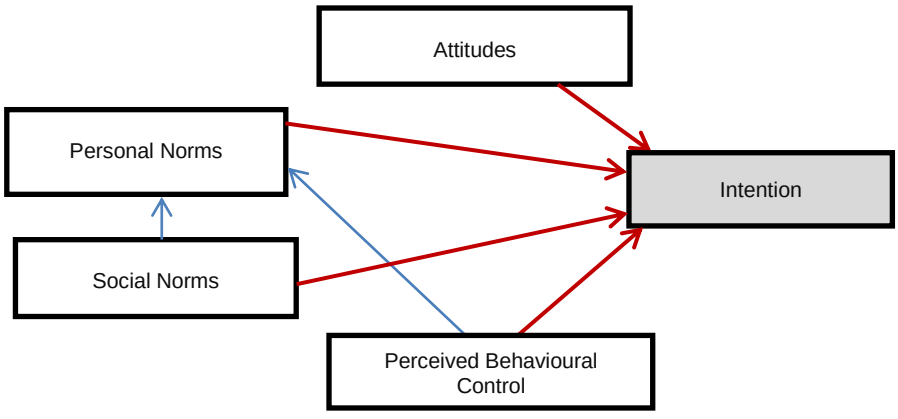
The sample was drawn by means of nonprobability sampling, as none of the probability sampling techniques which require a known population, can be employed. Convenience and snowballing sampling were used and participants were selected on the basis of availability, willingness to participate, and referrals. Participants were individuals who were employers, employees or own-account operators who identified themselves as either a plumber or electrician.

3.4.2.1 Research question 1

For research question 1 which was analysed using structural equation modelling path analysis, a general rule thumb for determining the sample size is used, which is P*q – where P the number of parameters to be estimated and q a multiple of 5-20 (Kline, 2023). In this case there are 11 parameters (5 constructs and 6 paths) as shown in **Error! Reference source not found.** which means a minimum sample size 55 up to 220 was required. However, since the modelling in AMOS is a covariance matrix-based approach, the three exogeneous constructs in the model (attitude, social norms and perceived behavioural control) must covary (Collier, 2020), increasing the number of parameters to 14, thus increasing the required sample size to 70 - 280. In this study, 125 was achieved which dropped to 107 after data cleaning.

Figure 13

Simplified and Reconfigured CADM



Note. Proposed theoretical model to be tested via structural equation path analysis. Red arrows represent the paths relevant to testing hypothesis 1 to 4.

3.4.2.2 Profile of respondents

The respondent's characteristics are summarised in

Table 3 below by field of work or specialisation; age group, work experience, whether they possess a trade test or not, and lastly, professional organisations they are affiliated with. For affiliations, it was possible for respondents to select more than one answer in the questionnaire, hence the total is greater than the sample size of 107.

Table 3

Profile of Respondents

Indicator Label	Description	Options	Number
D1	Field of work	Plumbing	94
		Electrical	13
D2	Age group	24 years and below	16
		25-34 years old	42
		35-44 years old	28
		45 -54 years old	15
		55 years and above	6
D3	Work experience	Less than 5 years	30
		Between 5 and 10 years	41
		Between 11 and 20 years	22
		Over 20 years	14
D4	Trade test	Yes	40
		No	45
		Working on it	22
D5	Affiliations	PIRB	46
		ECSA	7
		SARS	23
		ECA(SA)	10
		Department of Labour (only)	29
		Total number of respondents	107

Note. The total number of valid respondents after data cleaning was 107 and were predominantly plumbers.

As per the definition outlined in 1.3.2 the level of formality was indicated by whether the participant is registered with SARS or not. Those who indicated as such were considered as being in the formal and those who didn't, in the informal sector. The results are summarised in Table 4 below.

Table 4

No. of Respondents in the Formal and Informal Sectors

Formal	Informal	Total
23	84	107

Note. Consistent with the literature reviewed in the previous chapter, the majority of respondents are part of the informal sector.

3.5 The research instrument

All data was obtained from closed-type questionnaires. The questionnaires comprised of two sections of closed questions. The variables in the first section were personal norms, social norms, attitudes, behavioural control, as well as intentions. The second section investigated the actual level of contractors' technical knowledge on geyser energy operations; the energy associated with different designs and operational parameters, as well as available energy efficiency technologies that can be used with geysers to improve their efficiencies. The design of questions was partly informed by the questions found in Manstead (1996), van den Broek and Walker (2019), van den Broek, Walker, and Klöckner (2019) as well as the researchers own ideas derived from the reviewed literature.

3.5.1 Testing the reconfigured CADM and evaluating the significance of the four factors linked to intention

Questionnaires were used to evaluate contractors' perceptions of the different factors that contribute to intentions and ultimately behaviour, namely: personal norms, social norms, attitude and perceived behavioural control.

The questionnaires were presented in the form of the Likert-scale questions. Likert data has been chosen as it is a widely used technique for attitude analysis that is quick and easy to understand. It is also useful because it has the ability to capture the essence of a specific construct through the use of simple statements and participants generally feel at ease using it (Subedi, 2016). On the other hand, some limitations do exist with Likert scales with one of the major issues being the classification of data as interval or ordinal and the determination of the appropriate analytical tools to analyse it (Murray, 2013; Subedi, 2016). Some researchers view Likert data as purely ordinal and believe that only non-parametric analysis will yield valid results (Murray, 2013), while others - Boone and Boone (2012), Creswell (2012) and Murray (2013) - have shown that parametric analysis can also be used to yield valid results, as long as the data is treated as interval by ensuring that a scale with several questions is constructed for each variable instead of analysing questions individually.

Data was collected using Likert-scale questions (indicators or observed variables) to measure each construct (unobservable variable).

Table 5 below summarises the structural equation modelling items. Each construct contains 4 to 5 questions which are labelled PN1 - PN4 for Personal Norms, SN1 – SN4 for Social Norms, A1 – A5 for Attitude, PBC1 – PBC 5 for Perceived Behavioural Control and I1 – I4 for Intentions. The Likert scale for Personal Norms, Social Norms, PBC and Intentions is a 5-point scale with 1 – Strongly Agree and 5 – Strongly Disagree.

Table 5

Likert-Scale Questions for Hypotheses 1 – 4

Construct	Indicators		No.of items
Personal Norms	*PN1*	I have a personal responsibility to tell my clients about more energy efficient geyser technologies geyser to conserve the environment	4
	PN2	I feel morally obliged to tell my clients about more energy efficient geyser technologies	
	PN3	I can't help but tell clients about more energy efficient geyser technologies	
	PN4	I feel guilty when I don't recommend more energy efficient geyser technologies to my clients	
Social Norms	SN1	Most people who are important to me and my work think that I should promote geyser efficiency technologies to households:	4
	SN2	The pressure to promote more energy efficient geyser technologies to households makes me comply	

Construct	Indicators		No.of items
	SN3	It is expected of me to promote more energy efficient geyser technologies in my work	
	SN4	I have no choice but to comply with the expectations to install more efficient geyser technologies	
Perceived Behavioural Control	PBC1	I am confident that if I install more energy efficient geyser technologies for my clients, their electricity usage will decrease	5
	PBC2	My clients trust my recommendations and usually adopt them	
	PBC3	Pursuing more energy efficient geyser technologies will increase my administration work with little gain	
	PBC4	I know that I can install any geyser technology that is currently on the market	
	PBC5	My clients are likely to adopt more energy efficient geyser technologies if I recommend them	
Intentions	I1	I plan to tell my clients about more energy efficient geyser technologies	4
	I2	It is one of my goals to tell my clients more about more energy efficient geyser technologies	
	13	I have no intentions of promoting geyser efficiency technologies because they are too much administration	
	I4	I will always recommend geyser efficiency technologies to my clients	

Note. There are 4 to 5 indicators or questions intended to measure each of the underlying constructs whose relationship is to be tested using SEM.

For attitude, the scale was also 1 - 5 with 1 being a positive response towards attitude and 5 being a negative response towards attitude as shown in Table 6.

Table 6

Questions for Attitude

ATTITUDE	
For me, promoting more energy efficient geyser technologies to households is:	
A1	Important 1: 2: 3: 4: 5 Unimportant
A2	Beneficial: 1: 2: 3: 4: 5 Harmful
A3	Good: 1: 2: 3: 4: 5 Bad
A4	Effective: 1: 2: 3: 4: 5 Not effective
A5	Favourable: 1: 2: 3: 4: 5 Unfavourable

Note. Unlike the traditional Likert Scale with a sliding scale from Strongly Agree to Strongly Disagree on the other end, for Attitudes, the ends of the scales were opposing attitudinal adjectives describing an energy efficiency technologies promotion.

3.5.2 Evaluating the extent of technical knowledge

The technical knowledge assessment consisted of questions that were designed to produce categorical, binary data as each question was intended to

have one correct answer. These questions considered basic and general elements such as the units used to measure electricity usage in geysers, how long it takes a geyser to heat up or cool down, how much electricity gets used up when heating water, how much heat is lost through standing losses, impact of usage of timers and lowering thermostat settings. The questions are presented in Appendix A.

3.6 Procedure for data collection

Questionnaires were created and distributed electronically. They took participants approximately 15 minutes to complete. The majority of contractors in the formal sector either had websites or had their contact numbers listed with Ethekwini Municipality. The list of the Ethekwini Municipality registered plumbers and electricians is publicly available and contained the contact details that were used to contact them.

Apart from the above, participants were identified by referral or word of mouth. They were contacted telephonically, and the surveys emailed or sent to them via WhatsApp. However, the response rate for this method was extremely poor. Participants were contacted in person as well. To maximise the reach and participation, participants were targeted at hardware shops.

3.7 Data analysis and interpretation

Statistical Package for the Social Sciences version 27 (SPSS) and SPSS AMOS were used for all statistical analysis. Data was analysed using the relevant descriptive statistical instruments.

3.7.1 Research question 1

Research question 1 investigating whether personal norms, social norms, attitudes and perceived behavioural control (independent variables) predict intention (dependent variable) in accordance with the reconfigured CADM as shown in Figure 7 was tested using structural equation modelling. Two

approaches were considered for this analysis: path analysis or a full structural equation model. In general, structural equation modelling is considered to be a combination of two statistical techniques: Confirmatory factor analysis and Path analysis (Murti, 2020). Hence, path analysis is sometimes cited as a subset of structural equation modelling.

Both approaches examine the relationships between constructs. however path analysis does not take the indicators for each construct individually into account (but lumps them into a composite variable representing the underlying construct), and therefore does not account for measurement error, while a full structural equation model does (Collier, 2020; Murti, 2020). So, in a full structural model, factor analysis and path analysis are essentially combined into a single model and computed simultaneously, while, for path analysis, confirmatory analysis must first be computed separately to test the measurement model before the path analysis can be done (Collier, 2020).

Path analysis's failure to account for random measurement error can inadvertently disguise effects of multicollinearity while the full SEM can result in less stable results as result of standard errors on higher estimated coefficients. (Grapentine, 2000). Ultimately, full SEM is perceived as a more robust approach especially when more complex models are analysed while path analysis suffices for simpler models with fewer, more straighthood dependent/independent variable relationships to be tested (Collier, 2020; Grapentine, 2000). In fact, Grapentine (2000) argues that when the test model is not very complex, the full SEM and path analysis yields similar results as demonstrated in their examples testing the relationship between six constructs. This also evident in Collier (2020)'s textbook examples which evaluates the relationship between 5 constructs. That said, the model in this study seeks to test the relationship between 5 constructs (as shown in Figure 8), thus considered similarly simple enough to render either path analysis or full SEM suitable approaches.

However, a full structural model has more paths to be tested and would therefore require a larger sample size (Collier, 2020; Kline, 2023). Given the relatively small sample size in this study, a full structural equation model may

present unreliable results, thus leaving path analysis as the more suitable approach for this study.

3.7.2 Research question 2

Research questions 2 related to the comparative knowledge between formal and informal contractors. Since both the formal and informal sector participants are part of the same sample of participants, and the hypothesis is not specific as to which group has higher or lower levels of knowledge, the two-tailed test for equality of means was used.

3.7.3 Research question 3

Research question 3 testing the relationship between knowledge and intention was analysed using the Pearson's correlation coefficient.

3.8 Limitations of the study

Due to the strong informality of the sector, it was difficult to select participants in a structured representative manner. As a result, the sample was drawn using convenient sampling, not probability sampling, so the results were not entirely representative of the Durban plumber and electrical contracting population. Furthermore, the constructs measured in this study such as attitude, for example, are hypothetical, and can not be directly measured, but can only be inferred from evaluative responses to the construct in question (Manstead, 1996), hence can never really be proven or demonstrated physically.

In addition, further risks with participants operating in the informal sector and particularly in the electrical trade may have given false information while some may have refused to participate altogether if they were aware of the legal requirements that govern electrical contracting.

The questionnaires were also presented in English which could have compromised a large proportion of participants for whom English is not the first language. To add on, the fact that the largest proportion of the plumbing and

electrical workers are in the informal sector with potentially low eduction levels further increased the risk of not fully understanding all the questons and therefore randomly selecting responses. In fact, the nature of the research instrument being in a multiple choice format, lent itself to a higher likelhood of random responses that have not been fully thought through or reflective of the particpants' true standpoint or view on any given question.

3.9 Validity and reliability

3.9.1 External validity

External validity refers to the extent that the results of a study can be generalised to a wider population or situations (McDermott, 2011). As stated in the limitations, this study employed convenient sampling rather probability sampling which takes away from the data being representative and therefore diminishes generalisability. Furthermore, the study only focused in the Durban area which may be dissimilar to other parts of the country in terms of the characteristics of the contractors or the environment under which they operate.

3.9.2 Internal validity

Internal validity is the extent to which the research instrument is able to confidently measure the construct it is intended to measure (McDermott, 2011). This is evident in this research as the questionnaires have a set of specific questions to address each of the constructs separately to allow for the evaluation of each construct to be measured independently. Furthermore, these questions were derived using the definitions obtained in literature and present the qualities of those constructs. For example, when assessing "personal norms", the Likert items in the questionnaire asks about the contractors' sense of responsibility or moral obligation which are the elements that lead to formation of personal norms in the CADM (Klöckner & Blöbaum, 2010). In the structural equation model, the construct validity is assessed through confirmatory factor analysis (Collier, 2020; Shau, 2017) as conducted in 0.

3.9.3 Reliability

Reliability is the extent to which a research instrument is able to produce the same results consistently when used under the same conditions repeatedly (Heale & Twycross, 2015). In this research, this is achieved by ensuring that the questions use simple English, and are clear and unambiguous (Creswell, 2012). Reliability was assessed using Cronbach alpha as indicated in 4.3.3.

3.9.4 Objectivity or conformability

The fact that the method of analysis in this research is purely quantitative minimises the level of depth of understanding possible as the data is analysed statistically, and the interpretations inferred from the analysis. The researcher had minimal contact with participants as the questionnaires were conducted via online platforms. Where assistance with the clarification of questions arose, a third party with limited knowledge of the content of this study other than administrating the questionnaires, predominantly assisted with this. Furthermore, the participants were anonymous in that no personal information other than their qualifications, work experience and age groups were required for participation in the study.

3.10 Ethical considerations

The research proposal for this study was vetted by the Wits Business School Research Committee and an Ethics Clearance Certificate (Appendix B) was issued before any data collection commenced. Participants were provided with introductory information relating to the study (Appendix C) and signed an electronic consent before they could commence with the questionnaire (Appendix D). Participation was voluntary and participants were given the freedom to answer the questions freely without any input or pressure from the researcher or questionnaire administrator. Participant responses were confidential and anonymous as no personal information pertaining to the identity of the participants was collected and were stored in an electronic format that only the researcher and supervisor had access to. Participants were selected

based on their work (residential plumber or electrician) and were not discriminated on the basis of race, gender, age or sexual orientation.

CHAPTER 4. PRESENTATION OF RESULTS

4.1 Introduction

Data screening as well as assessment of validity and reliability are presented first. This is followed by the results of the first research question relating to the testing of the CADM using structural equation modelling. This entails results of confirmatory factor analysis which measured how well the indicators measured the constructs as well as the path analysis which shows the relationships between the constructs – hence, answers to hypothesis 1 to 4. Lastly, results of the t-tests and significance testing of hypotheses 5 and 6 relating to research questions 2 and 3, respectively, are then presented.

4.2 Data screening, assessment of validity and reliability

4.2.1 Data screening and imputation

4.2.1.1 Respondent misconduct

This assesses whether the respondent answered every item of the Likert scale with the same response e.g., strongly disagree or simply agreeing with whatever was being asked. To determine this, the standard deviation of each respondent's answers to the Likert Scale items was computed in Excel and all responses with a standard deviation of less than 0.25 (Collier, 2020) were considered for deletion as they demonstrated little or no variance. 13 such cases were found and deleted, leaving the total number of viable responses at 107.

4.2.1.2 Respondent abandonment and missing data

Two respondents did not attempt the knowledge-based questions (relating to hypothesis 5-6) at all. These respondents were retained in the analysis for hypothesis 1-4 and excluded only for hypotheses 5 and 6. There was one missing response on one of the Likert scale indicators (PN1). The missing data

did not warrant deletion of the participant from the survey as it was the only missing data point in a response profile of 43 questions (constituting a mere 0.9% of missing data). This missing data point was therefore estimated using the series mean imputation technique.

4.2.2 Data meaning

All the Likert scale questions, except PBC3 and I3 were framed in such a way that a response that was in agreement with the statement was a positive result towards the underlying construct and vice versa with a response that was disagreeing. PBC3 and I3 which read:

"Pursuing more energy efficient geyser technologies will increase my administration work with little gain".

and

"I have no intentions of promoting geyser efficiency technologies because they are too much administration".

were framed in the negative, hence a response with a positive view towards the underlying construct or energy efficiency would have disagreed with the statements and attracted a 4 or 5 in the Likert scale. This would lead to a distortion of the composite result for PBC and Intention (as composite results for each of the constructs were obtained by computing the average of all the responses under each construct). To rectify this, the responses to the above questions were reversed by subtracting the original response from 6. For example, an original response of 2, would change to a 4 - thus being consistent with the other questions in terms of meaning in relation to the underlying construct.

4.3 Results pertaining to Research Question 1

4.3.1 Descriptive statistics

Table 7 below shows the results of the Likert-scale questions (indicators or observed variables) used to measure each construct (unobservable variable) which are presented in

Table 5 in the previous chapter. The Likert scale for Personal Norms, Social Norms, PBC and Intentions is a 5-point scale with 1 – Strongly Agree and 5 – Strongly Disagree.

As seen below, the participants expressed strong agreement with each indicator representing the constructs with the mode being 1 in nearly all of them except PBC3 and I3. As discussed in the previous section (4.22) PBC3 and I3 were the only questions framed in the negative which means that a mode of 5 for PBC3 implies strong agreement with the underlying construct similar to all the other indicators. I3, having a mode of 1 seems to be the only indicator with the majority disagreeing with the underlying construct. However, it is important to note that the percentage (32%) is the lowest compared to the other modes and the rest of the responses seem scattered widely across the other point scales. This might possibly be an indication of how the negative framing of the question may have been confusing to participants and they may or may not have been a true reflection of the participants' intentions.

Overall, the data is severely skewed towards support of the underlying constructs with over 65% of participants selecting 1 and 2 and less than 10% selecting 5. This is further depicted in Table 8 by the mean which is less than 3 for all the constructs (3 being the mean that would have indicated perfectly symmetrical data) and skewness that is notably positive for all the composite constructs. The standard deviation is less than 1, which is low and indicates the data is fairly aggregated around the mean and not too spread out.

Table 7

Responses for Each Likert Scale Selection for Each Indicator by Percentage for Each Construct

Indicator	1	2	3	4	5	Mode
PN1	46%	36%	12%	4%	2%	1
PN2	50%	20%	18%	7%	6%	1
PN3	50%	15%	21%	6%	8%	1
PN4	42%	22%	19%	12%	5%	1
SN1	46%	20%	22%	8%	4%	1
SN2	55%	16%	21%	6%	3%	1
SN3	50%	20%	20%	7%	3%	1
SN4	50%	21%	16%	8%	6%	1

Indicator	1	2	3	4	5	Mode
A1	68%	7%	13%	7%	5%	1
A2	63%	15%	10%	8%	4%	1
A3	68%	12%	13%	7%	0%	1
A4	56%	18%	16%	6%	5%	1
A5	68%	14%	10%	6%	2%	1
PBC1	52%	28%	11%	6%	3%	1
PBC2	54%	16%	20%	7%	4%	1
PBC3	7%	12%	20%	17%	44%	5
PBC4	49%	21%	21%	6%	4%	1
PBC5	58%	21%	14%	5%	3%	1
I1	62%	21%	12%	3%	2%	1
I2	58%	20%	16%	5%	2%	1
I3	32%	19%	24%	11%	14%	1
I4	59%	19%	13%	7%	2%	1

Note. The data is heavily skewed towards agreement with the underlying constructs with the mode being 1 (strongly agree) for nearly all the indicators.

Table 8

Statistics of The Composite Likert Scale Measures by Construct

	PN	SN	A	PBC	I
Mean	2	2	1.7	2.2	1.9
Standard deviation	0.813	0.884	0.843	0.634	0.790
Skewness	0.687	0.513	1.051	0.346	0.788

Note. The composite mean scores are below 2 across all constructs which indicates agreement with the underlying constructs corroborated by the skewness statistic which is positive. The standard deviation is less than 1 indicating data that is fairly aggregated around the mean

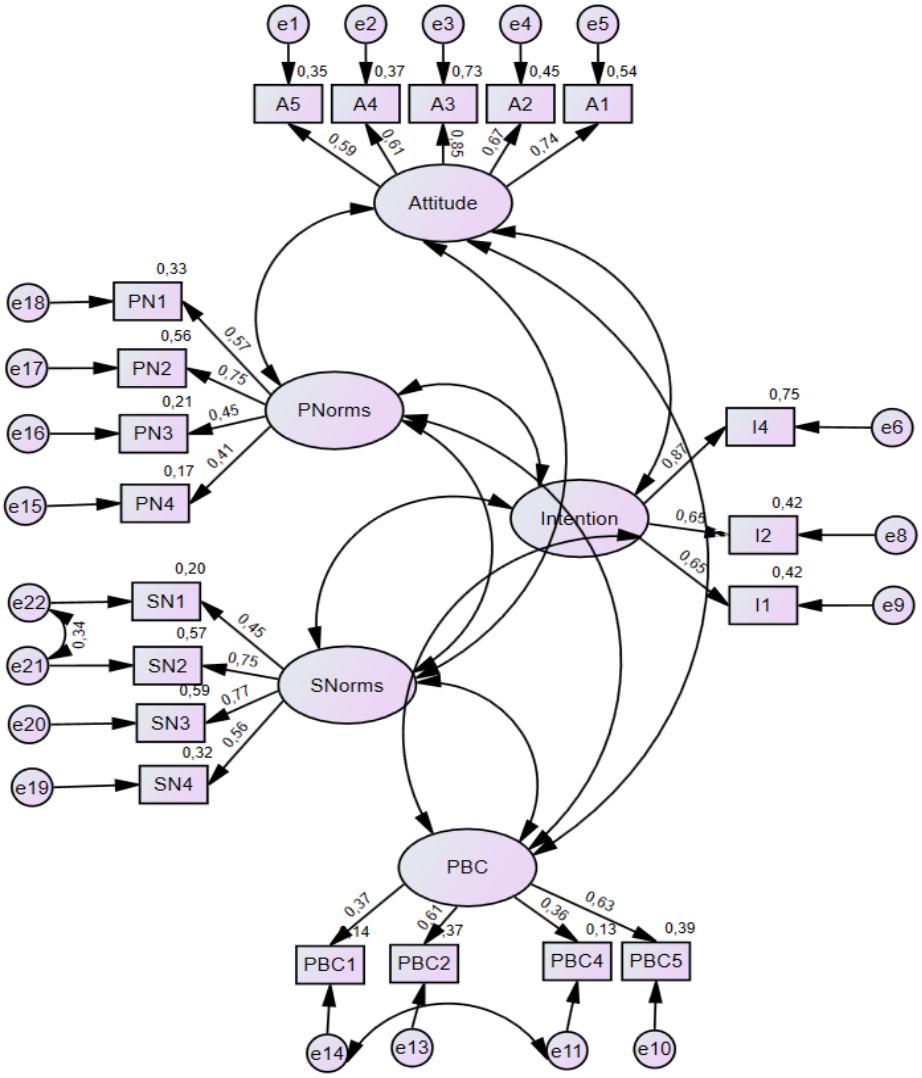
4.3.2 Confirmatory Factor Analysis

The first step in using structural equation modelling is to test the measurement model by performing a Confirmatory Factor Analysis. This is a statistical technique which assess how well the indicators measure the underlying constructs and whether the constructs are unique in relation to one another (Collier, 2020). The CFA was computed using AMOS (as per model shown in Figure 14 below) and entails analysing (1) the factor loadings (standardised regression weights) which estimate the direct effect that a construct has on its

indicators, and (2) the model fit statistics which indicate how well the specified or estimated model actually fits or is a good representation of the collected data.

Figure 14

CFA Model Computed on SPSS Amos



Note. The above model was computed in SPSS Amos and shows the factor loadings of all the indicators on the underlying constructs as depicted by the values on the arrows and the R^2 values shown at the top right corner of each indicator.

The model was computed with the constructs as independent variables, underlying indicators as dependent variables and the relationships or paths between them shown by a single-headed arrow going from the construct to

each of its indicators. Error terms used to account for the unexplained variance brought about the measurement error of the indicators are also depicted. These are also treated as independent variables and shown with a single-headed arrow going into their respective indicators. Double headed arrows which represents covariance between two independent terms were drawn between all the constructs to account for covariance between them. Covariance between the error terms were only drawn between error terms belonging to the same constructs to improve the model fit by accounting for any covariance they might possibly exist between them. This is because indicators from the same construct can sometimes be very similar, thereby not only be redundant but covary. In this study, only those covariances that improved the model fit were left as part of the final model presented in this report.

4.3.2.1 Factor Loadings

Error! Reference source not found. and Table 9 both illustrate the standardised regression weights or factor loadings for each construct. These were assessed to determine the extent to which indicator represented the underlying construct.

PBC3 and I3 had the lowest factor loadings of less than 0.3 (R^2<0.09 or 9%) which meant that they contributed very little to explaining the variance in the underlying construct, hence these were deleted from the model. After rerunning the model, several of the remaining indicators' factor loadings were below 0.7 which means that the R^2 was less than 0.5 (50%) as depicted in

Table 10 (implying that the indicators explained less than half of the variance in the construct). Nevertheless, these did not necessarily warrant deletion as the model fit statistics and reliability did not improve by their deletion. In fact, the model fit statistics were already within acceptable limits, as discussed in the next section.

Coincidentally, PBC3 and I3 are the only two questions in the research questionnaire that had been asked in reverse as explained in 4.2.2. and whose

responses had to be manipulated or reversed such that their meaning would be consistent with the other questions under the corresponding constructs. Perhaps, the uniqueness of the way in which these two questions were asked tricked the respondents or threw them off a particular line or pattern of thinking about the meaning of the questions and caused them to think about them differently to the way they were thinking about the other questions. As a result, their responses to these two questions seemed to deviate from the general perception of the underlying construct that they seemed to have formulated as seemingly captured more consistently by the other indicators.

Table 9

Factor Loadings or Standardised Regression Weights

			Estimate				Estimate
PN1	<---	PNorms	0.571	PBC4	<---	PBC	0.357
PN2	<---	PNorms	0.748	PBC5	<---	PBC	0.625
PN3	<---	PNorms	0.455	A1	<---	Attitude	0.737
PN4	<---	PNorms	0.414	A2	<---	Attitude	0.667
SN1	<---	SNorms	0.448	A3	<---	Attitude	0.854
SN2	<---	SNorms	0.753	A4	<---	Attitude	0.611
SN3	<---	SNorms	0.767	A5	<---	Attitude	0.590
SN4	<---	SNorms	0.563	I1	<---	Intention	0.650
PBC1	<---	PBC	0.369	I2	<---	Intention	0.648
PBC2	<---	PBC	0.612	I4	<---	Intention	0.865

Note. The factor loadings are less than 0.7 for the majority of the indicators which means the R^2 values will be less than 50% for those indicators. However, the data still fitted the model well with the indicators shown in the table as shown in the next section. PBC3 and I3 which had substantially lower factor loadings (less than 0.3) negatively affected model fit hence were removed from the final model.

Table 10

Squared Multiple Correlations

	R^2		R^2
PN1	0,326	PBC4	0,127
PN2	0,560	PBC5	0,391
PN3	0,207	A1	0,543
PN4	0,171	A2	0,445
SN1	0,201	A3	0,729
SN2	0,567	A4	0,374
SN3	0,588	A5	0,348
SN4	0,317	I1	0,422
PBC1	0,136	I2	0,420

PBC2	0,375	I4	0,748

Note. The R^2 values in the above table expressed in decimals represents the percentage of the variation in the construct explained by each of the indicators. Although the values are less than 50% for the majority of the indicators, the data still fitted the model well as shown in the next section.

4.3.2.2 Model Fit

Model Fit statistics are sensitive to a variety of factors, such as sample size, number of indicators, number of constructs, etc. - which can make them give conflicting results (that is, one index would indicate a bad fit while the next indicates a good fit), hence, it is generally recommended to use a variety of options to assess one's model (Collier, 2020; Kline, 2023). The following were used in this study and the results are shown in Table 11 below:

- Relative Chi-Square test (CMIN/df),
- Goodness-of-Fit Index (GFI)
- Comparative Fit Index (CFI)
- Tucker Lewis Index (TLI)
- Root Mean Square Error Approximation (RMSEA)
- Standardised Root Mean Squared Residuals

Table 11

Model Fit Results

Model Fit Statistic	Recommended Value	Result
CMIN/df	<3.00	1.646
GFI	>0.90	0.823
CFI	>0.90	0.889
TLI	>0.90	0.867
RMSEA	<0.08	0.078
SRMR	<0.08	0.070

Note. The recommended values for the model fit statistics were obtained from *The Confirmatory Factor Analysis (CFA) Of Preschool Management Model in Sarawak* by T. V. Shau, 2017, International Journal of Academic Research in Business and Social Sciences, 7(6), 221-231; *Applied Structural Equation Modelling Using AMOS: Basic to Advanced Techniques and Principles* by J. Collier, 2020; and *Practice of Structural Equation Modelling* by Kline, R. B. 2023.

Although GFI and TLI are outside the acceptable range, CFI is borderline so considered acceptable, and PCMIN/df, RMSEA and SRMR are good – the overall verdict on fitness is that the model fits the data acceptably well.

4.3.3 Reliability Assessment

The construct reliability was assessed using Cronbach's alpha which measures the extent to which participant responses are consistent across each construct's items. A generally accepted threshold is that the Cronbach alpha of at least 0.70 (Hair, Ringle, & Sarstedt, 2011) for each construct is good. The results are shown in **Error! Reference source not found.** below.

The Cronbach alpha for Social Norms, Attitude and Intentions were comfortably over the threshold of 0.7, while Personal Norms and Perceived Behavioural Control were below. While these are not good, values at 0.6 have been accepted in several studies in literature (Taber, 2018).

Table 12

Cronbach Alpha Results

Model Fit Statistic	Cronbach Alpha
Personal Norms	0.637
Social Norms	0.762
Attitude	0.824
Perceived Behavioural Control	0.592
Intention	0.764

Note. Although the Cronbach Alpha is below the threshold of 0.7 for some of the constructs, it is still in the range of 0.6 and therefore considered acceptable.

4.3.4 Path Analysis

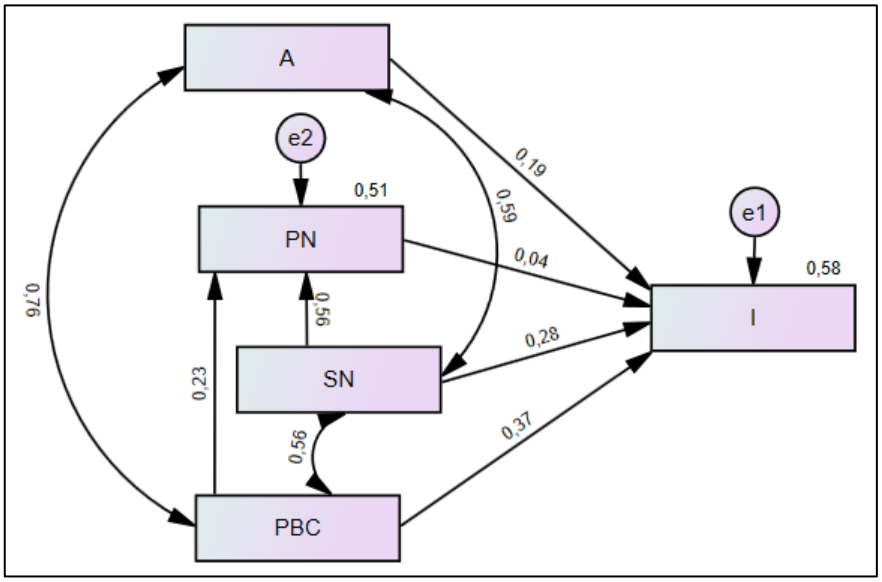
Having tested the fitness of the measurement model and reliability of the constructs, the next step was to perform the structural model analysis which focuses on analysing the relationship between the constructs, and thereby providing the means of testing the hypotheses raised in this research question. That is, how the independent constructs (personal norms, social norms, attitudes and perceived behavioural control) influence the dependent constructs

(intention). Note that while personal norms is an independent variable relative to intention, it is treated as a dependent variable in the analysis as the CADM posits that is also influenced by perceived behavioural control and social norms. That is, it is a mediating variable between perceived behavioural control and Intention.

A path analysis was computed by first computing composite variables of each construct and then testing the relationships between the constructs as shown in the structural model in Figure 15 below.

Figure 15

Path Analysis Structural Model Computed in SPSS AMOS



Note. The Standardised Regression Weights are indicated between the four independent constructs (Personal Norms, Social Norms, Attitudes and Perceived Behavioural Control) and intention. For path analysis, covariances are also drawn between the independent variables A and PBC as well as A and SN. PN is a mediating variable between PBC and I as well as SN and I.

4.3.4.1 Model Fit

The fitness of the model was assessed using similar model fit statistics as used in the testing of the measurement model through CFA. The results for CMIN/df, GFI, CFI, TLI and SRMR fell within the acceptable range while RMSEA was

significantly off target as shown in Table 13 below. However, since most of the indices are positive, overall, the model is considered to have an acceptable fit.

Table 13

Model Fit Indices for The Path Analysis Structural Model

Model Fit Statistic	Recommended Value	Result
CMIN/df	<3.00	2.254
GFI	>0.90	0.992
CFI	>0.90	0.996
TLI	>0.90	0.959
RMSEA	<0.08	0.109
SRMR	<0.08	0.0165

Note. All indices except RMSEA are within the acceptable thresholds, hence, overall, the model is considered to have a good fit.

4.3.4.2 Hypothesis testing

In this research question, the four hypotheses made were that there will be a correlation between each of the independent constructs (personal norms, social norms, attitudes, and perceived behavioural control) and intention. The path analysis results showed that the direct impact of personal norms and attitudes on intention were positive but statistically non-significant (b = 0.036, t = 0.403, p = 0.687 and b = 0.189, t = 1.860, p = 0.630, respectively) while the impact of social norms and perceived behavioural control on intentions was positive and significant (b = 0.285, t = 3.013, p =0.030 and b = 0.371, t = 3.646, p<0.001, respectively). Hence hypotheses 2 and 4 were supported which indicate the existence of a relationship between social norms as well as perceived behavioural control with intention. Hypotheses 1 and 3 were not supported, thus failing to support the existence of a relationship between personal norms as well as attitude with intention. This is summarised in Table 14 below.

Table 14

Hypotheses 1 to 4 Testing Results

Hyp	Hypothesised	Standardised	t-value	p-value	Decision

#	Relationship	Estimate			
1	Personal Norms →Intention	0.0360	0.403	0.687	Failed to reject H_0 Hypothesis not supported
2	Social Norms →Intention	0.285*	3.013	0.030	Rejected H_0 Hypothesis supported
3	Attitude →Intention	0.189	1.860	0.630	Failed to reject H_0 Hypothesis not supported
4	PBC →Intention	0.371*	3.646	<0.001	Rejected H_0 Hypothesis supported

Note. * means p<0.05, i.e. the relationship between Social Norms and Intentions as well as PBC and Intentions is significant within a 95% confidence level.

4.3.4.1 Squared Multiple Correlation

In addition, the squared multiple correlation (R^2) for intention was good at 0.58 which indicates that 58% of its variance can be attributed to personal norms, social norms, attitudes, and perceived behavioural control.

4.4 Results pertaining to Research Questions 2 & 3

Research questions 2 and 3 investigate the extent of knowledge that contractors actually possess in the subject of geyser efficiency technologies and whether there is a difference in the level possessed by those in the formal versus informal sectors (hypothesis 5) and whether the extent of the knowledge possession has any correlation to intention to use that knowledge to influence households positively (hypothesis 6). Two respondents who had not attempted the knowledge-based questions at all were removed from analysis in this section – reducing the sample size to 105. The knowledge-based question consisted of 10 questions that only had one right answer. Each correct answer scored a 10, thus bringing the total possible score to 100.

4.4.1 Descriptive statistics

The points scored by 3 of the respondents was the minimum of 0 and the highest points of 80 was scored by one respondent. The mean of the scores was 32 while the median was 30 which based on the basic questions on the questionnaire indicates a poor level of knowledge amongst the participants. A

minimum score of 0 was observed which means that the participant(s) would not have answered any of the questions correctly. The standard deviation is 17.8 as shown in Table 15 which indicates large dispersion among the participant scores. Given that the median and mean values are so close together, there were only a few participants who scored very high as shown in

Table **16** and therefore disproportionately enlarged the standard deviation.

Table 15

Descriptive Statistics for Scores

Descriptive	Statistic
Minimum	0
Maximum	80
Mean	32.3
Median	30
Standard deviation	17.8

Note. The mean and median of the scores is below 50% which is a poor with the minimum being a score of 0. The standard deviation is very large, indication a notable dispersion of the scores.

Table 16

Number of Respondents by Score

Score	0	10	20	30	40	50	60	70	80
No. of respondents	3	14	24	22	19	10	7	5	1
Total - respondents	82					23			
Total %	78%					22%			

The scores by formality are shown in Table 17. Although there were substantially more participants in the informal versus the formal sector, the mean scores are nearly identical and the standard deviations similarly very large. Hence irrespective of the sector, the overall knowledge levels seem to be very poor and largely dispersed.

Table 17

Descriptive Statistics for Scores by Sector (Formal Vs Informal)

Descriptive	Formal	Informal
No. of respondents	22	83

Mean	32.27	32.28
Standard deviation	18.75	17.62

Note. There are nearly 4 times more participants in the informal sector versus the formal sector. However, irrespective, the mean scores are nearly identical and the standard deviations similarly very large in both cases.

4.4.2 Hypothesis 5 results

Hypothesis 5 stated that there is no difference between the levels of knowledge held by formal contractors compared to informal contractors.

$$H_0: \mu_{formal} = \mu_{informal}$$

$$H_1: \mu_{formal} \neq \mu_{informal}$$

The two tailed test for equality of means generated a t-value of -0.004 and a p-value of 0.997 which is non-significant at a 95% confidence interval. Therefore, H_0 is not rejected, indicating that there is no difference in the levels of knowledge held by contractors in the formal and informal sectors.

4.4.3 Hypothesis 6 results

Hypothesis 6 stated that there is a correlation between contractors' knowledge or competence and their intentions to promote household energy efficiency technologies.

$$H0: \rho = 0$$

$$H1: \rho \neq 0$$

The Pearson correlation coefficient was calculated to be 0.310 which indicates a weak positive correlation. However, the two tailed significance test indicated that it is significant at a 0.01 level ($p < 0.001$) which means that H_0 is rejected. This indicates that the greater the knowledge, the higher the intention indicated to embrace an intermediary role and recommend energy efficiency technologies to households.

CHAPTER 5. DISCUSSION OF RESULTS

5.1 Introduction

This chapter discusses the results presented in chapter 4 considering the literature reviewed in chapter 2 along with additional insights drawn from other sources. Hypotheses 1 to 4 which relate to the testing of the simplified and reconfigured CADM which evaluated the influence of four constructs on intention will be discussed. This will be followed by the discussion related to hypotheses 5 and 6 which consider the knowledge that contractors possess about the relevant geyser efficiency technologies in this study.

5.2 Discussion pertaining to Research Question 1

The first four hypotheses sought to examine the relationship between personal norms, social norms, attitudes and PBC on contractors' intentions to behave in a way that would encourage or persuade households towards adopting add-on technologies that would improve the efficiency of their geysers.

5.2.1 Hypotheses 1

The mean and median of the sample contractor's personal norms was 2 (1 being the most agreeable to the underlying construct and 5 being the least agreeable) which represented a fairly strong declared sense of personal responsibility, obligation or duty, hence personal norm. According to (Klöckner & Blöbaum, 2010; van der Werff & Steg, 2015) the presence of this dynamic ought to trigger the plumbing and electrical contractors' intentions to positively influence households they work with to adopt more energy efficient geyser technologies. However, the path analysis shows that this relationship does not exist within the sampled group of contractors,

On the contrary, the path analysis results in the study conducted by van den Broek, Walker, and Klöckner (2019) testing the drivers of energy behaviour

among university students using the CADM revealed a very strong correlation between personal norms and intention, which was significant.

The abovementioned study corroborates the theory posited by the CADM where the relationship between personal norms and intention is positive, which may suggest that the non-significance in the results of the current study may possibly be due to other factors unrelated to the validity of the theory itself, i.e. sampling factors, particularly, sample size. Even though the sample size was calculated to be in line with accepted research standards, it was still (Kline, 2023) small according to other researchers (Collier, 2020; Hair, Ringle, & Sarstedt, 2011) and could have contributed to this deferring result. Other studies testing the CADM had considerably larger sample sizes at 247 (van den Broek, Walker, & Klöckner, 2019), 508 (Balundė, Jovarauskaitė, & Poškus, 2020) and 362 (Tang, Zhou, & Warkentin, 2022).

Be that as it may, the non-existent relationship in the sample observed between personal norms and intentions in this study is somewhat aligned with Owen, Mitchell, and Gouldson (2014)'s framework that noted that, in the context of energy efficiency adoption, the participants in their study had negative personal views towards this advisory activity as they felt that it did not align with their business priorities and motivations such as stability and employment security. That said, it is possible that the validity of personal normal as predictor of intention is context sensitive.

In the context of van den Broek, Walker, and Klöckner (2019)'s study which explored university students' energy saving behaviours in their residences, the activation of personal norms was limited by the fact, for some, the usage patterns for their dwellings were not controlled by them individually, but centrally by the mangers of the residences. For others, who did have greater control of their energy usage activities, their awareness of the extent of their energy usage was also limited by the fact they never got to see their bills. The energy bills were either already incorporated into their fees or were settled by someone else, e.g. parents. Hence, their sense of personal responsibility or duty is superficial, ideological at best– possibly linked to a greater cause such as climate change or pro-sustainability activism.

For contractors, on the other hand, there is myriad of considerations with serious, practical consequences to be considered which makes the personal norm activation towards intention more complex as a multitude of competing values come into play. The Likert scale results for personal norms reveal a score of over 60% being 1 and 2 for each of the four indicators indicating fairly strong agreement with the personal norm statements presented on the survey. So, while they may also hold ideological values related to climate change, sustainability energy security, conservation and cost, the other personal value such as not jeopardising their core business models, reputation, client relationships or job security by deviating their energy and resources to an intermediary role (Owen, Mitchell, & Gouldson, 2014) may supersede them. As a result, the predominant factors that make up the contractors' personal norms may not consistently be inclined towards an intention to take up an intermediary role.

For the van den Broek, Walker, and Klöckner (2019)'s students, however, the lack of personal consequences makes their personal norm activation towards intention risk free. It eliminates any other value that could compete and consequently weaken their personal activation towards intention. In this case, it may possibly reinforce their personal norm activation if they saw their bills and realised that they couldn't afford them without making some changes.

Regardless, the individual's position in relation to consequences if they choose to act in a particular way can also be observed in how energy advisors- who, like contractors, are also intermediaries- may have different inclinations compared to contractors. Energy advisors are generally employed by government or NGOs for the sole purpose of advising households and steering them towards energy efficiency (Laborgne, 2023; Mignon & Winberg, 2023; Zaunbrecher et al., 2021). So, for them, the intermediary role is not an add-on to their existing business models or job functions, and therefore runs no risk of compromising it – it is their core business or job function. With that, it is not unreasonable to assume that their default personal norm would be pro-energy efficiency intermediation and their intention would similarly be high as a matter of not just professional obligation, but personal conviction as well. This is noted

in Zaunbrecher et al. (2021)'s study that looked at intermediaries' roles in homeowners' energy efficiency retrofit decisions. Energy advisors were found to have somewhat higher personal standards and motivations in getting their clients to adopt more energy efficiency measures that were not necessarily observed among the tradesmen [contractors].

5.2.2 Hypothesis 2

Hypotheses 2 examined the impact of social norms on intentions. The results showed a significant but moderately weak, positive correlation to intentions (with a path strength of b = 0.285). This positive observation of social norms' influence on intentions reveals that contractors' external environments and influences has an important impact in swaying them towards desiring to play a positive role in advising households to adopt more energy efficient geyser technologies.

Again, the discrepancies in the above results and the CADM theory could perhaps be explained by the context. In the van den Broek, Walker, and Klöckner (2019) study for instance, the study sought to explore university student's energy saving behaviours in their residences. It noted that many of them likely had very little exposure to the external influences that would pressure them to behave in more energy saving ways, as, for some students, their energy usage is incorporated into their monthly rentals, and they do not have to pay it separately. For some who live in university residences, have restricted control in how energy in the residences is used in general. This predicament makes it difficult for them to measure their energy usage behaviours - whether they are being efficient or inefficient - and therefore have no reference to activate the sense of responsibility or duty to behave any differently. The lack of responsibility for their energy usage and associated cost takes away the awareness and experience of consequences of not being efficient, hence weakens the external economic pressure to behave more efficiently. Hence, social norms would logically be a non-significant driver in their energy behaviours.

For contractors in this study on the other hand, legislative and social influences that seek to enforce energy efficiency behaviours are more pronounced. The SANS 204 (2011): *Energy Efficiency in Buildings* standard makes clear reference to expected insulation requirements for geysers (South African Bureau of Standards, 2011) while MEPS prohibits manufactures from selling geysers that have standing losses exceeding some predefined limit for different size geysers within a 24-hour period (Johnson et al., 2013). The 2016 amendment of VC 9006 requires all sold geysers to have a minimum rating of Class B (Department of Trade and Industry, 2016) and must be labelled with the South African efficiency Label that indicates its energy efficiency class, the standing losses over a period of 24 hours and its rated capacity (Department of Mineral Resources and Energy, 2023). While the insulation requirements and efficiency rating happen before the contractors' locus of control, the selection of the best geyser to purchase lies on their shoulders and the labelling requirements provides crucial information to enable them to ascertain the relative efficiency of one geyser and another.

In addition, the constant loadshedding schedules and Eskom pop-ups on local television stations continually remind end users of the significant draw of electric geysers on the national grid. All the above are external factors that build into the social norms within which contractors operate, and their consistent messaging towards more efficient energy usage logically explains why it is plausible in this study that social norms are a significant and valid predictor of intentions to pursue more energy efficient geyser technologies in their work with households.

While the *Cost-benefit analysis of energy efficiency in urban low-cost housing study by* Winkler et al. (2002) and the Department of Energy (2015)'s household energy survey found that many households do not have spare funds to invest upfront in energy efficiency (which mostly referred to more capital intensive options such solar geysers or heat pumps), the add-on energy efficiency technologies of concern in this study are worth a fraction of the cost of these, and therefore cut away at the argument that energy efficiency adoption may not be feasible without subsidies. In fact, it is possible that the rising cost of energy could be at a place where households may consider these add-on technologies

as viable energy saving tools, and contractors may feel confident that advising households about them would yield positive responses. This may not only be an improvement in their motivation to comply (an element of the social norm construct), but an area that also enhances contractors' confidence of success if they do take up this advisory role, i.e. perceived behavioural control.

5.2.3 Hypotheses 3

Like personal norms, the results for correlation between attitude and intentions is non-significant (with the path strength of b = 0.189) at a confidence level 95% which indicates that there is insufficient statistical evidence to infer that this relationship exists among plumbing and electrical contractors.

However, overall, the results show a strong positive attitude towards an intermediary role as responses with 1 and 2 in the Likert scale constituted more than 70% for all 5 indicators. This is contrary to the negative attitude noted in the Owen, Mitchell, and Gouldson (2014), Wade, Murtagh, and Hitchings (2018) and (Zaunbrecher et al., 2021)'s studies. The reasons for the seemingly different attitudes that the intermediaries in these two studies expressed compared to the overwhelming positivity evident in the current study perhaps lies in the research methodologies used. The questions in this study were in the form of a questionnaire and by design had to be simple and easy to understand which unintentionally sacrifices depth, detail and nuances of a participant's response. As such, the questions were narrow and to some extent, hypothetical – asking whether they felt or perceived that promoting more energy efficient geyser technologies was important or unimportant; good or bad; harmful or beneficial; effective or not effective and favourable or unfavourable as shown in Table 6. On the contrary, the other studies employed interviews from which they were able to draw more detailed responses. Participants were able to express themselves in their own words and were not restricted by a preselected list of choices, hence provided more reliable and representative results of the participants' true perceptions or views.

Nevertheless, these questions represent the more cognitive and affective aspects of the different aspects that (Manstead, 1996) theorises come together

to form attitude, i.e. cognitive, affective and behavioural perceptions. In the other studies, however, the negative attitudes expressed in interviews are rooted, not in the cognitive or affective processes, but in the behavioural process, i.e. the practical considerations or consequences of pursuing energy efficiency promotion on their businesses. For instance, being seen as a nuisance to their clients by forcing something they are not interested in, being fearful due to lack of confidence in the technologies or their knowledge of them or not wanting to waste time they could be using to safeguard the stability of their core businesses.

Little insight is given as to whether their attitudes would still be negative if it were assessed purely through the lenses of the cognitive and affective paradigms disjointedly. For instance, it is possible for them to consider this intermediary role with a positive attitude if they believed households would become more energy efficient as a result. However, it is also possible for some to retain their negative attitudes (irrespective of how households respond) if they believe that the action wouldn't improve their personal or business goals (Owen, Mitchell, & Gouldson, 2014).

Ajzen and Madden (1986) assert that the formulation of the construct of perceived behavioural control can be influenced by "second-hand information" and the experiences of external people that individuals interact with. There is no reason why this reasoning cannot similarly be applied to the formulation of attitude. Since beliefs concerning consequences of a particular behaviour are thought to shape attitude, it is possible that negative consequences to their businesses reported by other contractors may deter them from pursuing this course of action too and cause them to hold a negative attitude towards the action, even though, objectively, they believe that the action is good. That is, the role of an intermediary is good in light of the principle of improving energy efficiency - just as long as it is not done by them personally. It is therefore possible, that while attitude is positive from an ideological perspective, the awareness of negative behavioural consequences may have diluted the positive cognitive and affective attitude responses resulting in an overall inconsistency towards intention. While no formal intermediary work of this nature is known to

be taking place in South Africa or with the current study's participants, it is possible that their previous experiences in other tasks may have also led them to anticipate obstacles should they embark on this intermediary work.

5.2.4 Hypotheses 4

Perceived behavioural control showed a significant relationship to intentions (with a path strength of b = 0.371). The mean composite score for participant responses was a 2 which indicates a strong perceived behavioural control amongst the contractors. This aligns with observations that showed increasing numbers of new entrants into the plumbing and electrical sectors between 2013 and 2017 (Skills Development for a Green Economy, 2019b). Logically, the only way that new entrants would enter the field would be because they feel that they have what it takes to do the work of a plumber or electrician and that it is within their control to attain the desired outcomes in their respective tasks. This points to the existence of a high sense of perceived behavioural control generally among contractors in the plumbing and electrical trades.

It is perhaps plausible to conclude that the same general sense would spill over to the energy efficiency intermediary role, being perceived simply as another task – no different to the other tasks they have been taking on in these fields. Contractors in South Africa have not yet been adequately tested in this area; they have not had enough experiences installing the energy efficiency technologies successfully or unsuccessfully; or have them yield or not yield the expected results; and as a result, they have no reason to doubt success.

In the van den Broek, Walker, and Klöckner (2019) study, however, which explored university student's energy saving behaviours in their residences, the students had little access to the effects of their energy behaviour on energy consumption i.e. limited confirmation ability of positive or negative outcome, hence little behavioural control. For them, a sense of lack of behavioural control was not hypothetical – based on an activity that they had to imagine and therefore try to predict whether it would be within their control or not, to do. It was a reality. So, the fact that the relationship between PBC and intention was non-significant, isn't surprising. Only their lack of PBC in influencing intention

may not stem from lack of ability to do the actions, rather the inability to see the impact of what they do.

Nevertheless, the lack of outcome visibility was found to have no impact in a German study where tradesmen expressed high optimism about the impact of their energy efficiency recommendations regardless of the fact that they usually do not see the households again after a consultation (Zaunbrecher et al., 2021). In fact, it was noted that their high confidence was not limited to the effectiveness of their recommended measures but prevailed in the general perception of their influence on the households' decisions to adopt or reject what they recommended or condemned, respectively. This perception of their inherent power to influence was also observed among contractors in Belgium (Decuypere et al., 2022).

With that, perhaps the confidence for contractors to achieve positive outcomes isn't dependent on the experience with a specific task directly but comes from gradual emboldening derived from success with a variety of tasks in the field and with successful persuasion of customers. The relevance of Guibentif and Patel (2023)'s model as shown in Figure 10 in capturing the multidimensional functions that are necessary to bring about a holistic and sustainable EE programme come to the fore, highlighting soft skills such as communication, persuasion, coordination skills. Perhaps, contractors' inherent knowledge of this and their professional experiences using a broad array of skills to gain households' trust and leverage their emotions as highlighted by Biswas et al. (2024) and Bobrova et al. (2024) is what gives them their confidence.

5.3 Discussion pertaining to Research Question 2 and 3

Research questions 2 and 3 dealt with the level of knowledge held by contractors relating to energy efficient geyser technologies. In hypotheses 5, it was stated that there would be no difference in the levels of knowledge between those contractors in the formal versus informal sectors, while hypothesis 6 stated that whatever the status of that level of knowledge may be, it would be

positively correlated with their intention to promote energy efficient geyser technologies to households.

5.3.1 Hypothesis 5

The null hypothesis 5 stated that there is no difference in the level of knowledge held by contractors in the formal or informal sectors. The mean score in the knowledge related questions was 32.27 and 32.28 (out of 100) for contractors in the formal and informal sectors, respectively. The hypothesis testing results for equality of means was non-significant (t-value = -0.004 and a p-value = 0.997) which Indicates that there is no difference in the knowledge level of formal and informal contractors.

Such poor results related to questions which assessed contractors' knowledge of basic concepts such as the mechanism that geysers employ to heat water, the temperatures, time and units of measurement involved; are a clear indication of the lack of explicit knowledge which is generally gained through formal education. This clearly cannot be made up for by the tacit or experiential knowledge of simply knowing how to, for instance, install a geyser, without knowing the theory or background as to why certain nuanced things are done in a specific way.

That said, one would have expected the contractors in the formal sector (who are more likely to be qualified as formality exposes a business's existence to the prying eyes of all manner of regulators and law enforcers) would have scored higher than their informal sector counterparts. However, drawing from the PIRB inspections conducted in 2017 that found high rates of plumbing installation non-compliances and certification assessment failures among already qualified plumbing who were pursuing the PIRB certification (Plumbing Industry Registration Board, 2017); this is clearly not so. In fact, the high non-compliance rate of geyser installations in the national geyser installation audit further paints a grim picture (Plumbing Industry Registration Board, 2023), even though it cannot be determined what the qualification statuses of the installers in the affected cases were.

Insight to the low knowledge levels among formal and informal contractors in South Africa can be largely explained by the general lower education levels. Firstly, the plumbing industry recognises self-reports (as did this study) for the classification of individuals as plumbers and not necessarily their qualifications or certification. This makes it possible for not just unqualified people, but people with potentially very little explicit knowledge of the work they do, to be recognised as acceptable and legitimate members of the industry. On the other hand, it is illegal to work on electrical installations without the necessary qualifications (Skills Development for a Green Economy, 2019c), and this should theoretically eliminate unqualified electrical contractors. Yet, there were several electrical respondents who participated in this very study who were going about their electrical work even though they had indicated not having a trade test (although there are other acceptable qualifications beneath trade test not captured in the survey).

For the qualified - whether working in the formal or informal sector – who has undergone formal training, this poor knowledge on energy efficiency technologies related to geysers can possibly be explained by the fact that at TVET level, the curriculum for plumbing, for instance, is vague about what should be taught in relation to energy efficiency (Institute of Plumbers South Africa & Quality Council for Traders and Occupations, n.d.). Thus, it is up to each training institutions' discretion to determine what topics get covered in their curriculum. Furthermore, the quality of what does get taught in TVET institutions in general, is itself, under harsh criticism (Windapo, 2016), with Nkambule and Ngubane (2023) actually noting a "culture of public mistrust in TVET College Education". In fact, not only is the level of education and skills taught in TVET colleges believed to be poor, but low student performance or success rates are observed as well (Makole, Moeti, & Ntshangase, 2023; Nkambule & Ngubane, 2023). Consequently, the education of the formally educated contractor possibly gets devalued and essentially renders their level of knowledge no superior to that of the learn-on-the job, informally trained contractor. This may explain the views held by those electrical and plumbing contractors who do not see value in TVET colleges.

Be that as it may, the failure of the TVET college systems in general is a complex matter as higher education institutions have limited ability and resources to be continuously adding on to their curricula every time a new technology enters the market. Hence, they are intended to focus on imparting the fundamental skills core to students' respective fields of study. Imagine if the duration of college programs got longer and longer as they scrambled to cover all the fundamentals of the fields plus expose learners to all the varying and ever-evolving technology developments in those fields. Firstly, not only would the cost associated with longer programs increase but affordability would decrease, resulting in fewer people completing or even attempting them - thereby adding to the problem of unregulated informal sector participation. Secondly the deficit in the labour market as new qualified entrants take longer and longer to enter may also result in increased, unqualified, informal sector participation. Formal higher education systems must, therefore, as a matter of necessity, maintain their focus on the core fundamentals of each field and let the workplace or professional training and development programs take over further development once participants enter the world of work. With that in mind, it is justifiable to assert that the deficiency in TVET colleges' energy efficiency coverage, is only partly to be blamed for the qualified contractors - whether in the formal or informal sectors - being undifferentiable in their knowledge of energy efficiency geyser technologies.

Yet, even though opportunities do exist for contractors to upskill themselves and keep up with technological and regulatory changes through privgate training, supplier/product training and trade specific professional bodies continuous development programmes – some contractors reject it due to time and resource constraints (Zaunbrecher et al., 2021). This is understandable as taking time out for training often means a loss of potential income as individuals are physically not at work and therefore cannot generate any income.

However, others simply aren't interested in formal training at all and prefer in-house training (Skills Development for a Green Economy, 2019a, 2019b). The problem with the exclusive use of this type of training is that on-the-job training relies on experience and knowledge being passed down from older, more

experienced personnel to the younger inexperienced newcomers. Such experiences or long- ago acquired knowledge fails to keep up with changes in standards of working, regulation, and new technologies – which cannot be attained unless individuals avail themselves to formal platforms of knowledge exchange and dissemination. This is evident in the knowledge-based questionnaire results that demonstrated that the majority of contractors (which consisted of 78% informal sector participants) are not familiar with current technologies that can be used to address energy efficiency challenges related to geysers.

What is particularly pertinent about this is that in technical scopes, new ways and standards of working not only occur to address obsoletion of existing technologies or introduce new technologies and standards of working, but they may also do so to address potentially unsafe products and processes (Salama, 2023). Notably, some of the products and ways of working may very well have been considered best practices at some point in the past, but through experience, get deemed unacceptable in light of new standards of working and safety.

This dynamic is no different with geysers as the plumbing compliance standard that deals with the installation, replacement and repairs hot water systems, has been reviewed approximately four times between 2011 and 2021 (Plumbing Industry Registration Board, 2021) with the most recent amendment finalised in June 2022 (Insititute of Plumbing South Africa, 2022). This demonstrates the effort placed on establishing frameworks to regulate and standardise the way work is carried out in the industry. Whether the standards diffuse into the industries or not, ultimately, failure to acquire new knowledge and keep with up changes related to equipment that contractors work with poses challenges for new opportunities such as having them act as intermediaries or champions for energy efficiency promotion towards households as is the focus of this study. Not only that, but more significantly, non-complaint installations resulting from practices that have been phased out can have serious safety and financial repercussions for end-users (Khabele, 2022; Salama, 2023).

5.3.2 Hypothesis 6

The hypothesis stated that there would be a positive correlation between contractors' knowledge and their intentions to promote household energy efficiency. The results revealed that a positive correlation does exist (though moderately weak at $\rho = 0.310$), and therefore could be inferred to the wider population of electrical and plumbing contractors in the study.

This result is consistent with the literature that suggests that knowledge and competency are one of the core elements that ultimately lead to the formulation of intention to engage in a particular behaviour (Bandura, 1997; Bandura & Schunk, 1981; Williams, 2010). According to the TPB and CADM (Klöckner & Blöbaum, 2010; Manstead, 1996), these intentions are in turn, a core determinant of the desired behaviour.

This phenomenon is observed in the results of the surveys conducted by the Department of Energy where, not just the intention to engage in energy efficiency behaviours was observed among respondents with higher education levels, but the action itself. Although plumbing and electrical contractors were not the subject of focus in the Department of Energy (2013)'s survey which assessed the general residential sector's energy related behaviours and perceptions, the study found that people with a tertiary education were nearly three times more likely to be aware of energy saving strategies/technologies in comparison to people with no formal education, and adoption rates were also higher amongst them (Department of Energy, 2015).

That said, there remains a high sense of self-efficacy that seems to exist among electrical and plumbing workers evidenced by the high numbers of new informal sector entrants increasing despite low levels of underlying formal competency or qualification 2017 (Skills Development for a Green Economy, 2019b). This means that although the formal education may not be evident, there must be another form of knowledge present to fuel intention. That is, the level of knowledge informally acquired through in-house approaches may actually be correct enough times when put into practice to produce positive outcomes. According to Bandura (1997) and (Maddux, Norton, & Stoltenberg, 1986), it is

positive outcomes (or at least, the perception of it) that reinforces self-efficacy and encourages behaviour.

However, the question of the assessment of the outcome as being positive or negative, is relative. To the standards, legislation and reinforcing bodies, an installation may be non-complaint or not be up to standard, hence a negative outcome is observed. However, to a plumber or electrician who has a happy client because they have running hot water - for that same installation, the outcome may be satisfyingly positive.

Plumbing systems, even with inherent non-compliances, can exist for years (Van Zyl et al., 2008) without resulting in any catastrophe that would expose them. Case in point, is the PIRB's national geyser audit that found that an overwhelming majority of installations were not compliant (Plumbing Industry Registration Board, 2017, 2023). Where catastrophes do occur, the household may themselves be so uninformed or unknowledgeable about what the correct standards should be, that the non-compliance that caused the catastrophe is dismissed as a typical geyser burst or another leaking or noisy pipe. What this ultimately means is that the lack of immediate exposure of substandard installations, provides a false confirmation of positive outcome and reinforces confidence in the incomplete or even wrong knowledge about a task and therefore perpetuates a sense of self-efficacy. Ultimately, since behaviour is influenced and reinforced by its consequences (Bandura & McClelland, 1977; Maddux, Norton, & Stoltenberg, 1986), the apparent success or lack of immediate negative consequences, keeps the contractors' intentions positive.

This phenomenon is confirmed in the German study where tradesmen expressed high optimism about the impact of their energy efficiency recommendations even though they never see the households again to confirm if the outcome was indeed, positive (Zaunbrecher et al., 2021). Hence, contractors may walk away from a task with a sense of a successful job, whether it was actually up to standard or not. The fact that they are not aware on any shortcomings, belief that whatever level of knowledge they possess gives them success, remains intact.

That said, the overall knowledge results on geyser efficiency technologies were extremely poor with only 22% of respondents scoring 50% and above, while intentions were strong with more than 70% of respondents scoring 1 and 2 on the Likert scale indicators. This further corroborates this notion that the true state of knowledge or competence isn't what builds self-efficacy and intention, but what the respondents believe they know. That is, the reason for the correlation being weak may have been the fact that individuals with low knowledge scores also expressed high intentions, thereby diluting the strength of the correlation.

Nonetheless, while the finding of intention being high is a great outcome from this study, the fact that the underlying knowledge backing this intention is poor, is not. The electrical fraternity uses a certificate of compliance to ensure that work is done correctly. This is a common requirement used by insurance houses, municipalities all over South Africa, and is also sometimes expected and demanded by businesses and households getting electrical work done. The PIRB, seeing the disfunction in the plumbing sector, attempted to implement a similar certificate of compliance system which the government adopted into the SANS 10254 standard in 2011/12 and subsequently reversed in 2023 (Ryan, 2023). According to the PIRB, the main reason for the reversal was that the municipalities who are required to enforce adherence do not have the capacity to do so. While nothing stops the PIRB from continuing with the issuance of the same COC, their hold remains only over qualified plumbers (as registration with them is only available to qualified plumbers). This leaves the majority of the plumbing sector without a quality assurance mechanism.

If the government or other regulatory bodies are not able to police correct implementation and functioning of basic plumbing installations, what hope is there for add-on endeavours such as energy efficiency technologies? What will the implications an industry with virtually non-existent quality check mechanisms be on energy efficiency technologies? Installations that are implemented incorrectly or improperly explained to the end-users would fail to yield the expected result and completely undermine energy efficiency initiatives or possibly destroy them.

CHAPTER 6. CONCLUSIONS & RECOMMENDATIONS

6.1 Introduction

In this chapter, conclusions relating to the three research questions presented in chapter 1 will be drawn based on the findings from the research conducted. Recommendations will then be made and suggestions for further research to explore gaps identified in this study will also be highlighted.

6.2 Conclusions regarding research question 1

The first research question sought to explore the factors that would influence contractors' intentions to play an intermediary role in influencing households to adopt energy efficiency technologies to improve the overall energy efficiency of their geysers. This was done using a reconfigured CADM which postulates that there are four main constructs that directly influence intention, i.e. personal norms, social norms, attitudes, and perceived behavioural control. As such this research question asked: "*How do personal norms, social norms, attitudes and perceived behavioural control affect contractor's intentions to promote the use of geyser efficiency technologies?"*

The proposed hypotheses stated that there is a positive correlation between each of the constructs and intention. Data was collected using Likert scale questionnaires for each of the constructs and intention and analysed using structural equation modelling path analysis. The results did not support that personal norms and attitude have a direct influence on intention, respectively (hence the hypothesis that a correlation exists between them was rejected). However, it supported social norms and perceived behavioural control, respectively having a direct influence on intention (hence, the hypothesis that a correlation exists between them was not rejected).

For personal norms, it was found that the complexity of considerations and competing values that shape the formulation of personal norms and ultimately influence intention may have not been strong or consistent enough to support

intention. It was found that taking up a more deliberate and active intermediary role may conflict with their core priorities such as business stability and employment security as it requires more effort and time that would otherwise be spent on securing the said primary interests. The overall presence of strong personal norms among the surveyed participants indicated that perhaps their held ideological views to support energy efficiency invoked by a sense of personal responsibility and duty. However, the awareness of consequences of not behaving in support of that sentiment may be overpowered by the perceived negative consequences of actually doing so. That is, the potential risk of jeopardising their core businesses or job security by diverting their energy and resources to such an intermediary role. Thus, ultimately tipping the scale against intention to act as intermediary.

A similar conclusion regarding attitude, and the fact that the results showed no relationship between attitude and intention, is drawn. That is, while the participants demonstrated strong positive attitude towards energy efficiency intermediary roles, the research instrument tested ideological beliefs, and was not able to adequately capture behavioural perceptions related to it. Hence, any possible awareness or reasoning about negative consequences that may arise as a result of participating in this intermediary action may have diluted their overall drive towards intention.

Overall, in this study neither personal norms nor attitudes affected intention. It is suggested that this was due to the potential negative consequences of pursuing the behaviour. This highlights the significance of practical considerations over ideological or theoretical ones.

For social norms, it is concluded that the existence of external pressures to reduce energy usage in South Africa, arguably in light of the current Eskom power supply crisis, has been effective in shaping contractors' drive towards actively participating in promoting energy efficiency. The new regulations that have come into effect from 2011 to date - particularly the colour coded energy labels - provide immediate awareness to contractors about the energy efficiency classification of the geysers they choose and whether that is considered good or not. Furthermore, the rising cost of energy and general pressure that

households find themselves in may possibly, also be a motivator for contractors to see energy efficiency intermediary roles as necessary inclusions in their portfolios.

Lastly, perceived behavioural control appeared to not be rooted in the evidence of a positive outcome derived from performing a specific technical task successfully or reduction in a customer's energy consumption as a result of adopting a recommended solution. However, it seems to come from an intrinsic sense of belief that their recommendations work because they have never been told or experienced otherwise. Although, neither specific failures nor successes have been confirmed, their general sense of perceived behavioural control stems from the general success and trust they enjoy with households in their other tasks. The technical inadequacies alone, confirmed or not, seem to get minimised by the confidence that contractors derive from the other soft skills that they possess to win customers, as they have clearly been successfully doing. Otherwise, they wouldn't be in business anymore.

6.3 Conclusions regarding research question 2

The expectation that there would be a difference between formal and informal contractors in terms of knowledge stems from the likelihood that formal sector participants are more likely to be qualified. However, no difference was found. This was attributed to the general poor state of TVET education and non-specific focus on energy efficiency technologies, rendering their graduates not superior in knowledge about energy saving technologies to the informal sector participants who are predominantly not qualified and learn on the job.

In addition, contractors across the board seem to struggle with time and resources to invest in continuous learning activities, as the time taken to attend a training or trade fair means an absence from the business or work, and thus a loss of income generating activities. Hence, this failure to engage more meaningfully in private or professional body continuous development programs also keeps them from accessing new knowledge and keeping abreast of new technologies and changes in regulatory standards.

6.4 Conclusions regarding research question 3

Where the relationship between knowledge and intention is concerned, the results showed that the level of knowledge does have a positive correlation to intention, although it was weak. It was concluded that this weakness may be due to the absence of mechanisms that provide immediate feedback in terms of the contractors' work or effectiveness of recommended technologies. This lack of feedback, partly exacerbated by uninformed households who cannot themselves tell if a job is up to standard or not, gives contractors a heightened sense of confidence in whatever knowledge they think they possess - even if it is not necessarily correct. As a result, contractors maintain a positive sense of intention even though their true levels of knowledge may be poor.

6.5 Recommendations

6.5.1 Certificate of compliance or other quality feedback mechanisms

Whilst the government has rejected putting the PIRB's certificate of compliance into regulation, it needs to consider other forms of quality feedback mechanisms to ensure not only compliance to basic plumbing standards and practices, but evolutions in technology within the industry. While at it, it also needs to develop or support and encourage other professional bodies or interested parties to develop similar mechanisms for energy efficiency related work.

6.5.2 Incremental approach to qualifications through piecewise certifications

The government should also consider different classes of qualifications for the plumbing sector as what exists in the electrical trade where different levels of certification that grant holders different levels of permissions of installations to work on. For instance, geyser installation or the applicable energy efficiency technologies could be a single area of certification. Once an individual has completed a certain predefined number of modules that are covered in the general plumbing trade, they would be eligible to do a trade test and become a

qualified plumber. Instead of trying to have a single, costly and lengthy qualification, the government would make it easier and cheaper for individuals to achieve piecewise certifications in different areas of work. Ultimately, this would slowly reduce the number of activities where work is done by unqualified personnel and consequently reduce substandard work in general.

6.5.3 Include geyser efficiency content in TVET curriculum

Geysers are critical pieces of equipment in the residential sector for both households and power suppliers. For households, from a high energy consumption, hence cost and therefore energy vulnerability perspective. For the power supply utilities, from an energy demand and grid stability perspective. With that, government needs to consider reviewing academic curricular especially at TVET colleges to integrate an energy focus in all practical study areas. This will sensitise future electricians and plumbers of the importance of energy efficiency in the greater national energy security agenda as well personal energy vulnerability mitigating perspective.

The approach should be such that electricians and plumbers going through TVET education see energy efficiency advising as a default part of their future roles as contractors and not add-ons, as has been the case with many studies reviewed in this research, including this one. The strategic position of contractors ought to be highlighted as much as possible in the curriculum to engrain a sense of responsibility and duty in them regarding the education and persuasion of end-users (households) to become more energy efficient.

With that said, government ought to consider creative ways of disseminating energy information and expanding energy literacy in the residential sector above and beyond reliance on the contractors in order not to weigh them down and completely derail them from their core trade work.

6.5.4 Energy Literacy campaigns and programs

The government should invest time, effort and resources in building energy efficiency information and educational programs as the primary source of

information for households. These should be the core information and educational mechanisms, with contractors merely supplementing them by providing additional information and advice to secure energy efficiency adoption decisions at the coal face, via household consultations.

While some countries have employed individual energy advisors to conduct training and do household visits and others run more structured, project like programs, it is recommended that South Africa chooses the latter approach. Individual energy advisors employed by a single municipality that services a particular community in a specific location are likely to be more costly and riskier in terms of labour relations in the sense of either being on contract versus being permanently employed. In the event that they are on contract and their services are required for a prolonged period of time, permanent employment may become demanded. On the hand, if the energy efficiency education programs reach maturity and are no longer required, retrenchments may become unavoidable, leaving the employers in a difficult position as retrenchments and are not easy domains to navigate in the South African labour market. Alternatively, project structured programs may be more flexible in that roles can adapt and evolve with whatever project is undertaken; in whatever location the project is required.

While the general programs targeting households should be simple, creative, and easy to understand, government should design more in-depth training programs for contractors to ensure they are able to perform the necessary calculations for energy savings and associated costs to enable them to deal with more difficult households. They should consider structuring short 45 minutes to 1 hour, after-hours, online training sessions in order to not interrupt their daily businesses or work routines. To attract them to give up their time to attend these training sessions, government should consider incentives such as tool giveaways, hardware store vouchers, etc.

6.5.5 Partnering with businesses and professional bodies

As part of these energy education campaigns, the government should seek partnerships with large retail hardware businesses and manufacturers of

relevant efficiency technologies and equipment to provide demonstrations and training at the retailers' premises. This will ensure wider reach of not just households, but also contractors as well. It would also be an opportunity for manufacturers to market their products. The involvement of government is crucial because education is not generally the priority of contractors, businesses, or manufacturers. However, if opportunities where the effort, resources and costs for educating the market can be shared, and businesses and manufacturers can get exposure for their products while at it, it is very likely that they would come to the table.

For the design of these training sessions and materials, government could partner with professional bodies such as IOPSA, ECA(SA) and bring in the expect organisations specifically in the field of energy efficiency such as the NCPC-SA, the SAEEC or the AEE.

6.6 Suggestions for further research

An area of further research identified in this study is to investigate whether the low investment in continuous development programs is purely due to the time and resource constraint or a general distaste for their services. Perhaps, the bad reputation prevalent for TVET colleges gives all other private or organised forms of education a similar bad reputation.

Another area of further research is the accessibility of the geyser efficiency add-on technologies in the market. Are they readily available in general hardware, plumbing and electrical outlets that ordinary people go to for their day-to-day hardware needs? If they are not easily accessible, could this impact the level of knowledge that they would hold about them? Conversely, could the low levels of knowledge about them be the reason that general hardware, plumbing and electrical outlets do not stock them readily? If they are readily available, then why would the knowledge levels about them be as low as what has been observed in this study?

That said, and to bring this report to a final conclusion, the observations made in this study are based on an imperfect research methodology largely as a consequence of a heavily informal electrical and plumbing sector. As a result, the research had several limitations including the fact that sampling was convenience and snowballing which could not yield a representative sample of the Durban contractor population and therefore weakened the generalisability of the findings.

REFERENCES

Acikgoz, F., Filieri, R., & Yan, M. (2023). Psychological predictors of intention to use fitness apps: The role of subjective knowledge and innovativeness. *International Journal of Human–Computer Interaction, 39*(10), 2142-2154.

Ajzen, I., & Madden, T. J. (1986). Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavioral control. *Journal of experimental social psychology, 22*(5), 453-474.

Aniello, G., & Bertsch, V. (2023). Shaping the energy transition in the residential sector: Regulatory incentives for aligning household and system perspectives. *Applied Energy, 333*, 120582.

Balundė, A., Jovarauskaitė, L., & Poškus, M. (2020). Exploring adolescents' waste prevention via value-identity-personal norm and comprehensive action determination models. *Journal of Environmental Psychology, 72*, 101526.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, USA: W.H. Freeman and Company.

Bandura, A., & McClelland, D. C. (1977). Social learning theory. In R. A. Falk & S. S. Kim (Eds.), *The war system. An interdisciplinary approach* (Vol. 1). New York, USA: Routledge.

Bandura, A., & Schunk, D. H. (1981). Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. *Journal of Personality and Social Psychology, 41*(3), 586.

Biswas, S., Fuentes, T. L., McCord, K. H., Rackley, A. L., & Antonopoulos, C. A. (2024). Decisions and decision-makers: Mapping the sociotechnical cognition behind home energy upgrades in the United States. *Energy Research & Social Science, 109*, 103411.

Bobrova, Y., Papachristos, G., Chiu, L. F., Tikhomirova, S., & Coon, T. M. (2024). Home for the common future (HCF): The use of home-meanings to promote domestic energy retrofit. *Energy Research & Social Science, 107*, 103358.

Boone, H. N., & Boone, D. A. (2012). Analyzing likert data. *Journal of extension, 50*(2), 1-5.

Booysen, M., Engelbrecht, J., & Molinaro, A. (2013). *Proof of Concept: Large-scale monitor and control of households water heating in real-time*. Paper presented at the International Conference on Applied Energy, Pretoria, South Africa.

Booysen, M., Engelbrecht, J., Ritchie, M., Apperley, M., & Cloete, A. (2019). How much energy can optimal control of domestic water heating save? *Energy For Sustainable development, 51*, 73-85.

Booysen, M., Nel, P., & van der Merwe, B. (2016). Energy Perceptions in South Africa: An Analysis of behaviour and understanding of electric water heaters. *Energy For Sustainable development, 32*, 9.

Bordass, B., & Leaman, A. (2013). A new professionalism: remedy or fantasy? *Building Research & Information, 41*(1), 1-7.

Bouzarovski, S., Damigos, D., Kmetty, Z., Simcock, N., Robinson, C., Jayyousi, M., & Crowther, A. (2023). Energy justice intermediaries: Living Labs in the low-carbon transformation. *Local Environment, 28*(12), 1534-1551.

British Petroleum. (2019). *BP Statistical Review of World Energy*. Retrieved from https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2019-full-report.pdf

Catherine, Q. (2009). *Effective geyser management through intelligent hot water usage profiling.* (Magister Technologiae). Cape Peninsula University of Technology,

Catherine, Q., Wheeler, J., Wikinson, R., & Jager, G. d. (2012). Hot water usage profiling to improve geyser efficiency. *Journal of Energy Southern Africa, 23*(1), 7.

Chandel, S., Sharma, A., & Marwaha, B. M. (2016). Review of energy efficiency initiatives and regulations for residential buildings in India. *Renewable and Sustainable Energy Reviews, 54*, 1443-1458.

Chiu, M.-C., Kuo, T.-C., & Liao, H.-T. (2020). Design for sustainable behavior strategies: Impact of persuasive technology on energy usage. *Journal of Cleaner Production, 248*, 119214.

Chun, J. (2023). *New roles for intermediaries: the case of community-owned solar energy development.* Massachusetts Institute of Technology,

Collier, J. (2020). *Applied structural equation modeling using AMOS: Basic to advanced techniques*: Routledge.

Construction Industry Development Board. (2011). *Construction quality in South Africa; A client perspective*. Retrieved from http://www.cidb.org.za/publications/Documents/Construction%20Quality%20in%20South%20Africa%20-%20A%20Client%20Perspective.pdf

Creswell, J. W. (2012). *Educational research: Planning, conducting and evaluating quantitative and qualitative research* (P. A. Smith Ed. 4th ed.). Boston, USA: Person Education.

Daae, J., & Boks, C. (2015). A classification of user research methods for design for sustainable behaviour. *Journal of Cleaner Production, 106*, 680-689.

Decuypere, R., Robaeyst, B., Hudders, L., Baccarne, B., & Van de Sompel, D. (2022). Transitioning to energy efficient housing: Drivers and barriers of intermediaries in heat pump technology. *Energy Policy, 161*, 112709.

Department of Energy. (2013). *A survey of energy related behaviours and perceptions in South Africa*. Pretoria, South Africa

Department of Energy. (2015). *South Africa's energy efficiency targets: Second Annual monitoring report*. Pretoria, South Africa

Department of Energy. (2019). *Integrated resource plan*. Pretoria, South Africa

Department of Mineral Resources and Energy. (2023). Storage water heaters. Retrieved from https://www.savingenergy.org.za/asl/consumers/storage-water-heaters/index.html

Department of Statistics South Africa. (2017). *Measuring informality in SA*. Pretoria: Department of Statistics South Africa Retrieved from http://www.mile.org.za/QuickLinks/News/PresentationsILO%20IE%202018/Day%201-Stats%20SA-%20Measurement%20of%20informality%20in%20SA%20.pdf

Department of Trade and Industry. (2016). Compulsory specifications for geysers amended. Retrieved from https://legal.sabinet.co.za/articles/compulsory-specifications-for-geysers-amended/

Dolšak, J. (2023). Determinants of energy efficient retrofits in residential sector: A comprehensive analysis. *Energy and Buildings, 282*, 112801.

du Plessis, C., Irurah, D., & Scholes, R. (2003). The built environment and climate change in South Africa. *Building Research & Information, 31*(3-4), 240-256.

ESKOM. (n.d.). Switch off your geyser. In ESKOM (Ed.).

Fishbein, M., & Ajzen, I. (2011). *Predicting and changing behavior: The reasoned action approach*: Taylor & Francis.

Frankowski, J., & Herrero, S. T. (2021). "What is in it for me?" A people-centered account of household energy transition co-benefits in Poland. *Energy Research & Social Science, 71*, 101787.

Gram-Hanssen, K., Heidenstrøm, N., Vittersø, G., Madsen, L. V., & Jacobsen, M. H. (2017). Selling and installing heat pumps: influencing household practices. *Building Research & Information, 45*(4), 359-370.

Grapentine, T. (2000). Path analysis vs. structural equation modeling. *Marketing research, 12*(3).

Guibentif, T. M., & Patel, M. K. (2023). Do intermediaries have blind spots? Mapping the activity lifecycle of an energy efficiency programme. *Energy Research & Social Science, 101*, 103141.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing theory and Practice, 19*(2), 139-152.

Heale, R., & Twycross, A. (2015). Validity and reliability in quantitative studies. *Evidence-based nursing, 18*(3), 66-67.

Home Insulations. (n.d.). Can I save electricityby turning off the geyser? Retrieved from https://www.homeinsulations.co.za/saving-energy/can-save-energy-turning-off-the-geyser/

Hyysalo, S., Heiskanen, E., Lukkarinen, J., Matschoss, K., Jalas, M., Kivimaa, P., . . . Primmer, E. (2022). Market intermediation and its embeddedness–Lessons from the Finnish energy transition. *Environmental Innovation and Societal Transitions, 42*, 184-200.

Insititute of Plumbing South Africa. (2022). Changes to SANS 10254 - 2022. Retrieved from https://www.iopsa.org/news/12835092

Institute of Plumbers South Africa. (2020). Plumber registration. Retrieved from https://www.iopsa.org/Plumber-Registration

Institute of Plumbers South Africa, & Quality Council for Traders and Occupations. (n.d.). *Curriculum document - Occupational certificate: plumber*. Pretoria, South Africa Retrieved from https://www.qcto.org.za/index.php/plumber?layout=table

Isotherm Thermal Insulation. (2020). Does switching off geyser really save energy? Retrieved from https://www.isotherm.co.za/switching-off-geyser-really-save-energy/

Johnson, A., Lutz, J., McNeil, M., & Covary, T. (2013). *An international survey of electric storage tank water heater efficiency and standards*. Paper presented at the Southern African Energy Efficiency Convention Johannersburg, South Africa.

Kepplinger, P., Huber, G., & Petrasch, J. (2016). Field testing of demand side management via autonomous optimal control of a domestic hot water heater. *Energy and Buildings, 127*, 730-735.
Khabele, K. (2022). New Technologies.
Kivimaa, P., Bergek, A., Matschoss, K., & van Lente, H. (2020). Intermediaries in accelerating transitions: Introduction to the special issue. In (Vol. 36, pp. 372-377): Elsevier.
Kline, R. B. (2023). *Principles and practice of structural equation modeling*: Guilford publications.
Klöckner, C. A., & Blöbaum, A. (2010). A comprehensive action determination model: Toward a broader understanding of ecological behaviour using the example of travel mode choice. *Journal of Environmental Psychology, 30*(4), 574-586.
Laborgne, P. (2023). Local intermediaries in energy transitions: bridging the gap from niche level to changing the regime. *Zeitschrift für Politikwissenschaft*, 1-20.
Maddux, J. E., Norton, L. W., & Stoltenberg, C. D. (1986). Self-efficacy expectancy, outcome expectancy, and outcome value: Relative effects on behavioral intentions. *Journal of Personality and Social Psychology, 51*(4), 783.
Makole, K., Moeti, K., & Ntshangase, B. (2023). Repurposing public technical vocational education and training colleges in South Africa: A response to the national development plan on reskilling youth and learners with technical skills. *African Journal of Public Affairs, 14*(1), 43-62.
Manstead, A. S. (1996). Attitudes and behaviour. In G. R. Sermin & K. Fiedler (Eds.), *Applied social psychology* (Vol. 3, pp. 29). London: SAGE Publications.
McDermott, R. (2011). Internal and external validity. In J. N. Druckman, D. P. Greene, J. H. Kuklinski, & A. Lupia (Eds.), *Cambridge handbook of experimental political science* (pp. 27-40). New York, USA: Cambridge University Press.
McNeil, M., Covary, T., & Vermeulen, J. (2014). *South Africa geyser: Cost-effciency technical study*. University of Stellebosch, Cape Town, South Africa.
Mignon, I., & Winberg, L. (2023). The role of public energy advising in sustainability transitions–empirical evidence from Sweden. *Energy Policy, 177*, 113525.
Mogensen, D., & Gram-Hanssen, K. (2023). Why do people (not) energy renovate their homes? Insights from qualitative interviews with Danish homeowners. *Energy Efficiency, 16*(5), 40.
Murray, J. (2013). Likert data: what to use, parametric or non-parametric? *International Journal of Business and Social Science, 4*(11).
Murti, B. (2020). *How to conduct path analysis and structural equation model for health research.* Paper presented at the International Conference on Public Health. Surakarta, Indonesia.
Ngo, C., & Natowitz, J. (2009). *Our energy future: Resources, alternatives, and the environment*. USA and Canada: John & Wiley.
Nkambule, B. I., & Ngubane, S. A. (2023). Eradicating a culture of public mistrust in tvet college education in South Africa: A manifesto for the

sector's sustainability ahead of 4IR. *Research in Social Sciences and Technology, 8*(4), 301-329.
Owen, A., & Mitchell, G. (2015). Outside influence–Some effects of retrofit installers and advisors on energy behaviours in households. *Indoor and Built Environment*.
Owen, A., Mitchell, G., & Gouldson, A. (2014). Unseen influence—The role of low carbon retrofit advisers and installers in the adoption and use of domestic energy technology. *Energy Policy, 73*, 169-179.
Page, M., & Fuller, S. (2021). Governing energy transitions in Australia: Low carbon innovation and the role for intermediary actors. *Energy Research & Social Science, 73*, 101896.
(2017). *In's and Out's of CPD.* Retrieved from http://pirb.co.za/webinars-2/ https://www.youtube.com/watch?v=ta2dHPnnC9I&feature=emb_title
Plumbing Industry Registration Board. (2021). SANS 10254: The background.
Plumbing Industry Registration Board. (2023). Household plumbing non-compliance: water heaters.
Powertime. (2015). How to save Electricity and money from your geyser? Retrieved from https://powertime.co.za/online/how-to-save-electricity-geyser/
Risholt, B., & Berker, T. (2013). Success for energy efficient renovation of dwellings—Learning from private homeowners. *Energy Policy, 61*, 1022-1030.
Ryan, E. (2023). Update on COCs for electric geysers. Retrieved from https://pirb.co.za/update-on-cocs-for-electric-geysers/
Salama, M. (2023). What are technical standards? – Importance, types, benefits. Retrieved from https://instrumentationtools.com/technical-standards/#:~:text=Ensuring%20quality%20and%20safety%20of,risks%20to%20users%20and%20customers.
Scharnigg, R., & Sareen, S. (2023). Accountability implications for intermediaries in upscaling: Energy community rollouts in Portugal. *Technological Forecasting and Social Change, 197*, 122911.
Schueftan, A., Aravena, C., & Reyes, R. (2021). Financing energy efficiency retrofits in Chilean households: The role of financial instruments, savings and uncertainty in energy transition. *Resource and Energy Economics, 66*, 101265.
Shau, T. V. (2017). The confirmatory factor analysis (CFA) of preschool management model in Sarawak. *International Journal of Academic Research in Business and Social Sciences, 7*(6), 221-231.
Siegel, J. E., Das, A., Sun, Y., & Pratt, S. R. (2020). Safe energy savings through context-aware hot water demand prediction. *Engineering Applications of Artificial Intelligence, 90*, 103481.
Skills Development for a Green Economy. (2019a). *High-level statistical analysis of the plumbing and electrical trades*. Pretoria, South Africa:
Skills Development for a Green Economy. (2019b). *Industry analysis of the electrical contracting industry*. Pretoria, South Africa:
Skills Development for a Green Economy. (2019c). *Industry analysis of the plumbing industry*. Pretoria, South Africa:
Sohre, A., & Schubert, I. (2022). The how and what of bottom-up governance to change household energy consumption behaviour. *Energy Research & Social Science, 89*, 102570.

South African Bureau of Standards. (2011). Energy efficiency in buildings. South African Bureau of Standards, South Africa.
Subedi, B. P. (2016). Using Likert type data in social science research: Confusion, issues and challenges. *International Journal of Contemporary Applied Sciences, 3*(2), 36-49.
Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research In Science Education, 48*, 1273-1296.
Tang, Z., Zhou, Z., & Warkentin, M. (2022). A contextualized comprehensive action determination model for predicting consumer electronics recommerce platform usage: A sequential mixed-methods approach. *Information & Management, 59*(3), 103617.
Tassiello, V., & Tillotson, J. S. (2020). How subjective knowledge influences intention to travel. *Annals of Tourism Research, 80*, 102851.
Terry, D. J., & O'Leary, J. E. (1995). The theory of planned behaviour: The effects of perceived behavioural control and self-efficacy. *British Journal Of Social Psychology, 34*(2), 199-220.
Trafimow, D., Sheeran, P., Conner, M., & Finlay, K. A. (2002). Evidence that perceived behavioural control is a multidimensional construct: Perceived control and perceived difficulty. *British journal of social psychology, 41*(1), 101-121.
van den Broek, K. L., & Walker, I. (2019). Exploring the perceptions of drivers of energy behaviour. *Energy Policy, 129*, 1297-1305.
van den Broek, K. L., Walker, I., & Klöckner, C. A. (2019). Drivers of energy saving behaviour: The relative influence of intentional, normative, situational and habitual processes. *Energy Policy, 132*, 811-819.
van der Werff, E., & Steg, L. (2015). One model to predict them all: Predicting energy behaviours with the norm activation model. *Energy Research & Social Science, 6*, 8-14.
Van Zyl, J., Lobanga, K., Lugoma, F. M., & Ilemobade, A. (2008). *The state of plumbing in South Africa* (1702/1/08). Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.469.148&rep=rep1&type=pdf
Wade, F., Hitchings, R., & Shipworth, M. (2016). Understanding the missing middlemen of domestic heating: Installers as a community of professional practice in the United Kingdom. *Energy Research and Social Science, 19*, 39-47.
Wade, F., Murtagh, N., & Hitchings, R. (2018). Managing professional jurisdiction and domestic energy use. *Building Research Information, 46*(1), 42-53.
Wade, F., Shipworth, M., & Hitchings, R. (2017). How installers select and explain domestic heating controls. *Building Research & Information, 45*(4), 371-383.
Willand, N., Torabi, N., & Horne, R. (2023). Recognition justice in Australia: Hidden energy vulnerability through the experiences of intermediaries. *Energy Research & Social Science, 98*, 103013.
Williams, D. M. (2010). Outcome expectancy and self-efficacy: Theoretical implications of an unresolved contradiction. *Personality and Social Psychology Review, 14*(4), 417-425.

Windapo, A. (2016). Skilled labour supply in the South African construction industry: The nexus between certification, quality of work output and shortages. *SA Journal of Human Resource Management, 14*(1), 1-8.

Winkler, H., Fecher, R. S., Tyani, L., & Matibe, K. (2002). Cost benefit analysis of energy efficiency in low-cost housing. *Development Southern Africa, 19*(5), 593-614. Retrieved from http://www.erc.uct.ac.za/sites/default/files/image_tool/images/119/Papers-pre2004/02Winkler-etal_CBA_energy_efficiency.pdf

Yamin, P., Fei, M., Lahlou, S., & Levy, S. (2019). Using social norms to change behavior and increase sustainability in the real world: A systematic review of the literature. *Sustainability, 11*(20), 5847.

Zaunbrecher, B. S., Arning, K., Halbey, J., & Ziefle, M. (2021). Intermediaries as gatekeepers and their role in retrofit decisions of house owners. *Energy Research & Social Science, 74*, 101939.

Zolait, A. H. S. (2014). The nature and components of perceived behavioural control as an element of theory of planned behaviour. *Behaviour & Information Technology, 33*(1), 65-85.

APPENDIX A: The Research Instrument (Participant information and Knowledge-based questionnaire)

Table 18

Participant information

1	*PLEASE SELECT YOUR TRADE*
	Plumbing
	Electrical
2	*PLEASE SELECT YOUR AGE GROUP*
	24 years and below
	25-34 years old
	35-44 years old
	45- 54 years old
	55 years and over
3	*HOW LONG HAVE YOU BEEN WORKING IN THE PLUMBING OR ELECTRIC INDUSTRY?*
	Less than 5 years
	Between 5 and 10 years
	Between 10 and 20 years
	Over 20 years
4	*DO YOU HAVE A TRADE TEST CERTIFICATE?*
	Yes
	No
	Working on it
5	*ARE YOU AFFILIATED WITH ANY OF THE BELOW ORGANISATIONS? (please select as many as apply)*
	Plumbing Industry Registration Board (PIRB)
	Engineering Counsel of South Africa (ECSA)
	South African Revenue Services (SARS)
	Electrical Contractors Association of South Africa - ECA (SA)
	Department of Labour

Table 19

Knowledge-Based Questions and Scoring

Given a geyser size of 150L, please answer the following questions:							
1	Which power rating of the geyser will take the quickest time to heat water						
	2,5kW		3,5kW		4,5kW		All the same

2	Which power rating will use more electricity if turned on for an hour						
	2,5kW		3,5kW		4,5kW		All the same
Given a geyser with a power rating of 3,5kW, please answer the following questions							
3	Which geyser will have hottest water after an hour						
	100L		150L		200L		All the same
4	Which geyser uses more electricity if turned on for an hour						
	100L		150L		200L		All the same
5	If the geyser is turned on for an hour how much electricity will it consume?						
	3,5 kWh		2 kWh		7 kWh		5,5 kWh
If a geyser blanket is installed on a geyser,							
6	The amount electricity used to heat the water from 20 degrees Celsius to 60 deg will						
	Decrease		Increase		Be the same		
7	The amount of heat lost when geyser is not in use (standing losses) will:						
	Decrease		Increase		No difference		Remain the same
If the thermostat setting on a geyser is lowered from 60 degrees Celsius to 45 degrees,							
8	The time it takes for water to reach 45 degrees Celsius will:						
	Decrease		Increase		Remain the same		
9	Electricity used to get to 45deg C will:						
	Decrease		Increase		Remain the same		
10	The amount of heat lost when geyser is not in use (standing losses) will:						
	Decrease		Increase		Remain the same		

Note. All choices highlighted with green represent the correct answer. Question 6 had two possible answers that would have been correct hence both would have been awarded 10 points in the rating.

APPENDIX B: Ethics Clearance

Graduate School of Business Administration
University of the Witwatersrand, Johannesburg

Wits Business School Ethics Committee
Constituted under the University Human Research Ethics Committee (Non-Medical)

Ethics Clearance Certificate

Ethics protocol number: WBS/EL0707172J/322
This certificate is only valid with a legitimate ethics protocol number and signed by the Researcher (below).

Project title	Knowledge and perceptions of electrical geyser efficiency technologies held by contractors in Durban.
Investigator / Researcher	Miss Snothando Mzobe
Nature of Project	MM (Energy Leadership)
Decision of the Committee	Approved, provided stakeholders and participants are guaranteed anonymity and confidentiality.
Issue Date of Certificate	2022-02-28
Expiry date	Date of submission of the project report
Chairperson	Prof Anthony Stacey ☎ +27 11 717 3587 +27 82 880 4531 anthony.stacey@wits.ac.za

---

Declaration by Researcher

One copy must be signed by the Researcher and returned to the Chairperson of the Wits Business School Ethics Committee.

I fully understand the conditions under which I am authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I undertake to resubmit the protocol to the Committee.

Signature

10/03/2022
Date:

APPENDIX C: Participant Information Sheet



PARTICIPANT INFORMATION

KNOWLEDGE AND PERCEPTIONS OF ADD-ON ELECTRICAL GEYSER EFFECIENCY TECHNOLOGIES HELD BY CONTRACTORS IN DURBAN

Dear Participant,

My name is Snothando Mzobe and I am undertaking a research project as part of my Masters of Management in Energy Leadership at the Wits Business School. The purpose of my research is to better understand plumbing and electrical contractors' knowledge and perceptions of household geyser efficiency technologies, as well as the factors that affect their intentions to promote them within the residential sector of Durban.

To gather this information, you are requested to please fill in the online questionnaire that follows. It should take you approximately 15 minutes. The information you provide will be confidential and will not be shared with anyone without your consent. It will be combined with data provided by other participants and only used for data analysis.

The findings of the project will be available by the end of September 2021. If you would like to receive a summary report of my findings, please take down my email address at the end of the survey and send me an email separately. This is to ensure the anonymity of your responses as I will not be able to link you with the questionnaire responses.

I am extremely grateful for your participation in this project.

Thank you for your time.

APPENDIX D: Participant Consent Form



PARTICIPANT CONSENT FORM

KNOWLEDGE AND PERCEPTIONS OF ADD-ON ELECTRICAL GEYSER EFFECIENCY TECHNOLOGIES HELD BY CONTRACTORS IN DURBAN

Electronic consent

Please accept the following in order to proceed with the questionnaire:

- ***I consent to participate in this project research***
- **I agree that my participation will be confidential**
- **I agree that my participation is voluntary and I can withdraw from at any time**

***Participants will not be able to proceed to the questionnaire without ticking all three points.**