FRAMEWORK FOR THE IMPLEMENTATION OF COMMUNITY RENEWABLE ENERGY PROJECTS IN THE UK

By

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ABSTRACT

Community Renewable Energy Projects (CREPs) are among the most significant contributors to the UK CO_2 emission reduction targets, and therefore have become a key agenda in many UK sustainable Energy reports. Unlike conventional energy projects, CREPs are particularly focused on how community engagement can facilitate Renewable Energy projects delivery process; enhance local ownership through the various Business Models deployed. There is a common believe that business models are central to understanding an organisation's many approaches to capturing the customer's needs, how these needs can be met to their satisfaction and how revenue can be generated in the process. The thesis explores the impacts of the UK Community Energy Business Model (CEBMoD) on the success of CREPs in planning, implementation, operational and disposal phases of the project.

Drawing on extant literature, factors that describe CEBMoD effectiveness, management structure as well as common influencing factors to overall project success were obtained. To further gauge the opinion of experts on the importance of these factors, questionnaire survey was administered to UK wide CREPs practitioners while some sitting directors in the board of selected CEBMoDs and key personnel from CREPs support organisations in Scotland were interviewed. Based on its open sourced nature, robustness and flexibility in coding, R programming language and the relevant packages were used in the analysis of the questionnaire items, while NVivo was used in analysing the interview data.

The factor analysis revealed four principal influencing factors to CREPs planning phase, three for implementation and operational phases respectively, and two for disposal phase. Another eleven principal factors which are focused on testing CREPs impacts and seven most parsimonious set of components for CEBMoD's management structure were also obtained. A total of twenty-three regression models were tested for relationship between an effective CEBMoD and CREPs success.

The principal issues and suggestions which have arisen from the regression models and interview analysis is used in the development of a framework for the selection of appropriate Community Energy Business Model (CEBMoD) for a particular Community Renewable Projects (CREPs) development. Guiding recommendations for improving incumbent/setting up new CEBMoD for implementation of future CREPs have been specified in the framework.

DEDICATION

I dedicate this piece of work to

Jesus Christ, the author and finisher of my faith

To my wife **Karen-Ngozi** for all the supports and encouragement and to

My precious children **Brian, Sean, Mikel, Manny and Zarah and finally**

To

Mr Asuquo Okon Iboh

My late father, whose desire it was for me to attain highest academic degree but never lived to see it happen

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DECLARATION STATEMENT

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Version: *(i.e. First, Resubmission, Final)*	FINAL	Degree Sought:	PhD in Construction Management

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ACRONYMS AND ABBREVIATIONS

CREPs	-	Community Renewable Energy Projects
CEBMoD(s)	-	Community Energy Business Model(s)
CEGs	-	Community Energy Groups
DECC	-	Department for Energy and Climate
CARES	-	Community and Renewable Energy Schemes
CES	-	Community Energy Scotland
CEE	-	Community Energy England
FCA	-	Financial Conduct Authority
Coops	-	Cooperatives
SocEnt	-	Social Enterprise
CIC	-	Community Interest Companies
ComCha	-	Community Charites
DevTru	-	Development Trust
RBV	-	Resource-based view theory
REPs	-	Renewable Energy Projects

CHAPTER 1: INTRODUCTION

1.1 Introduction

This Chapter establishes the need for this research which seeks to make valuable contributions to the subject of renewable energy governance practices in the UK; this however is within the context of citizen's participation and ownership of these projects. Drawing on contemporary literatures within this knowledge area, the chapter reveals a research gap in the area and further presents the aim and objectives to address key unanswered questions raised from extant literatures reviewed. In addition, the methodology congruent to the research, and the structure of the overall thesis are clearly outlined

1.2 Context of Research

Recently, there have been so much socio-economic and environmental debate on how Energy should be harnessed, stored, sold, used and managed (Núñez-Nickel and Moyano-Fuentes, 2004; Sperling, Hvelplund and Mathiesen, 2011; Trutnevyte, Stauffacher and Scholz, 2011). Energy being a basic need of man is however in short supply globally (Pernick and Wilder, 2007; Abbasi and Abbasi, 2010; Srirangan *et al.*, 2012).

According to the United Nations, one fifth of the world population have no access to clean energy (UN, 2013). The lack of adequate electricity in many rural areas has crippled economic and educational activities as well as denied majority access to modern health care system; as evident in the level of fuel poverty in developed nations and constant load shedding between households in most developing nations.

The unending quest for quality lifestyle by man has placed huge burden on the environment with an increase in global energy demand, consumptions and by extension, a change in global climate (Holmes and Hacker, 2007). This human induced change can be traceable to Green House Gases (GHG) emitted into the atmosphere by everyday human activities (Vitousek et al., 1997) and GHG emission has become a significant problem in the World.

Evidences from intense heat wave in North America (Palecki, Changnon and Kunkel, 2001), to Poor Agricultural production in Africa (Müller, 2011), increased coastal flooding in Asia (McGranahan, Balk and Anderson, 2007), biodiversity loss in Latin America (Altieri and Masera, 1993) and glacial retreat which is very obvious in mountainous Europe (Hewitt, 1999) all attest to this fact. However, streams of research have been carried out to gain deeper understanding of its causes and how it can be mitigated (Houghton, 2005; Clarke *et al.*, 2007; Hillman and Ramaswami, 2010).

Consequent upon these obvious threats to the environment and the gross imbalance in energy accessibility, it has been empirically and practically proven that Decentralisation of Energy system holds the future for energy sector (Alanne and Saari, 2006; Pehnt *et al.*, 2006; Karger and Hennings, 2009; Engelken *et al.*, 2016). While there are growing interest and focus on decentralizing energy generation, Strbac (2008) maintained that there are many uncertainties associated with its demand side. Despite Strbac's insistence, Decentralised Energy systems popularity remains high.

Based on the need to unbundle energy management systems globally, the United Nations in 2012 advocated for energy reforms (renewable energy for all) centred on a more flexible governance and environmentally sustainable structure that will eventually guarantee global access to clean energy by 2030 (UN, 2013). This is because the breakdown of actual costs of electricity per kilowatt supplied by the conventional centralised energy systems (CES) reveals that a composite cost comprising costs of Generation, Transmission, Distribution and related taxes are paid by the consumer (Geels, 2004). In addition, CES incurs huge investment burdens and is technically and institutionally complex (Kaundinya, Balachandra and Ravindranath (2009).

Therefore, amongst many reforms and possible alternative sustainable energy governance systems proposed is the subject of community championing of or involvement in renewable energy activities and or projects. Such activities are widely classified in the UK as Community Energy Project's (CEPs). Throughout this thesis, the term Community Renewable Energy Projects (CREPs) will be used to refer to these projects and its activities due to its emphasis on socio-economic and environmental sustainability.

CREPs contributions to the UK CO2 emission reduction target has become a key agenda in many UK sustainable Energy reports including the Department of Energy and Climate Change's *Community Energy Strategy* report (DECC 2013). However, its concept and gains are not fully explored and properly communicated to the general public thereby provoking great debate lately on its practicality (Bolinger, 2001; Munday, Bristow and Cowell, 2011; Sperling, Hvelplund and Mathiesen, 2011).

CREPs key focus is to support and empower the people (mostly non-experts in Renewable Energy activities) to make decisions and build an energy system that is centred on their needs and to ensure that such system is open to public scrutiny and accountability. CREPs programmes further aim to achieve full community leadership and control in one part and also fully or partly own the system on the other hand (Hinshelwood, 2001).

Several studies exist covering various important factors that influence CREPs diffusion and success, these factors include; political factors e.g. (Walker *et al.*, 2007; Denis and Parker, 2009; Bomberg and McEwen, 2012), institutional factors e.g. (Hoffman and High-Pippert, 2005; Walker, 2008; Hargreaves *et al.*, 2013), economic factors e.g. (Walker and Devine-Wright, 2008; Karakaya and Sriwannawit, 2015; Agostini, Nasirov and Silva, 2016).

Others are environmental factors e.g. (Sadownik and Jaccard, 2001; Warren and McFadyen, 2010) social factors e.g. (Rogers *et al.*, 2008; Walker and Devine-Wright, 2008; Hoffman and High-Pippert, 2010; Walker *et al.*, 2010; Warren and McFadyen, 2010; Walker, 2011) technical factors e.g. (McLaren Loring, 2007; Van Hoesen and Letendre, 2010; Ahadi, Kang and Lee, 2016) and so on.

Walker and Devine-Wright, (2008) summarised that the different forms of community-led and based ownership of energy projects are aimed towards establishment of a unique process of energy sector governance that fosters Citizen's participation, acceptance of the projects and creation of awareness on dangers of GHG emissions.

1.3 Research gap

Prior to the commencement of any CREPs irrespective of the scale and size, a vehicle for successful project delivery is a necessity. This is because energy projects are capital intensive (McLaren Loring, 2007) and usually depend on a long supply chain which must be put in place in an organised, structured and in most cases legal manner.

This vehicle usually is a network of professionals, volunteers, individuals and investors with a shared vision of getting involved in the planning, organisation, implementation and ownership of renewable energy projects (Walker and Devine-Wright, 2008).

Furthermore, consumers and service users are interested in a more persuasive and appealing products in terms of being personally engaged in product delivery processes because, it helps them to understand and appreciate the product's value and cost (Engelken et al., 2016). This places demand on energy suppliers to tailor service delivery programmes, processes and ownership model's structure to fit into users' expectation (Warren and McFadyen, 2010).

Ownership models for setting up rural electrification have been in use in Germany since the early 20th century (Shamsuzzoha, Grant and Clarke, 2012) and, at the moment, there are over 5,000 different community energy ownership groups (mostly based in rural communities) in the UK (DECC, 2014). Each is involved in different energy saving activities, such as promoting clean energy generation and usage, by offering energy advice to communities and negotiating affordable energy tariffs for them.

The ownership structure and membership of these groups vary greatly, but whether the ownership structure is designed and organized to give full ownership of projects to the community (Khan et.al, 2007), or just a sense of ownership (Schreuer and Weismeier-Sammer, 2010), the models are overwhelmingly recognized as platforms for achieving an overarching goal of CREPs. This includes helping locals reduce energy use, tackle climate change and end fuel poverty, amongst many other benefits.

Driven by the need for sustainable consumption of natural goods and a low carbon future, some community energy groups (CEGs) have modified social processes in existing community business organisations to accommodate the development of CREPs (van der Horst, 2008). That notwithstanding, it is still clear that the conventional model, where communities generate electricity and feed it into the grid, may not be very effective in the near future.

Growing research and policy attention on community energy development (Hanley and Nevin, 1999; Hinshelwood, 2001; Rogers et al., 2008; Walker, 2008; St Denis and Parker, 2009; Warren and McFadyen, 2010; Walker et.al, 2010; Cass et al., 2010; Munday et al., 2011), have identified the main barriers to the scaling-up of CREPs uptake to be: lack of access to funding, poor legal and regulatory frameworks, and lack of community capacity to cope with the growing demands of the renewable energy sector.

For instance, a recent report published by Community Energy England revealed that between 2015 and 2017, 31% of projects in England were suspended due to planning phase concerns such as dramatic cuts to UK feed-in tariffs, lack of funds and planning consent refusals. It is obvious from aforementioned that most of these barriers are peculiar to incumbent CEBMoD, in other words, most of them are not effective, efficient and proactive in their approach to CREPs delivery (Becker and Sloan, 1985; Wei, Varela and Hassan, 2002; Boyle, 2003; McKee, 2007; Perrini, Rossi and Rovetta, 2008; Cornett et al., 2010).

Several attempts have been made to examine how local ownership impacts local economies (Phimister and Roberts, 2012), the effects of technology on local ownership (Bain, 2011), local ownership impacts on local opportunities (DECC, 2014), local ownership impacts on public attitudes and acceptance (Schreuer and Weismeier-Sammer, 2010; Warren and McFadyen, 2010; Haney and Pollitt, 2013), among other things. However, **far too little attention has been paid to how these barriers affect CEBMoD's approach to CREPs delivery**.

There is a need to examine these barriers and how they affect the success of CREPs' planning, implementation, operational and disposal phases. The outcome of the investigation will serve as a guiding tool for CEGs to deliver a more successful CREPs in future.

1.4 Aim and Objectives

The aim of this research therefore is to develop a framework that complements incumbent Community Energy Business Model (CEBMoD), for effective delivery of on-going and new Community Renewal Energy Projects (CREPs) in the UK. Hence the main objectives of this research are:

1. To review the state of the art in research and practice in relation to the UK Community Energy sector, with a view to understanding the nature and performance of CREPs.

2. To appraise the various Community Energy Business Model (CEBMoD) in the UK, including its effectiveness, management structure and approach to CREPs development.

3. To identify the impacts CREPs is expected to generate and the common influencing factors to overall project success.

4. To develop and evaluate a framework for the selection of appropriate Community Energy Business Model (CEBMoD) for a particular Community Renewable Projects (CREPs) development.

5. Generate sets of guiding recommendations for setting up CEBMoD for implementation of future CREPs.

1.5 Scope of the Study

Community energy project ownership models are numerous in the UK and, as such, not all are covered in this research. However, the legal models commonly and widely used in setting up energy projects within the UK are identified for this study. The popular forms of partial or full CREP ownership range from an individual's ownership of a solar panel on a domestic building to commercially organized social enterprises, cooperatives, development trusts, community charities and community interest companies. The selected models reviewed in this research are those contained in the *UK Community Energy Strategy* report published by the Department of Energy and Climate (DECC, 2013), and are the unit of analysis.

The research covers only community wind and solar projects, because other technologies are still in their infancy or are at early stages of development at the local level. The selected study area is Scottish Highland/Islands, because this area benefits from a variety of renewable wind, hydro and solar energy projects (CES, 2014). As a matter of fact, the region contributes over 30% of Scotland's and over 12% of the UK's overall renewable energy (RE) capacities.

Plans are already underway to boost this capacity further through exploring the geothermal, biomass, offshore wind, hydrogen fuel cell, tidal and wave energy markets (Walker, 2008).

It is however important to state here that the process of arriving at the choice Scottish Highland/Islands as a case study area was not very easy but considering the presence of substantial and diverse nature of renewable energy projects (REPs) and their ownership models were the key factors that favoured the area over other regions in the UK.

At the moment, there are over 200 CEPs are already installed in highlands and other remote places as at early 2014, (Community Energy England, 2016); It is also important to state here that CEPs programs in the UK covers both Community generated electricity and recently community renewable heat initiatives (RHI). This research will try not to delve into RHI but focus more on the electricity aspects

1.6 Research Methodology

Drawing on Saunders et al.'s (2009) 'Research Onion' model, the pragmatic paradigm is adopted as the philosophical footing for this study. Surveys (for the quantitative phase) and case study interviews (for the qualitative phase) were chosen as the appropriate strategies. To make up for acknowledged limitations associated with using either quantitative or qualitative methods, a combination of both was employed. The research process shown in Figure 1.1 shows how each research objective was addressed by the methodology.

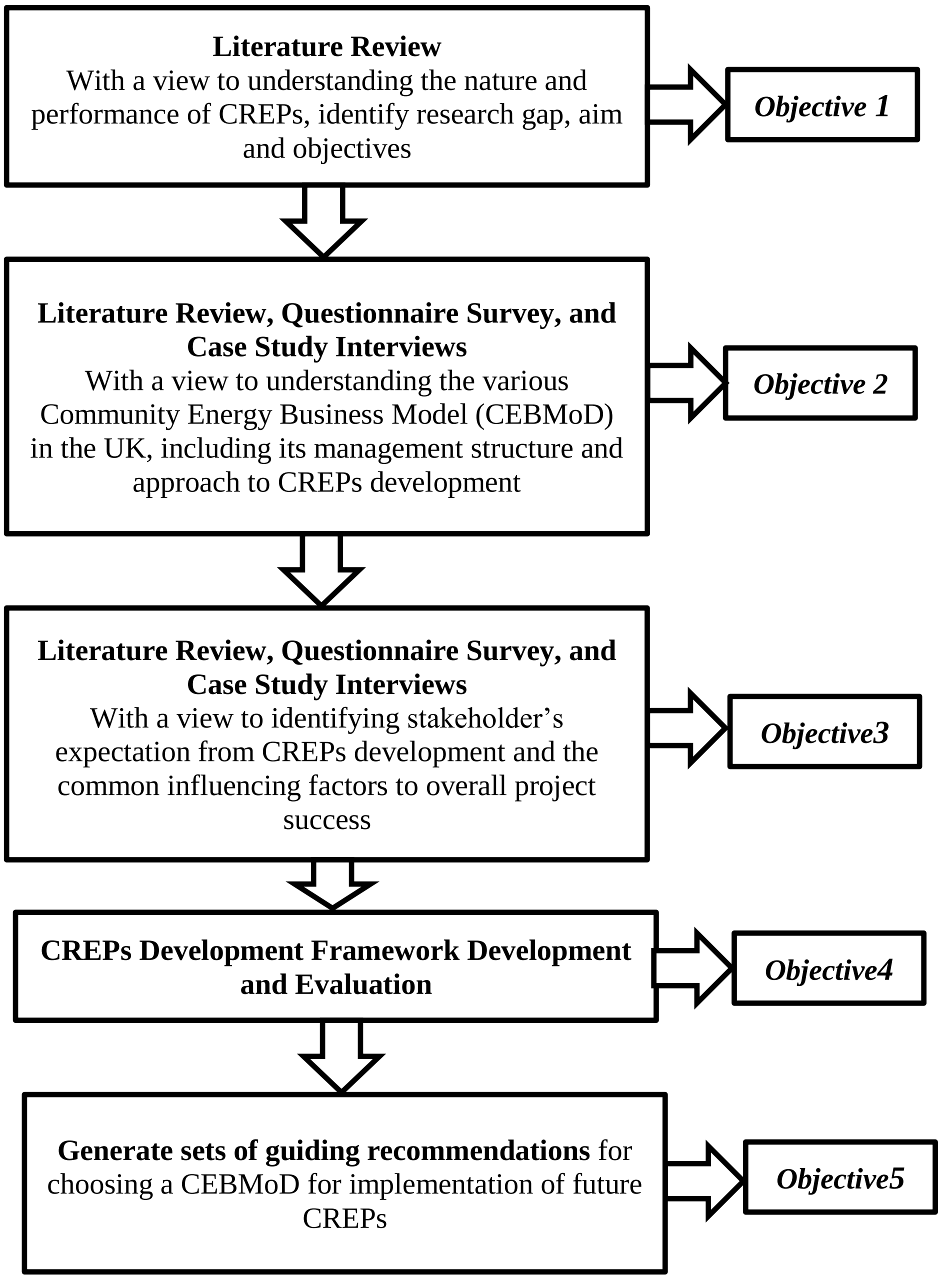

Figure 1.1: The research process

1.7 Outline of Thesis

This thesis is made up of ten chapters. Chapter 1 establishes the need for research into the subject of renewable energy governance practices within the context of citizen participation and ownership in the UK. Drawing on energy governance practice literature, the chapter reveals a knowledge gap in the research area. It then presents the aims and objectives needed to address key unanswered questions raised by the literature review. In addition, the chapter outlines the research process followed to address the objectives, and briefly discusses the overall structure of the thesis.

Chapter 2 presents an extensive literature review of the UK energy sector and REPs with a clear focus on CREPs. The chapter also emphatically captures the debates and reforms going on in the energy sector from global to local points of view, with the objective of identifying aspects of community energy project performance not adequately covered in research.

In Chapter 3, UK CEBMoDs are examined with a view to revealing their areas of competitive advantage in CREP development. The chapter goes further to review the historical background to community ownership of assets in the UK and explores local community ownership as a driver for REPs, with a particular interest in incumbent CEBMoDs in the UK. A key takeaway from the chapter is that the conventional model, where communities generate electricity and feed it into the grid, may not be very effective in the near future because of the overarching issues associated with CREP development, which are beyond the capacity of incumbent CEBMoDs to navigate.

In Chapter 4, factors that lead to effective internal organisation and efficient management structures of CEBMoDs, and their proactive approaches to CREP development, are obtained from the literature. These are combined with factors that may impede or assist overall project success to develop a simple conceptual framework. The purpose of the framework is to aid understanding of the dynamics of various incumbent CEBMoDs identified earlier for this research, and how these eventually impact on CREPs' overall performance.

Chapter 5 highlights the importance of the research methodology and explores the various philosophical assumptions associated with the research with a view to exposing the strength and drawbacks of each. The chapter briefly described the many influences these assumptions have on the act of research and then presents the author's research design, strategies and methods according to the onion research model.

Chapter 6 presents the findings of the questionnaire survey administered to CREP practitioners across the UK. This is the second aspect of the research strategy adopted from the third layer of the onion research model outlined in Chapter 5. The chapter discusses the scale reliability and validity of the survey instrument, the sample characteristics, and the internal consistency of the data. Simple descriptive statistics are derived from the quantitative data set, followed by a more complex analysis that reveals the existence of multivariate relationships.

Chapter 7 reports on the outcome of the interviews conducted on selected case studies. Some directors sitting on the boards of selected CEBMoDs, and key personnel from CREP support organisations in Scotland, were interviewed to gain wide expert opinion on how CEBMoDs can be effectively structured to deliver CREP goals.

Chapter 8 begins by running Pearson product-moment correlation coefficient (PPMCC) and multiple regression analyses on the efficient CEBMoD components and CREP performance/impact components obtained in Chapter 6. The purpose of these analyses was to figure out which CEBMoD component best predicts CREP success in each of the development phases, as well as the social, economic, and environmental impacts desired by project stakeholders.

In Chapter 9, the principal issues and suggestions which arose in Chapters 7 and 8 are used to develop a framework for the selection of an appropriate CEBMoD for development of particular CREPs. The chapter also reports on the outcome of the expert evaluation of the framework.

Chapter 10 presents a reflection on the entire study by reviewing the findings and highlighting their specific contributions to knowledge. In addition, the research limitations are acknowledged and key areas that require further research are recommended.

1.8 Summary

The background and need for this research, including the research gaps, aims, objectives and contributions to knowledge have been clearly outlined in this chapter. In addition, the methodology relevant to the research and the structure of the overall thesis were presented. The next chapter presents an extensive literature review on the UK energy sector and renewable energy projects, with a clear focus on CREPs.

CHAPTER 2: THE GLOBAL ENERGY SECTOR REFORMS AND ALTERNATIVE ENERGY MANAGEMENT SYSTEMS

2.1 Introduction

Having established the rationale for undertaking this study in the previous chapter, this chapter discusses various reforms in the global energy sector and how these have led to the need for alternative energy management systems. The chapter provides an in-depth review of the UK energy sector and renewable energy projects, with a clear focus on community renewable energy projects (CREPs). A review of relevant literature sheds light on the nature of CREPs in the UK and offers the researcher the opportunity to make meaningful contributions to existing knowledge. By so doing, the first research objective is addressed.

2.2 The Global Energy Market Reforms

Generally, countries embark on reforms mainly to break monopolies in any aspect or sector of the economy perceived to be lacking innovative solutions in infrastructural development and service delivery. This is done by partially or fully engaging the private sector to work alongside or replace the incumbent public sector workforce (Joshi and Little, 1996). The energy sector is no exception.

In the literature, several terms tend to be used to refer to ongoing and previous reforms in the global electricity market (Roberts, Elliott and Houghton, 1991; Borenstein, Bushnell and Wolak, 1999; Pierce Jr, 2005; Joskow, 2008). Based on specific motivations and needs, many countries have restructured their electricity markets (i.e. reordering of internal structures within organisations, or alteration of stakeholders' roles within the market). Others have either liberalised or privatised the sector (Newbery, 1997; Bacon and Besant-Jones, 2001). While liberalisation is concerned with the removal of business restrictions imposed by the government (Fabbri *et al.*, 2005), privatisation is about the transfer of asset ownership from the public to private sector on short- or long-term bases (Megginson and Netter, 2001).

As a matter of fact, Germany made an attempt to completely deregulate the energy sector in 2005; in other words, to position the sector to be driven by market forces instead of government laws and regulations (Wüstenhagen and Bilharz, 2006). The main reasons for these various approaches are to introduce market competition, management efficiency and drive down electricity prices (Hogan, 2002).

The energy sector witnessed its first major reform through the privatisation and commercialisation of the government-owned electricity scheme in Chile in the early 1980s (Bacon, 1995; Jamasb and Pollitt, 2005; Sioshansi, 2006). Consultations for this reform started in 1978, whereas the actual sectorial reform was implemented in 1982. The Chilean reform eventually paved the way for the global electricity sector reforms witnessed a decade later. Notably, in the 1990s, various investment banks and industry professionals partnered with governments in developing countries to overhaul electricity markets (Williams and Ghanadan, 2006).

Cherni and Kentish (2007) noted that within the same time frame of the Chilean reforms, China also embarked on three major reforms in their electricity sector. Firstly, capital investment opportunities within the sector were opened to external private investors in a bid to update and expand the energy infrastructure. The second phase of the reform was directed towards the identification of consumers' specific needs, while the latest reform was about unbundling electricity generation, distribution and transmission into separate business units in a bid to decentralise overall sector management.

Given the high success rate of the above reforms, electricity market reforms have become a common phenomenon in Argentina, Brazil, Canada, the US, the UK and other parts of Europe. In particular, following the devaluation of the local currency in Argentina in the early 2000s (Pollitt, 2008b), there was a need to privatise the electricity sector in order to provide opportunity for foreign investment in the market (Haselip, Dyner and Cherni, 2005). As a result of the privatisation, there was an obvious reduction in energy prices and government debt, and an increase in the size of the stock market (Haselip and Potter, 2010).

Also, in an attempt to address an investment capacity shortage in the Brazilian electricity sector, in 1993 the government opened the sector to private investors and regulated the prices charged by government-controlled utilities (Mendonça and Dahl, 1999).

The success rate of this privatisation scheme was evident in the increase in internally-generated revenue. In contrast to the Brazilian reform approach, the Canadian electricity market's reform was considered fragmented in nature (Pineau, 2013), due to its diversity of provincial and national controls, and other market forces. At the forefront of electricity sector reforms in Canada are Ontario, Alberta and New Brunswick (Trebilcock and Hrab, 2006). However, the outcome of the Ontario reforms were not well received because, according to Mirnezami (2014), they imposed huge investment burdens on private investors and escalated consumption prices.

As highlighted by Pineau (2013), Canada has a long history of cheap electricity pricing from a predominantly government-controlled market, making it difficult for the private sector to cope or compete (Froschauer, 2010). Just like the Canadian reform approach, the agenda of the US electricity market's reforms varied across its four regions; the Northeast, Midwest, South and West. However, the objectives of all the regions were similar, and focused on ways to enhance productivity and service delivery by introducing competition.

Weijermars (2012) believes that the US electricity sector has much to learn from its natural gas sector counterpart, which has been successfully liberalised and is performing to stakeholders' expectations. Hirschhausen (2008) maintains that there have been a lot of trial-and-error reforms in the electricity sector and pointed out that in 1992 the government introduced wholesale and retail competition to the sector, which resulted in mergers of electricity utilities. The mergers, however, did not make headway due to a lack of enthusiasm on the part of stakeholders (Joskow, 1997).

This lack of enthusiasm was believed to have been generated by the unfortunate California energy crisis of the early 2000s, which is traceable to undue market manipulation and stringent transitional rules (Woo, 2001; Friedman, 2008). In addition, the UK's reform models have been introduced in many parts of the US but no substantial achievement has been recorded (Friedman, 2008). One major criticism of the US reforms is that it introduced stranded costs in the sector (i.e. redundant existing investment as a result of new market competition; Woo *et al.*, 2003).

On a global level, critics have also argued that most electricity market reforms have not been as successful as they have been portrayed to be in terms of delivering anticipated benefits to stakeholders (Newbery, 2002; Green, 2003; Woo, Lloyd and Tishler, 2003;

Roques, Newbery and Nuttall, 2005; Blumsack, Apt and Lave, 2006; Sioshansi, 2006; Woo *et al.*, 2006). Woo, Lloyd and Tishler (2003) and Blumsack, Apt and Lave (2006), for example, argue that instead of driving down costs, factors such as capacity shortages, high costs of capital and abuse of power by stakeholders tend to escalate the cost of electricity in a competitive market.

Steiner (2000), however, explained that it would be unfair to draw conclusions on the performance of electricity market reforms from the analysis of a single country or regional market, and further posits that an index for assessing competitive market performance has not been set universally. Notwithstanding these country-specific limitations, the positive outcomes of electricity reforms remain high in a number of situations. For example, reforms have brought about technological innovation, and promoted the emergence of new market competitors, legislation and innovative solutions (Finon and Roques, 2013).

According to Woo, Lloyd and Tishler (2003), when there is competition among electricity suppliers, there is bound to be a reduction in the price of electricity, in addition to the new investment and job opportunities created by market competitors. Similarly, Zhang, Parker and Kirkpatrick (2008) maintain that electricity market reforms stimulate responsible investment decisions and performance improvements.

Furthermore, reforms have stimulated market competition globally and promoted favourable electricity prices. Clastres (2011) opined that it is important to maintain the exercise globally, especially in light of the current war against climate change and dependence on fossil fuels.

Consequently, it is fair to say that electricity market reforms has now become a recurrent practice in most developed and developing nations; the success rate however, is high in a few countries like Chile, the UK, US (Texas), and Norway (Pollitt, 1995; Pollitt, 2009). Today, the UK electricity sector reform model seems to have overwhelmingly become a standard for successive energy sector reforms across the globe (Woo, Lloyd and Tishler, 2003) especially in European Union states.

2.3 The European Union Carbon Reduction Targets and Energy System

The EU electricity market reforms symbolise what many scholars refer to as the single-most coordinated cross-border electricity market structure (Sioshansi, 2006; Sioshansi and Pfaffenberger, 2006; Moreno, López and García-Álvarez, 2012). Its main objectives were to bridge trans-border gaps in the electricity markets of member states and to establish a uniform market structure. However, for these objectives to be achieved, investments into the upgrade of existing energy infrastructure and the construction of new ones were necessary. The reforms were mainly driven by the commitments and efforts of the European Commission towards removing governments from direct involvement in electrical utilities and service delivery.

In December 2009, world leaders met at the Climate Change Summit in Copenhagen to discuss climate change mitigation strategies (Rogelj *et al.*, 2010). One of the achievements of that summit was the commitment made by various countries to consistently cut carbon dioxide emissions by 2050, using 1990 levels as the baseline (Keyman and Önis, 2004; Carter, Clegg and Wåhlin, 2011). As a fundamental part of these commitments, specific CO_2 emission reduction targets were set at both continental and national levels.

In particular, the European Union Commission pegged minimum reduction targets at 80%, while hoping that this could be stretched to achieve 95% reduction by 2050 (Böhringer, Rutherford and Tol, 2009). Furthermore, the European Parliament Directive 2009/28/EC is clear on the renewable energy production and promotion targets of member states (Capros and Mantzos, 2000). The target year is 2020, and by this year each state must ensure that RE contributes at least 20% of their energy needs (Murphy *et al.*, 2014). As it stands, member states are showing great enthusiasm towards RE, as evident in their respective policy discourses (Phimister and Roberts, 2012).

Reports by the Climate Policy Observer (2016) revealed some startling facts about EU energy systems. Of central concern are the volumes of oil and energy imports made by member states. The report indicates that, as of 2014, more than 90% of transport systems still use oil-based fuels, requiring the region to import more than half of its energy from external suppliers. Secondly, approximately £855 billion of investments in the sector are required to achieve the 2020 target.

Despite these obvious tasks ahead, the sector generated £110.3 billion per annum in turnover (Eising and Jabko, 2001). Sioshansi and Pfaffenberger (2006) reported that the main driver of European electricity sector reforms was the prioritisation of consumer needs, which eventually paved way for many policy changes, such as in the areas of electricity supply, sector monopolies, tariffs and government disengagement from all commercial activities within the sector. The EU reforms stimulated member states to introduce and facilitate the implementation of appropriate policies in support of their respective electricity markets.

2.4 The UK Energy Market

The UK has a long-term target to reduce its total GHG emission by 80% between 2008 and 2050, also on the interim, UK is expected to depend on Renewable Energy for at least 15% of total energy need of the Country by 2020 (Renewable Energy Directives, 2009). The primary functions of the UK energy sector however comprise Generation, Transmissions and distribution of energy to end users (von der Fehr and Harbord, 1993). Apart from above traditional activities, there are specialist secondary functions such as all activities that promote efficient generation, consumption (Boardman, 2004; Herring, 2006), as well as manufacture of clean energy technologies (De Coninck, Haake and Van Der Linden, 2007).

In addition, there are substantial amount of funded research into sustainable energy use (Gross *et al.*, 2012) and quite recently, supports are provided for local groups for the development of clean energy projects (Hinshelwood, 2001; Walker *et al.*, 2007; Cai *et al.*, 2009). This paved way for new Energy policy supports for decentralised generation, as evident in various new entrants' companies into various scale and capacity of generation (Rogers *et al.*, 2012).

At the National level, the UK Energy Market Reform (EMR) was launched to advance and motivate adequate clean energy investment in the energy sector and at same time ensure sustainable and affordable supply. These were the main focus of the UK "Contracts for Difference (CFD) and the Capacity Market" mechanisms. Currently the market is private sector driven, and energy consumers have the right to choose preferred supplier of choice (Toke, 2011).

However, major decisions on energy investments are taken centrally by the national Government (Sperling, Hvelplund and Mathiesen, 2011). For instance the UK Office of Gas and Electricity Markets (Ofgem) have the duties to protect consumer's interest by regulating activities of suppliers and setting market rules on wholesale energy pricing (Oswald *et al.*, 2006). In terms of sources of electricity supply, the UK relies primarily on Natural Gas, Coal, Nuclear Renewables, and Oil whose key facts are highlighted below:

2.5 The UK Centralised Conventional Energy Sources, Contributions and challenges

The *UK Energy Statistics Digest* of 2015, reports that the energy industries contributed 2.8% to the UK Gross Domestic Products (GDP) and generated employment opportunities for 162, 000 employees as at end of 2015 (DECC, 2016). Regarding specific sources of energy, Renewables and Gas exploration activities increased slightly in the same year by 6% (DUKE, 2016). An important point to note here is that a reduction in total annual energy generated in a country does not necessarily mean a reduction in production capacity of all energy sources.

For instance, between 2013 and 2014 while the annual electricity supply reduced by 4%, contribution from gas-based electricity increased by 2% (DECC, 2016). This increment was aided by regulated wholesale prices of gas. A brief overview of the performance of the various sources of the UK energy is captured below:

2.5.1 *Natural Oil and Gas*

Natural Oil and Gas are resources trapped beneath the lands and waters (Flouri *et al.*, 2015) and the UK is rich in these resources with first commercial activities taken place in the mid 1800 (Glennie, 1997). According to Biresselioglu, Yelkenci and Oz (2015) Oil and Gas sector has been at the fore front of supplying fuel, electricity and raw materials for production of many other consumables. It was also confirmed that as at the fourth quarter in 2015, the total amount of energy generated from all sources stood at 338Twh and natural gas stood out as a major source of electricity in the UK, contributing almost 99.71TWh (Terawatt Hour) (DECC, 2015).

In addition, Sharma (2011) showed that for a period of ten (10) years (1995-2005), Gas consumption rose above oil and coal in spite of the average reduction in its production for three (3) years (2000-2013). So far about 95% increase in Gas exploration has been recorded in contrast to what was projected in 1980 by experts (Söderbergh, Jakobsson and Aleklett, 2009). Particularly, production and consumption capacities increased between 1970 and 2004 (DUKE, 2016), however production alone dropped by 33% in 2004 and has not shown significant improvements till date (DECC, 2016), but for a minor surge in 2014 resulting from new fields discovered.

2.5.1.1 Demand, Production and Consumption

Oil demand and consumption has been on the decline, consumption dropped from 1,819,000 barrels per day (bbl/day) in 2005 to 1,510,000bbl/day in 2015 (Asif and Muneer, 2007). Regarding production, the July 1988 offshore oil disaster in Piper Alpha platform affected production, however, with the identification of new and recovering of abandoned oil fields, rate of production picked up in the 1990s, although not at same level prior to the disaster. Since 2011, the UK was a net importer of oil because of the inconsistent domestic production. Norway has been the main import partner for more than 50% of UK oil and gas needs in 2014 (Bjørnland, 2009).

However, the cumulative amount of domestic production in the UK peaked to 17% in 2016 above previous year thereby reducing net import of oil into the UK. According to Gupta (2008) previous Oil and Gas production decline can be attributed to the gradual switch to other sustainable alternative energy generation sources, moreover the International Energy Agency projects that Oil and Gas will be depleted in the next 20 years (IEA, 2008).

2.5.2 *Coal*

Another important source of energy in the UK is coal; historically, coal mining in the UK dates back to thousands of years ago (Kirby, 1995). Coal was largely regarded as the cheapest and major source of energy for electricity and heating in the ancient times. Rathore and Wright (1993) posits that surface mining was prevalent until the industrial revolution and further explained that although deep mining activities are gradually declining, coal is still important component of the UK energy mix.

Studies by Warren (2014) revealed that in 2014 coal contributed about 29.8% of total energy generation in the UK although towards the end of 2015 the capacity dropped to 22.7% (DECC, 2015). The sharp reduction of 7.1% was attributed to the closure of some coal mining plants occasioned by prevailing Energy Market conditions (DUKE, 2016).
Sithole *et al.* (2016) concludes that Coal is produced in the UK mostly for electricity generation. However, in a bid to boost energy mix, the UK Government further recognised nuclear power as a clean source of energy (DECC, 2015).

2.5.3 *Nuclear Power*

Ishii (2013) revealed the UK has a rich history in nuclear power generation, with the first nuclear power plant being constructed in 1953 (Wallbridge, Banford and Azapagic, 2013). As reported in a study conducted by DECC (2016), nuclear power supplied about 74.36TWh electricity to the UK consumers in 2015. In addition to work of DECC (2016), Elliott (2016) disclosed that nuclear based electricity supply has been grossly inconsistent due to the repeated closure of stations in 2006-2008, 2010 and, most recently, in 2014. It was later shown by Zhu and Guo (2016) that peak supplies were recorded in 1998 and 2011.

Since the commercialization of nuclear power operations, the sector has recorded many setbacks particularly from the growing divided public support for existing and construction of new plants. The Centre for Alternative Technology, Friends of the Earth and Greenspace raised several concerns about nuclear power station operations. Their concerns centre on possible accidents that may result from nuclear plant operations and the fears about how the government intends to dispose of nuclear waste.

They further advised that the disastrous accidents that occurred at Three Mile Island, Pennsylvania, USA, in March 1979 (De Sanctis, Monti and Ripani, 2016) and Chernobyl, Ukraine, in April 1986 (Flavin, 1987), should be guarded against.
According to a UK-wide study conducted by Pidgeon *et al.* (2008), nuclear power seems to be the least appealing energy source. That notwithstanding, it has become a fundamental part of the UK energy mix.

2.6 The UK Sustainable Energy Transition and Policy Direction

As postulated by Osborne et al. (2014), it is important for countries to tailor their business activities towards enhancing the living conditions for today's generation, but should do so without negative consequences for future generations. Admittedly, the UK is on track in this regard, particularly by contributing to the development of climate change solutions and meeting renewable energy obligations (Hopkins, 2016). The energy sector has received favourable policy and investment boosts in the last decade. In 2014 alone, the government earmarked £24 billion (b) of investment in the sector (Strantzali and Aravossis, 2016). Of the amount budgeted, oil exploration and electricity generation were allotted £12.48 b and £9.8 b, respectively. Coal mining was allotted £0.48 b, while gas and other mineral exploration got £1.2 b (DECC, 2016).

2.6.1 *Sustainable alternative energy supplies*

Fossil fuel energy sources (coal, oil and gas) have been widely reported as unsafe and insecure (Williams, 2002; Vernon, Thompson and Cornell, 2011; Rimmer, 2016). This is because they were formed in the geological past by natural processes and, as such, are not found everywhere (Desonie, 2014).

Furthermore, they are limited in terms of geographical distribution, are costly and hazardous to human health, and produce low quality energy. Consequently, switching from conventional fossil fuel energy systems to renewable energy technologies (RETs) is a preferred alternative (Hansen *et al.*, 2000; Dresselhaus and Thomas, 2001; Sims, Rogner and Gregory, 2003). Besides, the technology and facilities needed to harness renewable energy (RE) can be produced in almost every part of the world where RE resources are available in abundance (Raj, Iniyan and Goic, 2011).

The acknowledgment of this reality and the adoption of RETs as sustainable energy generation alternatives is evident in Europe, with Germany, Sweden, Denmark and, recently, the Netherlands and the UK, playing leading roles (Schreuer and Weismeier-Sammer, 2010). So far, Europe seems to take a global lead in the deployment of RETs to meet the 2050 GHG emission reduction targets.

The adoption of RETs as sustainable energy generation alternatives is at an advanced stage in most EU states, with Denmark, Sweden, the Netherlands and the UK playing leading roles (Reiche and Bechberger, 2004; Menegaki, 2013; Gullberg and Bang, 2015).

2.6.2 *Sustainable Energy Contributions and challenges*

In 2009, the EU renewable energy directive mandated that the UK produce 15% of its total energy from renewables by 2020 (Whittaker *et al.*, 2014). As at the first quarter of 2015, low-carbon energy sources contributed 14.2% of the UK's total energy (Pye, Sabio and Strachan, 2015); principally, more than half of this clean energy was generated from nuclear power (ECUK, 2016), followed by bioenergy and wind energy. Interestingly, renewable energy investments have been reported as an important driver of the UK's green growth (SNECS, 2015), and private investments in this sector summed to about £31 billion in 2013 alone (ClimateObserver, 2016).

These investments were clearly obvious in 2014 with significant increases in clean electricity generation and low carbon transportation; although renewable energy investors believe that returns on investments depend on renewable energy resource availability (Cowell *et al.*, 2015) and RE technology efficiency, and not necessarily the amount of funds invested or unstable financial markets (Richter, 2013a). For the same year, EnergyTrends (2016) reported that the capacity of renewable electricity generation appreciated above that of conventional energy sources. Out of the 339 TWh total electricity generated for supply, the share of wind appreciated by 2%, while those of nuclear and coal dropped by 1% and 7%, respectively (DUKE, 2016), compared to 2013 data.

2.6.3 *The UK Renewable Energy production capacity and sources*

Barnett *et al.* (2012) defined *renewable energy* as a general term for natural, infinite and replenished sources of energy such as wind, waves, the sun, and so on. According to Barnett *et al.* (2012), renewable energy projects can be implemented directly by the government, large and small energy companies, as well as third party organisations and local groups such as faith-based groups, school, farms and civil societies. Foxon (2013) stressed that there have been consistent increases in the scale of renewable energy generation in the UK because of its central importance in the reduction of carbon emissions. Similarly, reports from the UK Government website indicate that 83.5 TWh of renewable electricity was generated in 2015 (ECUK, 2016).

Prominent among the various renewable sources harnessed by the big six (DECC, 2017) and their percentage contribution to the UK electricity market, are offshore and onshore wind, which contributed 17.54% and 23.38%, respectively. Others are solar (9%), hydro (7%) and bioenergy (35%; EnergyTrends, 2016). In particular, hydro, onshore wind, and solar energy have been widely embraced by both commercial and private energy companies due to the increases in rainfall, wind speed and solar radiation (Ellabban, Abu-Rub and Blaabjerg, 2014).

2.6.4 *The main sources of Renewable Energy in the UK*

2.6.4.1 Marine and Wave Energy

Marine and wave energy sources hold a promising future the UK RE mix, although their technologies are in embryonic stages at the moment. That notwithstanding, the Government believes that these sources of energy have the potential to deliver around 20% of the UK's current electricity needs and have, therefore, commenced investing in it, particularly in Scotland (DECC, 2017). According to Bonar, Bryden and Borthwick (2015) the sector will achieve its full capacity by 2020.

2.6.4.2 Bioenergy

Bioenergy, on the other hand, is fast gaining prominence as a clean energy resource (De Laurentis, 2015) and the UK's coalition Government has set out a framework for its full development (Bakar and Anandarajah, 2015). Being a good source of energy produced from living organisms such as animals, wood, plants and waste (to mention but a few; Sinclair *et al.*, 2015), the end product of biomass conversion determines what biotechnology is deployed. For instance, biomass can be converted to gaseous fuel to generate heat and electricity (biopower), or converted to liquid transportation fuel (biofuel; Joly *et al.*, 2015). In Australia, biofuel is fast becoming a reliable source of liquid fuel for transportation (Azad *et al.*, 2015), while in the UK, the deployment of biomass boilers in renewable heat generation is widespread (Eyre and Baruah, 2015).

Biomass technology is cost-effective compared to other forms of renewable energy technology. Its development is, however, not without issues. Stakeholders have many concerns, among which are the carbon impacts associated with its generation, deforestation, future wood prices, and land-use change (Halder *et al.*, 2015).

2.6.4.3 Hydro energy

Hydro provides a considerable share of renewable energy generation in the UK. Electricity can be generated through a process of capturing kinetic energy from flowing water and converting it into mechanical energy (Rehman, Al-Hadhrami and Alam, 2015).

Atlason and Unnthorsson (2014) described the process of capturing water as involving either the building of a dam, diverting runoff water through a channel, or releasing stored water from a higher reservoir to a lower one. He further explained that each process requires the water to be forcefully released through a turbine, where the energy conversion takes place. In the UK, the largest hydro power station is located in Dinorwig, Wales, and produces 5,885GWh/year of electricity (Ferreira et al., 2013).

There are also many other mini hydro power projects spread across the UK, with most sited in Scotland due to the project-specific demands of top-down water flow (Sample *et al.*, 2015). Recently, however, turbines that can generate water from small flows have been manufactured to cater for various scales and categories of generation. Equally, just as kinetic energy in water is turned into mechanical energy to produce hydroelectricity, wind turbines also convert kinetic energy from the wind into mechanical energy (Hamilton *et al.*, 2012).

2.6.4.4 Wind energy

According to Islam, Mekhilef and Saidur (2013), the UK's wind energy market is fast becoming one of the biggest contributors to the country's energy mix. Distinguished as having the best wind speeds and most wind resources in Europe (Millward-Hopkins *et al.*, 2013), the UK can comfortably depend on wind energy for its lifelong energy demands if it is fully harnessed. Recent evidence (Bassi, Bowen and Fankhauser, 2012; Kota, Bayne and Nimmagadda, 2015; Enevoldsen, 2016; Kumar *et al.*, 2016) suggest that at the moment, most wind energy installations are onshore, with a handful of offshore installations springing up here and there.

In particular, onshore wind energy, which is classified as a low-cost route to energy security, has surged in recent times. It contributes to both national and local economic growth because of diversity in the categories of its developers (Tatchley *et al.*, 2016). As reported by Elliott (2017), wind energy is rated the cheapest RE electricity scheme in the UK because of its low operating costs.

Azad and Alam (2012) traced the existence of wind technology to the 14^{th} century and noted that it has progressively improved in size, noise level, performance and output. This is consistent with the findings of Peacock *et al.* (2008), which reveal that from small businesses and farms to community groups and commercial developers, there are turbines manufactured to cover all categories of development. Herran *et al.* (2016) also found that the extensive availability of wind resources has contributed to decreases in GHG emissions. In addition, according to Redlinger, Andersen and Morthorst (2016), turbines manufactured in the 21^{st} century are self-sustaining, and have short payback periods on some aspects of their costs. He observed that as soon as a turbine becomes operational, the amount of energy used in its construction can be recovered in less than one year, in addition to fewer environmental impacts being associated with its construction and operation.

Most wind energy projects are sited in remote locations for many reasons. In addition to the high wind speeds found in remote locations, wind flow directions are assumed to be influenced by the homogeneity of remote landscapes (Armstrong *et al.*, 2016). Statistics from the UK wind industry trade association indicate that approximately 35 TWh of energy was generated, powering 8 million homes, as at the end of the second quarter of 2016 (RenewableUK, 2016). The same RenewableUK (2016) further submit that 44.23% of operational onshore wind projects are located in England, while 39.58% are in Scotland. North Ireland and Wales host 6.57% and 9.62% of the projects, respectively.

These statistics contradict what was obtained earlier from the Renewable UK (2015) database, which reported that Scotland alone accounts for over 60% of the total onshore wind energy generation in the UK (Phimister and Roberts, 2012). There is, therefore, a need for a more accurate wind resource assessment and reporting tool in the UK. No doubt Scotland has better wind resources and topography for wind projects than England (Okkonen and Lehtonen, 2016); however, the question of where most of these projects are located is still a subject of debate.

2.6.4.5 Solar energy

Following the sudden thriving of solar energy globally (Kannan and Vakeesan, 2016), the installation of solar photovoltaic (PV) systems has witnessed exponential growth in recent times (Huijben *et al.*, 2016). Solar energy is generated from the electromagnetic radiation of the sun, which is a free and highly sustainable source of energy (Aguiar, Dıaz and López, 2016).

According to Pandey *et al.* (2016), the key technological components (PV panels and battery backup, inverter and charge regulators) for harnessing solar energy are not only inexpensive, but equally easy to install, and require low maintenance. For example, Mir-Artigues and del Río (2016) reported that between 2006 and mid-2016, the cost of PV systems declined slowly to a point where people can earn money from a scheme known as the rent-a-roof package (i.e. utilities paying to use a customer's roof for PV system installation; Richter, 2013a).

Historically, solar energy usage dates back billions of years, although the first solar panel was introduced into the market in 1956 (Wilson and Grubler, 2011). As at early 2015, more than 5,000 households in the UK have solar panels installed on their roofs (Baborska-Narozny, Stevenson and Ziyad, 2016). The UK Government must, however, be credited for incentivising the uptake of these energy systems. For instance, householders with solar panel installations on their roofs are entitled to subsidy payments from the Government (Cherrington *et al.*, 2013).

In addition, within a period of 20 years, solar panel owners could save up to £8000 from the Government's Feed-in Tariff, whether they are generating for sale or consumption, while some have benefited from free solar panels from the Government (Solangi *et al.*, 2011). With advancements in solar technology, there are also corresponding improvements in the quality of lighting, and availability of electricity all day, irrespective of time and season (Lewis and Nocera, 2006).

Sadly, however, smaller energy suppliers in the UK still rely on larger companies to purchase wholesale energy at an uncomfortable price, which they in turn retail to consumers (von der Fehr and Harbord, 1993; Bradley, Leach and Torriti, 2013; Bunn and Yusupov, 2015).

Although efforts have been made to ensure wholesale energy pricing information is made public in advance before a purchase agreement is entered into by trading companies (Huisman and Kiliç, 2015), the centralisation of energy systems is generally exposed to intermittent interruptions due to its lengthy and complicated supply chain (Alanne and Saari, 2006), as illustrated in Figure 2.1, below.

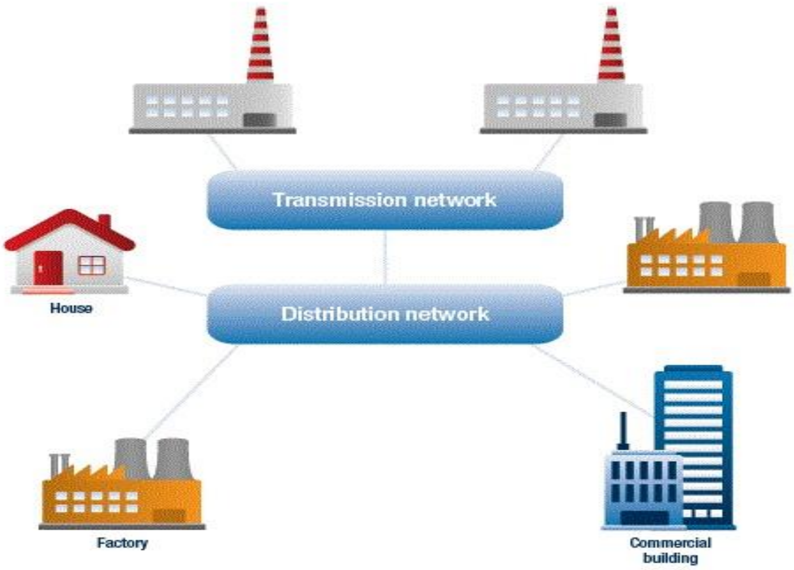

Figure 2.1: Centralized Energy System supply chain (Source: Roberts (2013)).

Having considered the UK energy sector, the various sources of central supply, and their performance over time, it is also reasonable to look at the controversies surrounding the centralised system with a view to identifying alternative or complementary energy management systems from the literature.

2.7 The Case for Alternative System

Centralised energy systems (CESs), as the name implies, involve the process of generating electricity from a large power plant that is connected to a national grid for transmission and distribution to the point of use (Martin, 2009). In other words, the point of generation is not necessarily the point of distribution or consumption.

In the face of ongoing collective actions towards carbon reduction, the efficiency of this type of energy system has been strongly challenged by a number of writers (Carley, 2009; Sanz *et al.*, 2011; Abbas and Merzouk, 2012; Momoh, Meliopoulos and Saint, 2012). In particular, Pepermans *et al.* (2005) listed three of the most common pitfalls of CESs, which are outlined below.

i. High Cost of transmission and distribution

As highlighted by Pepermans *et al.* (2005), the costs of electricity transmission and distribution constitute about one-third of end-users' total electricity bills, especially for electricity supplied from distributed networks. The high costs of transmission and distribution basically cover the losses incurred by energy companies in the process of switching between high and low voltages, as well as between networks. In addition to increased tariff, Strachan and Farrell (2006) opined that the GHG emitted from the fuel burnt to generate electricity centrally, contributes to climate change.

i. Challenges of powering remote locations

Comparatively, the cost of powering cities is 70% cheaper than what is required to power places remote from central power stations (Vovos *et al.*, 2007). This is because, apart from health, safety and environment considerations, power plants must be located where there is an adequate workforce and a viable market, and these are not common in remote places (Narula, Nagai and Pachauri, 2012). Also, returns on investment may be less attractive with a low-consumption population.

Moreover, the distance through which underground piping or overhead poles and cabling needs to cover may require huge investments depending on the topography of the area (Levin and Thomas, 2012). Generally, CESs depend largely on a lengthy supply chain, huge investments in production facilities and infrastructure and, sometimes, may lead trade partners into conflict (Weisser, 2007b).

ii. Lack of energy security and price stability

According to Li (2005), one major incentive of any energy system is the ability to guarantee long-term security of supply at a stable and affordable price. Unfortunately, this is not the case with CESs because, as pointed out earlier, fossil fuel energy sources (coal, oil and gas) are unsafe and insecure, and not as diverse as decentralised generation.

However, with the current deregulated electricity market, market flexibility has been introduced and unnecessary barriers to entry eliminated, while consumers now have many suppliers to choose from for their energy needs (Sioshansi and Pfaffenberger, 2006).

Also, Bouffard and Kirschen (2008) posit that large energy companies are adamant about the fact that consumers are keen and eager to become part of the system, understand how things work, and not be mere economic 'logs'. No doubt, the majority of large-scale renewable energy projects are equally centrally controlled because, according to Mitchell and Connor (2004), the earlier protagonists of renewable energy generation in the UK were mainly large energy companies and, as such, the roles of individuals and small-scale energy groups were not recognised in the development energy systems.

Instead, they were neglected and reduced to devoted disciples, observers and passive consumers who could be exploited for economic gain. This sectorial monopoly has been widely criticised by Cai *et al.* (2009) and Pollitt (2008a) for causing unrealistic economic, technological and political complexities in the energy supply chain.

Giannakis, Jamasb and Pollitt (2005), however, posit that it is unfair to always classify market monopolies as disadvantageous to consumers, because larger companies have the capacity to not only save future costs but to also sustain energy production. Citing the UK National Distribution Networks as an example, Giannakis, Jamasb and Pollitt (2005) maintain that introducing competition to the grid market will amount to reductions in economies of scale and wastage of resources in infrastructure development.

In the face of several criticisms, promoters of CESs have responded in a number of ways. Manfren, Caputo and Costa (2011) submit that, irrespective of the controversies associated with CESs, the systems do not impede local involvement in RE activities, and local authorities and municipal councils still control environmental and climate issues in some parts of Europe (McLaren Loring, 2007).

Nevertheless, current practice has expanded the community's capacity to be involved in various energy activities and, surprisingly, local communities and groups are gradually making a mark in sustainable energy generation in the developed world—Australia, Denmark, Sweden, Germany, the UK and the US (Gross, 2007; Loring, 2007; St Denis and Parker, 2009; Pitt, 2010).

This does not dismiss the importance of large-scale energy projects; however, linking community-led small-scale projects to larger ones can scale-up capacity (DECC, 2014). Against this background, one of the most effective emerging energy management systems that can complement or even replace the centralised system is that of *community-led renewable energy activities*, which will be discussed in detail in the next section

2.8 Overview of Community-led renewable activities

Although the UK Energy Market Reform mechanisms mostly favour large energy companies who, to date, still play the lead role in the reformed UK energy market, the number of community groups and individual developers has continued to expand greatly. The role of the community in the implementation of renewable energy schemes has been a subject of political commentary without clear policy supports.

Harnmeijer, Harnmeijer and Loyd (2012) observed that earlier policy instruments for the stimulation of renewable energy generation in the UK (Renewable Non-Fossil Fuel Obligation, NFFO; and, later, Renewables Obligation, RO) were not flexible enough to accommodate local participation in the generation and management of energy.

Similarly, Mendes, Ioakimidis and Ferrão (2011) assert that prior to the *UK Energy White Paper* of 2003, which recognised and encouraged community-led sustainable energy programmes, there were no sustainable energy generation projects with set energy agendas and benefits retained by the community (Walker, 2007). However, the devolution of land-use planning powers to Scotland and Wales has incentivised the scaling-up of citizen participation in energy projects.

However, in 2014, a practical policy document was released by the UK Department for Energy and Climate Change titled *Community Energy Strategy: Full Report*, with an updated version released in 2015 (DECC, 2014; Seyfang *et al.*, 2014). The strategy, which was the first of its kind in the UK, was birthed after the government became convinced that communities can organise and lead sustainable energy activities.

2.8.1 *Understanding Community Energy*

The word *community* is ambiguous and can mean different thing to different people, as its meaning revolves around the context in which it is used (Jewkes and Murcott, 1996).

While a variety of definitions of the term *community energy* (CE) have been suggested (Hain *et al.*, 2005; Walker and Devine-Wright, 2008; Warren and McFadyen, 2010; Hargreaves *et al.*, 2013; Seyfang, Park and Smith, 2013; DECC, 2014), this research will adopt the definition suggested by the UK Department of Energy and Climate (DECC).

The DECC (2014) defines *community energy* a diverse range of groups and the various responsibilities undertaken by these groups to ensure that local people accept and participate in small-scale RE projects, and also benefit from positive environmental, social and economic outcomes of the projects' activities. This can be either a temporary or permanent group of enthusiastic individuals generating, purchasing and managing energy, and/or promoting its efficient use. From the above definition, it can be deduced that local participation and leadership in energy matters is important in the deployment of renewables towards the fulfilment of carbon emission reduction pledges by the UK.

Historically, community-based activities related to environmental sustainability are not new, although the approaches are different. Emphasis on such activities in present times tends to be more on community renewable energy projects (CREPs). According to Alvial-Palavicino *et al.* (2011), CREPs are an integral part of global micro renewable energy generation programs.

2.8.2 *Brief overview of Community Energy in EU lead states*

2.8.2.1 Denmark Community Energy Sector

Community energy activities in Denmark date back to the late 1970s. At that time, the local authorities were responsible for implementation of energy projects and seized the opportunity to promote citizen participation and ownership of them (McLaren Loring, 2007). At the moment, the Danish energy sector roadmap aims for all the country's energy to be generated from renewables by the year 2050. In the meantime, a quarter of all the electricity consumed in Denmark comes from wind generators owned by the community (McLaren Loring, 2007). Evidently, 80% of these wind energy systems are owned locally through community partnerships (Devine-Wright, 2005), making Denmark one of the world leaders in wind energy development.

2.8.2.2 German and Spanish Community Energy Sectors

Germany is determined to switch to renewables for at least 80% of its total energy demand before the year 2050 (Lipp, 2007; Lehr *et al.*, 2008; Lund and Mathiesen, 2009). Approximately 47% of Germany's energy consumption will be sourced from renewables by 2020 (Hinrichs-Rahlwes, 2013). This projection is achievable if the competing commitments of the community groups are sustained (Julian, 2014). Spain, on the other hand, recorded a 12% contribution to its total energy demand from renewables in 2014, which has been reported as a breach of its commitment towards achieving its 2020 target (Romero, Santos and Gil, 2012; Montoya, Aguilera and Manzano-Agugliaro, 2014).

2.8.2.3 The UK Community Energy Sector

In the UK, it appears that the newly-introduced Renewable Obligation (RO) supports a centrally-governed energy system (Ward and Inderwildi, 2013; Kern, Kuzemko and Mitchell, 2014). This is not surprising, because according to DECC (2013), the UK only pledged to generate 15% of its total energy from renewables by 2020, which is rather low compared to the targets set by other EU states.

That notwithstanding, locally-organised energy delivered 508 MW of energy to many homes and businesses in Scotland alone as of late 2015 (Fiona and Kalina, 2015), and multiplier effects, which include the reduction of community carbon footprints, could lead to the attainment of the UK's carbon emissions reduction targets. In their studies on RE implementation, Shamsuzzoha, Grant and Clarke (2012) revealed that people are more willing to accept smaller RE projects than larger ones. This assertion further demonstrates the importance of engaging local stakeholders, with a view to ensuring they share the benefits accrued from the project, as witnessed in Denmark and Germany (Cowell, Bristow and Munday, 2011; Musall and Kuik, 2011; Li *et al.*, 2013).

2.8.3 *Market similarities and differences*

Comparatively, the UK energy market is different from those of Denmark and Germany in a number of respects. While the former is an emerging sector in terms of community participation, the latter are perceived as pacesetters in the sector, and have become a reference point for countries that are new entrants in CEPs. Another area of difference between Scotland, Denmark and Germany, according to Menanteau, Finon and Lamy (2003), is that Danish and German financial institutions support RE projects, unlike in the UK where the government only provides loans for micro energy project development.

The nature and conditions of CREPs vary from place to place. For instance, regulatory conditions in Germany support and promote CREP diffusion; while in the UK, policy supports are still canvassed for by local actors. In particular, according to Lipp (2007), German policies are tailored to fit specific RETs, because each technology comes with its own challenges that owner companies have to deal with (Karakaya, Nuur and Hidalgo, 2016). For instance, in 2011, the German Government launched a policy called *Energiewende* to serve as a blueprint for others looking to cut GHG emissions, enhance energy security and boost energy efficiency.

The UK's financial institutions have doubts about uncertainties in the UK electricity market, making the process of obtaining government grants in the UK very competitive for community-based developers. It is, however, not surprising that as at the end of 2015, Germany had the highest number of installed PV systems, with community ownership of energy projects standing at 60% as a result of these obvious differences (Karakaya, Nuur and Hidalgo, 2016).

2.8.4 *Overall Market barriers*

The community energy sector/market is faced with significant hurdles and, as such, raises questions and attracts criticism from both public individuals and organisations. One such question that needs an answer is: Can full global community leadership of energy projects be achieved, considering the continuously growing energy demand, changing market conditions and regulatory reforms which automatically place huge investment burdens on the energy sector (Haney and Pollitt, 2013)?

Furthermore, in a notable critique of CEPs, Bolinger (2001) believes that involving the people, energy groups and the community in energy generation and ownership is more wishful thinking than a sincere effort towards positive change, as community involvement and ownership does not translate into freedom from global energy challenges.

Several other scholars (Upreti, 2004; Devine-Wright, 2007; Minang, McCall and Bressers, 2007; Jones and Eiser, 2009; Mondal, Kamp and Pachova, 2010) doubt that local people have the right attitude, capability and capacity to sustain rising demand for energy infrastructural investments and the possibility of eventual government takeover of the sector. Furthermore, previous studies supporting the transition to full community leadership, such as Haney and Pollitt (2013), would have been much more persuasive and convincing if the authors had addressed the issues of future outcomes of energy systems with monopolistic ownership structures.

Undoubtedly, there has been a lack of adequate publicity on the achievements of CEPs in the past, thereby making such energy systems unpopular (Hoffman and High-Pippert, 2010). This may be due in part or wholly to the fact that most community energy initiatives are located either in rural areas or in small towns away from large urban centres. For example, in Scotland alone, over 200 CEPs are already installed in the Highlands and other remote places, as at early 2014 (Community Energy England, 2016), but their socioeconomic benefits are not widely communicated.

This lack of adequate communication regarding the gains and successes of CEPs echo the call of the UK Government to publish the benefits of all sustainable community energy generation projects in the UK and its environs (Hargreaves *et al.*, 2013). Some published intangible benefits include social regeneration, education and learning, social capital, empowerment, and capacity building. In addition, there are also tangible benefits; for example, reliable energy supplies, job creation, reduced energy bills, local income, GHG emissions reductions and delayed depletion of conventional energy resources (DECC, 2014).

2.8.5 *Ownership and management structure*

Prior to commencement of any REP, irrespective of its scale and size, a vehicle for successful project delivery must be put in place in an organised, structured and, in most cases, legal manner (DECC, 2014). Having a legal form of community-scale RE project ownership is a matter of choice, as investors and interest groups can decide to go against the rule. This vehicle is a network of professionals, volunteers, interested individuals and investors with a shared vision of getting involved in the planning, organisation, implementation and ownership of renewable energy projects (centred on citizen participation and ownership).

In their study, Harnmeijer et al. (2012) posit that accessing a group of experienced individuals or organisations for guidance, direction and professional advice on an issue that one is finding hard to navigate (for example, the challenges communities are likely to face when a new energy technology is introduced into the market) can be relieving and can further stimulate interest in that direction.

In other words, the overarching issues associated with CE development are beyond the community's ability to handle; hence the need to broker a mutually-beneficial partnership with relevant experts. The importance of developing partnerships between the community and other relevant actors in RE markets has been stressed (Walker and Cass, 2007; Van der Horst, 2008; Mendonca et.al, 2009; Sovacool, 2013). Moreover, The UK DECC conducted a study in 2013 (*Community Energy 'call for evidence'*) to ascertain the actual growth and potential capacity of CEPs in the UK. The outcome of this study revealed that there were over 5000 community groups across the UK doing amazing things in the areas of energy generation, promotion of energy efficiency, and renewable heat initiatives.

Several other research and on community energy development (Hanley and Nevin, 1999; Hinshelwood, 2001; Rogers et al., 2008; Walker, 2008; St Denis and Parker, 2009; Warren and McFadyen, 2010; Walker et.al, 2010; Cass et al., 2010; Munday et al., 2011), have identified the main barriers to the scaling-up of CE uptake to be: lack of access to funding, poor legal and regulatory frameworks, and lack of community capacity to cope with the growing demands of the renewable energy sector.

However, providing community energy groups with opportunities to access funding, skills, information and advice are some of the solutions prescribed (Walker, 2008). According to Walker *et al.* (2007), a more flexible legislative and policy support is necessary for expansion of community participation and ownership of RE projects to other parts of the UK, as witnessed in Scotland and England.

2.9 Summary

Chapter 2 began with an in-depth discussion of various reforms in the global, regional and national (UK) energy sectors, and how they have led to a prevailing need for alternative energy management systems. The second strand of the discussion focused on the UK energy sector and renewable energy projects, with a clear interest in CREPs. It was not, however, clear from the review whether reliable community leadership of energy projects can be achieved, considering continuously growing energy demands, changing market conditions, and regulatory reforms that automatically place huge investment burdens on the energy sector. Chapter 3 will appraise the various community energy business models used in the UK, including their effectiveness, management structures and approaches to CREP development.

CHAPTER 3: THE UK COMMUNITY ENERGY PROJECTS OWNERSHIP – PURPOSE, PRINCIPLES AND MODELS

3.1 Introduction

Emerging empirical evidence from Chapter 2 indicates that community groups are a common renewable energy (RE) activist organisations, which both developed and emerging economies rely on to meet their various greenhouse gas (GHG) reduction targets. It was also discovered that local participation and leadership in energy matters is an important aspect in deploying renewables towards the fulfilment of the UK's carbon emission reduction pledges. It was not, however, clear from the review whether reliable community leadership of energy projects can be achieved in the context of continuously growing energy demand, changing market conditions and regulatory reforms, which automatically place huge investment burdens on the energy sector. To fully understand the purpose and underlying principles of the community ownership of assets in the UK with a view to addressing the second objective of this research, this chapter will appraise the various community energy business models (CEBMoDs) used in the UK, including their effectiveness, management structures and approaches to community renewable energy project (CREP) development.

3.2 Brief historical background to community ownership of assets in the UK

The concept of community ownership of assets and infrastructure in the UK dates back to the 17th century (Aiken, Cairns and Thake, 2008) and has received favourable policy attention in the UK lately (Dixon, 2009; Bailey, 2012; Moore and McKee, 2014). This emerging trend entails a gradual transfer of rights for the development, management, and control of assets (land) and infrastructure (housing, energy, water, healthcare, sporting facilities projects, and so on) from public managers to organized community groups or locals (Bracht et al., 1994; Armbruster et al., 1999; Lehman et al., 2002).

According to Alexander and McShane (2006), the gesture is an innovative concept through which society is built and governed to ensure social, economic and environmental benefits for the people. In his work on Scottish community land ownership practice, Hoffman (2013) highlighted many intricacies involved in community ownership processes, structures and systems, although he did not cover community ownership of renewable energy projects (REPs). A key takeaway from his work is that local ownership can be configured in a variety of ways, such as changes to management control, rights and privileges over assets, infrastructure and services (Donais, 2015). As can be expected, these rights are transferred from a centrally-governed authority to a relatively decentralised market and people-oriented authority in the form of a long, free or short lease.

A number of other studies have reported that proper local community engagement in the ownership and management of public assets can yield positive benefits (Cai, 2003; Kerka, 2003; Mathie and Cunningham, 2003; Antonopoulos and Floro, 2005). Also, there is overwhelming evidence corroborating the notion that people-centred RE activities are easily accepted (Leaney et al., 2001; Shackleton et al., 2002; Varghese et al., 2006; Warren and McFadyen, 2010). These activities may be originally conceived, developed and owned by the community or, on the other hand, ownership, control and management could be transferred from public owners to the community. Apart from the transfer of control from a top-to-bottom management system, reforms in asset management can also mean the reassignment of rights over an asset to a user (Lane, 1997).

3.2.1 *Drivers of community-owned activities*

Most community-owned endeavours are created in response to perceived or anticipated local economic benefits. One view expressed by Sachs et al. (1995) is that economic reasons are not enough to justify local investment and/or ownership of assets, or market or sector reforms. Rather, long-term security of the investment, the extent of ownership rights, and easy access to credit are the major drivers of community endeavours. Similarly, research by Waldron (1990) accedes to Sachs et al.'s (1995) standpoint by stressing that rights to assets must not only be secured, but control over such assets by the new owners must be unrestrained.

To further buttress the submissions above, Salerno (2008) reiterated that full-scale entrepreneurial activities are enhanced when control is total. Most importantly, a measurement of the impact of community ownership structures on the value and performance of the assets, services and infrastructure is what defines an explicit roadmap for future schemes (Buckley, Wang and Clegg, 2007).

Corresponding research in this area (Becker and Sloan, 1985; Wei, Varela and Hassan, 2002; Boyle, 2003; McKee, 2007; Perrini, Rossi and Rovetta, 2008; Cornett *et al.*, 2010) has tried to establish a relationship between community ownership and performance. The details of these relationships will be captured in the next chapter of this thesis; but before then, the next section examines how local ownership impacts REPs.

3.3 Local community ownership as a driver for renewable energy projects

The main theoretical and practical premise behind local ownership advocacy is its creation of local synergy, and facilitation of people-centred projects. It tends to be preferred over conventional business structures based on certain perceived distinctive features of success, as summarised below (Barkley, 1978; Carter, 1996; Borzaga and Defourny, 2004; Wiersum, Elands and Hoogstra, 2005; Varghese et al., 2006; Schreuer and Weismeier-Sammer, 2010).

1. The business is owned and controlled by the local people in most cases
2. The primary aim of engaging in these businesses is to meet local needs, which in turn is great motivation for local support and participation
3. The business is not-for-profit, although in some cases local investors get returns on their investments
4. The process of setting up the business requires wide consultation with various categories of stakeholders, and this allows for comprehensive assessment, identification and mitigation of risks
5. The decisions arrived at reflect the contributions and interests of all stakeholders and are binding
6. Knowledge transfer is a mandatory responsibility of the enterprise
7. Financial incentives and similar models are easily accessible by new enterprises
8. There are always similar enterprises doing similar business, which new groups can learn from

In a nutshell, local ownership can be described as an opportunity created by community activists for the purpose of driving local participation in RE activities (Smith, 2007; Allan, Mcgregor and Swales, 2011). It provides a platform for local people to buy shares into RE and other community schemes. This implies that local people can become both financial shareholders and community stakeholders in projects.

In 2012, Dewald and Truffer conducted a study to understand the geography of photovoltaic market formation in Germany and found that place-based activities and ownership are key to promoting and sustaining the growth and expansion of CREPs.

3.3.1 *Success of local ownership of assets*

The effectiveness and degree of success of local ownership of any asset depends on favourable regulatory supports and structured business models (List and Co, 2000). For instance, the Danish Government recognises the central role that local consumers play in the fight against climate change and, as one of the many ways to encourage and sustain these local actions (Lund and Mathiesen, 2009), the law supports consumer ownership of wind turbines, either individually or jointly (Lund, 2007).

In particular, local farmers and land owners have successfully partnered to implement CREPs in many parts of Europe (Meyer, 2003). Similar partnerships exist in Sweden between consumer cooperatives (coops) and local real estate experts, where local owners draw dividends from the project based on what each member consumed in a year; i.e., a reward for participation and patronage (Leaney et al., 2001).

In the UK, local ownership has redefined business relationship configurations in the energy sector because people are no longer seen only as customers/consumers, but also as producers, owners and experts in energy projects (Schreuer and Weismeier-Sammer, 2010). Local ownership diffusion has led to local value creation and further positioned community energy groups (CEGs) as major actors with competitive advantage in the energy market (Urbanchuk and Director, 2006). This approach has necessitated the introduction of constant innovative procurement and financial schemes to accommodate new entrant actors in the sector; it further provides flexible business models for CEGs to engage in energy transition.

Although some community energy projects have been executed by individuals and informal community groups (Hargreaves et al., 2013; Seyfang, Park and Smith, 2013), the government, however, is strongly supportive of formal registration, and has mandated third-party support organisations to provide necessary encouragement to these groups (Hall, Lobina and Motte, 2005). In particular, the UK Government has empowered local authorities to provide prompt and adequate support to CEGs.

It has been contended that continuous support to individual consumers will result in low patronage to utility companies, because the more self-sufficient customers become, the less revenue utility companies generate.

On the hand Richter (2013a) asserts that when similar consultancy services are provided by utility companies to customers of a competing company, they bring about competitive advantage. Richter (2013a) further claimed that significant success has been recorded in gas and heating efficiency activities of CEGs, which has resulted in less reliance on gas providers (Richter, 2013a). Fundamentally, the success of these RE schemes depends largely on the business model deployed.

3.4 Renewable Energy Projects and Business Model Theories

The concept of business models (BMs) proved to be an important field of research in the mid-1990s (Strupeit and Palm, 2016), notably in m-commerce (Sadeh, 2003), e-commerce (Lee, 2001), product market strategy (Zott and Amit, 2008), technology and innovation management (Chen, 2015), the research community and, quite recently, in the energy community (Behrangrad, 2015; Engelken et al., 2016; Herbes et al., 2017).

Generally, BMs are central to understanding an organisation's approaches to capturing customers' needs, how these needs can be met to their satisfaction, and how revenue can be generated in the process (França et al., 2016). In essence, value creation, delivery and capture are the cruxes of any organisation, and these are achieved by the organisation's ability to clearly identify needs that can be met to derive sustainable gains (Chesbrough and Rosenbloom, 2002).

Equally, when an organisation recognises the importance of sustainability in its business undertakings and demonstrates and upholds this as its core principle, then such an organisation can be classified as a *sustainable organisation* (Miller, 2011). This also applies to the BM of that organisation, because as earlier stated, BMs are the vehicle for the delivery of an organisation's core business activities (Stubbs and Cocklin, 2008).

3.4.1 *Understanding the BM concept*

In a bid to buttress the importance of sustainable development in all sectors of human endeavour, a considerable amount of literature has been published on the need for sustainable BMs (Comes and Berniker, 2008; Lindgardt et al., 2009; Chesbrough, 2010;

Sosna, Trevinyo-Rodríguez and Velamuri, 2010; Amit and Zott, 2012; Massa and Tucci, 2013). These studies have been carried out from a multi-disciplinary perspective, but without any consensus on what the overall BM concept is about, as evident in the conflicting and sometimes complementary representations of the concept by researchers.

Magretta (2002) argues that although the topic has been well researched by e-business, innovation and strategy scholars in recent times, in the renewable energy research domain, no consensus has yet been reached as to what it should mean. This indicates a need to be explicit about what exactly is meant by "business model". A few definitions of BMs exist.

Engelken et al. (2016) defined BMs as business tools for analysing a firm's or company's activities and programmes for generating and obtaining value. For Richter (2013a), BMs describe how a firm organises its financial, human and other business-related resources towards value creation and service delivery to customers, thereby profiting from the value delivered.

Funkhouser et al. (2015b) gave the term four overlapping definitions: 1) a platform for understanding the business and the market, 2) a business management tool, 3) a duplicable business blueprint, and 4) a control mechanism for business operations. A similar view is held by Nichifor (2015), who believes a BM is a corporation's blueprint for effective business operations.

This definition has been further extended by Xiang et al. (2015) to mean a market device that identifies possible financial and market barriers to business success, and offers solutions to overcoming those barriers. To elaborate upon these definitions, Strupeit and Palm (2016) maintained that, in spite of their varying opinions, the fundamental characteristics of BMs are generally similar. A key take-away from these definitions can be summarised thusly. BMs are the main drivers of every business.

They are rooted in, and can be better understood within the sociotechnical context. In respect to sustainable business delivery, various definitions of BMs are found, although most RE BM researchers tend to adopt Osterwalder, Pigneur and Tucci's (2005) definition. According to Osterwalder, Pigneur and Tucci (2005), it is important to understand the keywords *business* and *model* before the combination of these words can have a clearer meaning.

Based on the above assertions, they coined the following definition for *business model*: *"A business model is a conceptual tool containing a set of objects, concepts and their relationships with the objective to express the business logic of a specific firm. Therefore we must consider which concepts and relationships allow a simplified description and representation of what value is provided to customers, how this is done and with which financial consequences" (Osterwalder, Pigneur and Tucci, 2005, p. 4).*

With this definition in mind, it can be inferred that renewable energy business models (RE-BMs) are configured basically to derive full value from projects. The literature has provided evidence of the common characteristics of these models. One such characteristic is that they are novel ideas rooted in proffering innovative solutions, and networking and skill-set development

3.4.2 *Classification of business model themes*

Huijben and Verbong (2013) and Asmus (2008) combined the recommendations of BM innovation and transition studies to advance the understanding of the impacts of viable BMs on RET diffusion. Similar work by Wainstein and Bumpus (2016) presented a framework for analysing REPs based on combination of sociotechnical transitions, BM theory and multi-level perspectives, while Richter (2013a) put forward the view that innovation literature can offer insights into BMs arguments.

In 2002, Chesbrough and Rosenbloom identified value proposition as a critical factor to be considered when trying to understand the concepts of BMs. Lindic and Marques da Silva (2011) further posit that value creation and capture provide a common complementary ground where most BM definitions are merged. Again, Zott, Amit and Massa (2011) pointed out that the economic aspects of BMs dominate BM research (Richardson, 2008; Teece, 2010; George and Bock, 2011; Boons *et al.*, 2013), and lamented the total disregard of most studies for the infrastructure-customer interface, which is an equally important component of BMs.

An in-depth study by Engelken *et al.* (2016) covered all the components of BMs and their conceptual frameworks. The study also compared RE-BM success factors across different economies of the world. The revenue models and theories that underpin BM research, are classified in Table 3.1, below.

Table3.1: Classification of Renewable Energy Business Models Research by literature themes and underlying frameworks [Adapted from Engelken et al. (2016)]

RESEARCHERS	RESEARCH EMPHASY	UNDERPINNING THEORIES
Engelken *et al.* (2016) Richter (2012b) (Richter, 2012a)	Electric Utilities Business Model Innovation	Disruptive innovation
Andersen, Mathews and Rask (2009) Budde Christensen, Wells and Cipcigan (2012) Lih *et al.* (2012) Rodríguez-Molina *et al.* (2014) Wakkee, Barua and Van Beukering (2014)	Electric Vehicles Business Model Business models in the smart grid Static business models	Business model concept
Chang *et al.* (2011)	Hydrogen Production Business Model	Business model concept
Jolly, Raven and Romijn (2012) Richter (2013b) Varun and Benjamin (2013) Davidson and Steinberg (2013) Funkhouser *et al.* (2015b) Biswas, Diesendorf and Bryce (2004) Strupeit and Palm (2016) Karakaya, Nuur and Hidalgo (2016)	Solar PV Business Model	Social entrepreneurship Disruptive innovation Decision theory Economies of scale Business model concept Microfinance Business model concept Business model concept
Balachandra, Kristle Nathan and Reddy (2010) Schleicher-Tappeser (2012) Aslani and Mohaghar (2013) Cucchiella and D'Adamo (2013) Bocken *et al.* (2014)	Sustainable Energy Technologies Market Analysis	Decision theory Resource-based view Business model concept Supply chain management theory Bottom/base of the pyramid
Hultman *et al.* (2012) McIntosh *et al.* (2011) Nair and Paulose (2014)	Biofuels Business Models	Business model concept Bottom/base of the pyramid Innovation theory
Juntunen and Hyysalo (2015)	Business Models for Renewable micro-generation of Heat and Electricity	Bottom/base of the pyramid
Schmidt et al. (2013)	Private investments into rural electrification	Levelized cost of energy
Lenssen *et al.* (2012)	Viability of business models	Life cycle costing and Micro Finance
Loock (2012)	Service-driven business models	Multi-level perspective theory
Behrangrad (2015)	Demand side management business models	Optimization theory
Yildiz *et al.* (2015)	Renewable energy cooperatives	Transaction costs theory

The next section reviews incumbent CEBMoD with a view to understanding their area of competitive advantage

3.5 Understanding the UK Community Energy Business Models (CEBMoDs) - A Resource-Based View (RBV) approach

Research generally involves the use of theory, which may or may not be explicitly required in the overall research design. However, when reporting the findings and conclusions of any research, it is important to highlight the underpinning theories. According to Saunders et al. (2011), at the beginning of any research, theory definition is what defines the direction of the research design.

In the scientific community, several organisational management theories have been developed to understand the competitive advantage achieved by some organizations over their contemporaries operating within the same business environment and market conditions (Ahmad, Bosua and Scheepers, 2014; Wagner III and Hollenbeck, 2014; Albrecht *et al.*, 2015; Saeidi *et al.*, 2015). For instance, Delery and Roumpi (2017) believe there is a connection between specific human resource management (HRM) practices within an organisation and their competitive advantage. Numerous other studies have attributed competitive advantage to organisational culture (Barney, 1986), internal knowledge transfer (Argote and Ingram, 2000), and the organisation's strategic supplier partnerships (Li *et al.*, 2006).

However, the resource-based view (RBV) appears to be a suitable theory for understanding and addressing this research aim, particularly in a competitive business environment such as the RE sector, where CREP organisers are expected to develop unparalleled local capabilities and other resources to successfully deliver the project goals, and achieve and maintain competitive advantage (Almarri and Gardiner, 2014).

3.5.1 *RBV history and usage*

Hitt, Xu and Carnes (2016) traced the history of RBV theory to 1959 when it was first used by an economist Edith Penrose, to describe how a firm's enormous resources, can be used to diversify the firm's business, thereby giving it competitive edge over similar businesses.

Like any other newly introduced theory, RBV was rejected by industrial organization (I/O) economists on the grounds that resources within firms are acquired on a need-by-need basis, therefore should not be used to assess competitive advantage.

Despite this, Wernerfelt (1984) was able to practically interpret how firms can apply Penrose' ideas with their internal strategies to gain industry advantage over competitors. Since then, RBV has become a dominant paradigm for assessing a firm's competitive advantage in the following fields of study; Operations strategy (Oliveira and Roth, 2012), performance and supply chain management (Hult, Ketchen and Arrfelt, 2007; Cousins, Lawson and Squire, 2008; Penrose and Penrose, 2009; Barney, 2012).

RBV theorists believe that, one-way organisations can achieve and sustain competitive advantage is, to mobilize and use scarce and useful resources for continuous business expansion (Huang *et al.*, 2017). Since the aim of this research is to establish whether some CEBMoDs are more efficient in the way they deliver CREPs when compared to others.
The useful resources needed by CEGs to improve CREPs development include; combination of skilled workforce (human resource), sufficient funding (financial resource), and technical equipment (physical resource).

3.6 Local ownership and CREP development

Generally, the process of developing energy projects can be tasking for experts, and much more tasking is the fact that inexperienced local groups with little or no capacity are now engaging in energy projects. According to Hinshelwood (2001), these groups lack the in-house skill and capacity to overcome REP challenges, such as public resistance to certain technologies (e.g. wind turbines), or the ability to raise initial start-up costs or attract investors. In the UK, there are, however, a number of community groups that have overcome these challenges—through the collective enthusiasm and eagerness of their members—to engage in renewable energy projects and activities. There are myriad groups engaged in various RE activities across the UK and these groups, as well as their activities, have been on the increase lately (Community Energy Scotland, 2014).

This implies that people are switching from being only passive consumers of energy to active ones, apparently due to increased awareness of climate change's negative impacts and the benefits of local ownership (Huang *et al.*, 2017). These community organisations are structured differently in terms of their process of incorporation, mode of operation and available local incentives (Peredo and Chrisman, 2006).

Having a legal form of community-scale RE project ownership is a matter of choice, as self-sufficient investors and interest groups can decide to do otherwise (Seyfang, Park and Smith, 2013). However, the importance of a legally-formed ownership structure in CREP implementation and diffusion cannot be overemphasised. Particularly at the inception stage of REPs, most large project organisers are faced with the dilemma of choosing the right project financing options with low risk.

Smaller project organisers are faced with similar dilemmas; and even more, they have to make timely decisions on the right structure of ownership (Bull and Bull, 2008), board membership and structure, as well as compatibility of the project's location and type of technology used (Toke, 2002). Therefore, prior to commencement of any REP, irrespective of its scale and size, there is a need for a vehicle for successful project delivery to be put in place in an organised, structured and, in most cases, legal manner (Galera and Borzaga, 2009).

This vehicle is a network of professionals, volunteers, interested individuals and investors with a shared vision of getting involved in the planning, organisation, implementation and ownership of REPs. In an attempt to further highlight the importance of CEBMoDs in CREP delivery, Tsoutsos and Stamboulis (2005) revealed that CEBMoDs act as catalysts for the market diffusion of sustainable local innovations aimed toward the transition to a low-carbon future.

However, the question of whether CEBMoDs are effective tools for such transition has caused much debate recently (Daintith and Hancher, 1986; Eikeland and Sæverud, 2007; Leicester, Goodier and Rowley, 2011; Mendes, Ioakimidis and Ferrão, 2011; Trutnevyte, Stauffacher and Scholz, 2011).

The arguments in favour of CEBMoDs rest on a common and obvious fact: they are not-for-profit market strategies that define how CEGs conceive, implement and operate CREPs, as well as what revenue is generated and how it is used. Wainstein and Bumpus (2016) argued that BMs are not just business strategies, because strategies can change when the business environment is no longer favourable. Rather, they are structured to reflect an organisation's competence to compete in a changing market.

3.6.1 *The UK-CEBMoD Concept*

CEBMoDs comprise many strategies, activities and business objectives of CEGs (Gross, 2007). They provide CREPs a platform for the creation of value in the market, and have become a vital part of many local business and economic activities across the globe. CEBMoDs are gaining wider popularity, both in research and energy policy domains (Wainstein and Bumpus, 2016), and draw on general BM theory, which focuses on how to understand the impacts of public programs on organisational undertakings, and vice versa. The term *CEBMoD*, from this point onwards and throughout this thesis, is used to refer to:

i. A sustainable innovation tool employed by CEGs to achieve continuous RE technology evolution and diffusion (Löschel, 2002).
ii. A tool for effective CREP management that aims to deliver positive socioeconomic and environmental project goals (Krajnc and Domac, 2007).
iii. A design, strategy and process for local business alliances, for the purposes of creating and delivering socioeconomic and environmental value for the benefit of local people and the larger society (Domac, Richards and Risovic, 2005).
iv. A novel way that local people can respond to the many challenges posed by oil price volatility, climate change and energy security (Owens and Driffill, 2008).
v. A framework for understanding the processes of energy generation, transmission and distribution by local energy groups (Loock, 2012).
vi. A link between existing or emerging technology and local value creation (Cai *et al.*, 2009).
vii. An instrument for the proliferation of sustainable innovation (Martinot *et al.*, 2002).
viii. The safest approach deployed by CEGs to ensure that both the production and consumption costs of REPs are minimised without compromising their value (Burton and Hubacek, 2007).

Based on the aforementioned points, it is pragmatic to infer that a CEBMoD's configuration defines how community groups will deliver CREPs in line with their underlying objectives of ensuring local participation, benefit and ownership without compromising the socioeconomic and environmental considerations of the project.

Evidently, successful sustainable innovations, especially in the area of introducing new technologies in the market, have been traceable to the introduction and application of new BMs (Chesbrough, 2010; Burger and Luke, 2017; Sperling, 2017a). The characteristics and structures of some of these models, and their approaches to CREP delivery, are briefly examined in the subsequent sections.

3.6.2 *Incumbent CEBMoDs in the UK*

Like every project, energy projects are associated with some form of risk that must be fully identified, assessed and distributed for proper management and mitigation (Krupa, 2012). Upon satisfactory assessment of the actual merits of the project, the next thing to do is to identify a structure that aligns with the project goals, and local needs and expertise (Hoffman and High-Pippert, 2005). This is an onerous task for CEGs based on the multiple CREP organisational structures that are available to choose from. There is no doubt that the emergence of various CEBMoDs has altered the conventional paradigm of energy management systems (Foxon *et al.*, 2005).

However, the fact remains that the conceptualisation of BMs for CREP delivery is daunting due to the huge investments, categories of actors, and collaborations required for such projects. In addition, there is a high level of global energy market and policy uncertainty (Roh, Shahidehpour and Wu, 2009); hence, the composition of CREP management teams is usually based on who is available and willing to share in these risks. The common forms of CREP risks include market, financial, political and unforeseen risks (Ke *et al.,* 2012). That notwithstanding, Hawkey, Webb and Winskel (2013) suggest that a good grasp of the different organisational configurations of CEBMoDs identified for research is vital.

Furthermore, the global renewable energy market is prone to occasional spontaneous changes (Melikoglu, 2014). One such change is the proliferation of investment capitalists into the sector and, by implication, a remarkable sector expansion is anticipated in the future. This therefore means that only proactive, inventive and enterprising communities can survive such changes (Bird and Barnes, 2014).

Although there is no custom-built approach to organising or owning CREPs, there are certain recognisable and sometimes reoccurring issues with incumbent operational projects that must not be overlooked (DECC, 2014).

Consequently, all the right boxes regarding setting up a viable and vibrant community energy enterprise need to be ticked, which means there are underlying questions that new CEGs have to satisfactorily answer before embarking on a project (Morris and Jungjohann, 2016; Worthy *et al.*, 2016). The questions are:

- Is there a common/collective goal for embarking on CREPs?
- Are there similar local enterprises with similar problems, aims and goals, from whom lessons can be learned?
- What lessons can be learned, and at what phase of the project delivery process?
- What can be replicated or removed from existing projects?
- How can project goals be actualised through such organisational settings?
- What are the local supports, incentives and grants available?
- What ownership structure will facilitate access to these supports?

When appropriate answers to these questions have been obtained, the next task for the CEG is to design an RE business model that uniquely suits their in-house skillset (Muñoz and Steinerowski, 2012; Heiskanen, Johnson and Vadovics, 2013; Mcintyre and Robinson, 2014; Turvey, 2016), and provides access to adequate sector and project information to support the project from cradle to grave.

However, there is yet another onerous responsibility of CEGs, which is to assemble the people and win their support for a project (Van Der Schoor and Scholtens, 2015). It is easy to achieve this when the core objectives of the project align with the underlying needs and interests of the people. This is basically one of the reasons why CEGs in the UK are registered as charity organisations, as most of the benefits from the business undertakings of these groups are retained in the locality where the projects are domiciled. This gives them the leverage to source funds from the local public through share offers or crowdfunding.

3.6.3 *Key features and structures of incumbent CEBMoDs*

In terms of structure, community organisations can take various forms, depending on the program objectives the group aims to achieve (Bomberg and McEwen, 2012). For instance, if the goal of the group is to embark on a business that emphasises equal rights in terms of ownership, numbers of votes and decision-making powers, then the cooperative model is most suitable. According to Tozer (2013), CEGs are more comfortable in adopting or maintaining an existing community business organisation, rather than trying out a new form of local business ownership.

This simply implies that the goal set for any CREP/RE scheme is what determines its ownership structure, choice of technology and available support structures. Predominantly, and as earlier mentioned, the majority of these organisations are structured according to the incentives they tend to attract, while some are comprehensive and self-sustaining. A weak and impractical structure can impede a CREP's progress because the appropriateness and effectiveness of CEBMoD structures vary according to the project and jurisdiction (Huang *et al.*, 2015).

Strupeit and Palm (2016) examined how CEBMoDs responded to project-specific and place-based constraints in Germany, the US and Japan. This study, however, was limited to solar PV business models and did not provide adequate insights for other renewable energy technologies (RETs). While a variety of CEBMoDs exist in the UK, this research will adopt the models suggested by DECC, because fully-regulated models have proven to be effective vehicles for CREP delivery, and the five CEBMoDs identified for this research are no exception. These models are the Cooperative (Coop), Social Enterprise (SocEnt), Community Interest Company (CIC), Community Charity (ComCha) and Development Trust (DevTru) Models.

3.6.3.1 Social Enterprise (SocEnt) Model

The SE model is regarded as being innovative and breaking new ground in business. It is suitable for not-for-profit or for-profit organisations. Its core principles, however, are centred on ensuring that the socioeconomic and environmental needs of the people they represent are met.

They achieve this by engaging in people-centred and community-oriented activities, services and projects. According to Huybrechts and Nicholls (2012), SE is the best model for building a successful collaboration with external entrepreneurs for the benefit of the community. Bridgstock *et al.* (2010) further posit that there are over 50,000 SEs in the UK with an annual turnover of £26.7 billion. The activities of these groups cover a wide range of social, economic and environmental concerns of their immediate local communities. Although there are no clear studies on shareholding, Social Enterprise UK reports that the main source of income for these groups is through trading (SEUK, 2016). The SE model has traded in the health, education and energy sectors, with several CREPs and other activities completed successfully (Community Energy Scotland, 2014).

3.6.3.2 Cooperative Ownership Model

The cooperative ownership model seems to share some of the objectives of the SE model in the area of service delivery to its members. This objective also aligns well with the CREP principles of retaining project development, operations, ownership and benefits within the community (Walker and Devine-Wright, 2008). The social values and core principles of the cooperative model encourage equal rights and opportunity in decision-making and profit-sharing amongst its participants, based on the “one man one vote” right (Wirth, 2014).

Coops operate within the confines of internationally stipulated principles, which specify that membership must be open to motivated volunteers, and there must be equal voting and decision-making rights (Storey, 1982). Also, the coops must allow for full membership participation in every program and activity, as well as support education, information and training programmes for members and the wider community (Li and Clegg, 2006). Above all, certain underlying values, such as mutual support, accountability and team spirit, must be instilled in individual members and partners (Johnson, Johnson and Smith, 2007)

It is not surprising that the coop model is among the most adopted and widely employed for community ownership of REPs (CEE, 2017, CES, 2017). According to Willis and Willis (2012), the membership of UK cooperatives stands at over 900 million between 1844 to 2014, while about 90 million locals have been gainfully employed by these cooperatives as at 2014 (Tedestedt *et al.*, 2016).

It is important to state that there is no convincing empirical evidence that proves the availability of sufficient technical, administrative and project management capacities for undertaking CREPs using this model, but available third-party supports are usually explored. Also worthy of note is the fact that most cooperative models are not legally structured per se, but are mere umbrella name for Community Benefit Societies and Industrial Provident Societies (White and Boland, 2016).

3.6.3.3 Community Trust Model

In contrast to the cooperative model, the community trust model (also known as development trust in Scotland) does not emphasise equal rights among members; however, it supports local investors and non-investors alike in benefiting from CREPs (Dwivedi, Patkar and Beard, 2015). Community trusts serves as a medium for providing wider environmental, social and economic CREP gains to a community.

The model is structured such that no individual or group can lay claim to its ownership (Brouard, McMurtry and Vieta, 2015). Daily administration and decision-making are the preserves of a democratically-elected board of trustees (BOT). Development trusts have been at the forefront of promoting Scotland’s community energy activities (Community Energy Scotland, 2014), but not without grants and other support from the Scottish Community and Renewable Energy Scheme (CARES).

3.6.3.4 Community Interest Company Model

In the UK, community interest companies (CICs) are not registered as charities, but have the status of not-for-profit organisations (Armstrong-Gibbs and CIC, 2016). CICs are structured to clearly showcase and amplify the social benefits that projects deliver. The structure allows for CEGs to partner with other groups undertaking similar projects, or with external financial and technical experts (Nicholls, 2010).

CICs rely more on external funding for their operations and uses the funds generated to pursue both the commercial and social objectives of the community (Jordan, 2015).
The model is attractive to investors as it allows multiple investment opportunities; however, investors’ stakes in the company are restricted to their investments.

The model is strict about conflict of interest, as evident in the dividend cap set for CICs limited by shares (Araujo, 2016). Its structure is clear about what is due to the community by outlining these benefits and interests in the articles of the association.

This model's operations are monitored by the Financial Conduct Authority (FCA), which acts as a surety and, at the same time, as a watchdog for CICs (Ring *et al.*, 2016). In addition, the FCA ensures that all of CIC activities, programmes and projects are strictly community-focused, through the following means:

i. Performing compulsory community interest assessments
ii. Requesting annual reports from CICs detailing their financial transactions
iii. Ensuring close and regular collaboration with the community whose interest is at stake
iv. Encouraging investor return caps and asset locks by strictly monitoring the alignment of project interests to community interests
v. Ensuring that due process is followed in the incorporation of CICs with the appropriate companies' registration bodies
vi. Ensuring that community interest statements form part of all incorporation documentation

However, its activities are closely regulated by an independently registered assessor. As with the cooperative model, there is also no empirical evidence of local skill availability in CICs for CREP execution.

3.6.3.5 Community Charities Model

The last model of ownership identified for this study is that of community charities (normally in the form of a housing association) that act on behalf of a low-income group. They assist members in securing affordable accommodation in estates managed by the association, and in meeting any other special needs of this category of tenants.

According to Saunders et al. (2012), the law permits tenants to be accepted into the membership cadre and even the governing board of the association through democratic means. Egmond, Jonkers and Kok (2006) also opined that a well-organised board can access loans to execute projects for the benefits of other tenants in the estates.

The table below shows a checklist of some attributes common to the five CEBMoDs identified for this study.

Table 3.2: Attributes of CEBMoDs identified for this study

ATTRIBUTES \ CEBMoD TYPES	Coops	SocEnt	CIC	ComCha	DevTru
Registered under the companies acts	No	Yes	Yes	No	Yes
Regulated by Financial Conduct Authority	No	No	Yes	No	No
Structured strictly for community interest and benefits	Yes	Yes	Yes	Yes	Yes
Managed by members	Yes	No	Yes	Yes	Yes
Provision for asset lock in article of association	Yes	No	Yes	No	No
Maximises social benefit	Yes	Yes	Yes	Yes	Yes
Maximises economic benefit	Yes	Yes	Yes	Yes	Yes
Maximises environmental benefit	Yes	Yes	Yes	Yes	Yes
Provision for collaboration	Yes	Yes	No	Yes	Yes
Overseen by democratically elected board	Yes	Yes	Yes	Yes	Yes
Equal decision making and shareholding rights	Yes	No	No	No	No
Prolonged decision-making process	Yes	No	No	Yes	Yes
In-house skills availability as a prerequisite for starting a project	Yes	No	No	No	No
Depend on incentives and grants	Yes	No	No	Yes	Yes
Share offer is a means of raising capital	Yes	No	No	Yes	Yes
Coops – Cooperative; SocEnt - Social Enterprise; CIC – Community Interest Companies; ComCha – Community Charities; DevTru – Development Trusts					

The focus of the study is to investigate if incumbent CEBMoDs in the UK are efficient enough to deliver CREPs that emphasise local participation and ownership, as well as create socioeconomic and environmental value (Wainstein and Bumpus, 2016). It is important to understand the UK CEBMoDs' many approaches to CREP development and the challenges they face.

3.6.4 *Incumbent CEBMoDs and approaches to CREP development*

In most countries of the world, there is no distinction in how community models deliver CREPs, because all are classified as community cooperatives or social enterprises. This is, however, not the case when comparing small-scale community to large-scale utility models. There are clear distinctions in ownership structure, finance options, stakeholders, and capacity of generation, management and control. These distinctions exist mostly between the community and utility models.

In terms of disparity, there is a heterogeneous business environment, value chain and stakeholders associated with every project, and each project has distinctive transferable lessons and experiences that can benefit new project organisers. The implementation of REPs of any nature and size is generally a complex process because of its many requirements. One such requirement is that several stakeholders must come together to contribute specific skills, expertise and resources to achieve the project goals.

CREPs, on the other hand, form an integral part of the larger REP development process and, therefore, cannot be classified otherwise. However, CREPs are particularly focused on how local engagement can facilitate REP delivery processes and ownership structures. Ideally, most community projects are undertaken by small communities and a few individuals who have their own ideas about how the project should be planned and executed. They have very little time and capability to undertake complex technical due diligence, financial due diligence, local authority planning requirements, and negotiations over land.

They have to undertake an enormous learning exercise that is sometimes very demanding, and they sometimes resent outsiders (project managers, legal & financial advisors, government) becoming involved, as they want to do it all themselves as cheaply as possible. Furthermore, stakeholders are often unpaid and suffer volunteer burnout as they find the whole process very demanding and more complex than they had anticipated. Most community energy projects are run by organisations that do not have any employees, and this has resulted in many failed projects.

For instance, a recent report published by Community Energy England revealed that 31% of projects in England were suspended between 2015 and 2017 due to planning phase concerns such as unresolved feed-in tariffs, lack of funds and planning consent refusals, to mention but a few. In recent times, it has become even more challenging to develop traditional community energy projects from scratch due to the dramatic cuts to feed-in tariffs that occurred in the UK.

The rates were reduced considerably and there are deployment caps as well, which makes it riskier to develop new projects. Potential new local developers are not sure what their rates will be, coupled with the fact that the caps are being reached quite quickly by most incumbent projects caught up in the cuts. No doubt there are reasonable portfolios of other projects pre-accredited before the cuts that have locked-in rates.

That notwithstanding, it is still clear that the conventional model of communities generating electricity and feeding it into the grid may not be very effective in the near future because of the overarching issues associated with CREP development, which are beyond the capacity of incumbent CEBMoDs to navigate. While two similar CEBMoDs can be deployed for the development of two different projects under the same market and regulatory conditions, the outcome of these projects depends largely on innovative solutions introduced based on the value created, delivered and obtained by the organisers (Richter, 2013a). It is clear from the above review that incumbent CEBMoD approaches to CREP delivery are basically trial-and-error of what works and what does not and, by implication, this is a viable line of enquiry.

3.7 Summary

The main essence of this chapter was to appraise community energy business models (CEBMoDs) in the UK with a view to revealing their areas of competitive advantage in CREP development. The chapter began by reviewing the historical background of the community ownership of assets in the UK. It then explored local community ownership as a driver for renewable energy projects (REPs), with particular interest in incumbent CEBMoDs in the UK. A key take-away from this chapter is that the conventional model of communities generating electricity and feeding it into the grid may not be very effective in the near future because of the overarching issues associated with CREP development, which are beyond the capacity of incumbent CEBMoDs to navigate. The next chapter will review the factors that are considered important for CEBMoDs to be effective, efficient and proactive in CREPs, and present them in the form of a conceptual framework.

CHAPTER 4: COMMUNITY ENERGY BUSINESS MODELS (CEBMOD) AND COMMUNITY RENEWABLE ENERGY PROJECTS (CREPS) PERFORMANCE – A THEORETICAL FRAMEWORK

4.1 Introduction

The previous chapter identified and discussed the various community energy business models (CEBMoDs) used in the UK, and their management structures and approaches to community renewable energy project (CREP) development. Hence, the second objective of this research has been achieved. The next task is to identify the impacts CREPs are expected to generate, and the common factors influencing their overall success, which is the third research objective. This chapter will address objective three and develop a conceptual theoretical framework to aid the understanding of the underlying relationships between CEBMoDs and CREP success. It is believed that with the conceptual theoretical framework in place, the variables congruent to addressing the research aims will be empirically deduced, and the appropriate tools for primary data collection will be able to be identified.

4.2 Why a Theoretical Framework?

Generally, theoretical frameworks are deployed to systematically capture, interpret and simplify various aspects of a supposedly complex concept (Pintrich, 2004). According to Khan (2010), theories that underpin most research are either sustained or derived from their respective theoretical frameworks, and vice versa. However, Douglas (2003) warned that in developing theoretical frameworks, caution must be applied to ensure that the fundamental features of the concepts they capture are as close to reality as possible. In this research, the theoretical framework gives a visual expression of the relationships between effective/efficient CEBMoDs and successful CREPs.

There are a number of theoretical frameworks addressing various issues within and outside the UK community energy sector (Jacobsson and Johnson, 2000; Shackley and Green, 2007; Singhabhandhu and Tezuka, 2010; Müller *et al.*, 2011; Wüstenhagen and Menichetti, 2012; Marique and Reiter, 2014), but none of these frameworks clearly link

CREP success to specific CEBMoD attributes. In an attempt to visually explain this relationship, the factors that make for an efficient CEBMoD and successful CREP are examined within a community energy project context.

4.3 Incumbent CEBMoD Efficiency and Effectiveness

Already, so much has been written about CEBMoDs in Chapter 3 and, as such, this section presents only a brief discussion of how various attributes of these models can be improved upon, irrespective of type, for effective CREP delivery. Most successful sustainable innovations, especially in the area of introducing new technologies to the market, are traceable to the introduction and application of new business models (BMs; Boons *et al.*, 2013; Richter, 2013a; Funkhouser *et al.*, 2015b; Zhang, 2015).

Considerable research has been carried out to investigate the factors that drive or impede the efficiency of a BM, and how this impacts various aspects of a firm's performance (Armstrong *et al.*, 2012; Brettel, Strese and Flatten, 2012; Visnjic Kastalli and Van Looy, 2013; P?t?ri and Sinkkonen, 2014; Ben Romdhane Ladib and Lakhal, 2015; Guo *et al.*, 2016; Karimi and Walter, 2016; Visnjic, Wiengarten and Neely, 2016). The factors so far investigated are specific to the location, technology, project goals and availability of the investment portfolio (Rogers *et al.*, 2012).

The key focus of the studies of BM impacts highlighted above are, however, on the firm and not product performance. Product performance is a function of firm performance (Zott and Amit, 2008) and it is only logical that their impacts on each other are investigated. Hence, as a starting point for this investigation, this research empirically identifies certain factors that give a CEBMoD competitive advantage over its contemporaries.

Table 4.1 shows the 25 factors (from extant literature) that are considered important for CEBMoDs to be both effective, efficient and proactive in CREP delivery if community group aims are to either achieve or maintain relevance in the sector. The factors are categorised into two distinct groups.

Table 4.1: CEBMoD improvement factors

Sn	Factors	Sources
1	**BUSINESS MODEL EFFECTIVENESS** 1. Internal knowledge of evolving technology 2. Zero principal/Agent interest 3. Robust internal management 4. Good incentives/rewards to stakeholders 5. Good staff development programs 6. Transparency in financial dealings 7. Effective internal feedback system 8. Low administrative and overhead costs 9. Financial stability 10. Alignment of organisation goal to projects' 11. High risk appetite against externalities 12. Flexible membership route 13. Internal administrative efficiency 14. Less complicated incorporation process 15. Setting attainable economic, social and environmental goals 16. Substantial shares in the energy market 17. Evidence of long-term relevance in the market 18. Effective board/management system with professionals 19. Engaging locals as managers 20. Capacity to deal with bureaucratic obstacles	(Ison, 2009) (Bachrach, Carter and Jaffe, 2004) (Jaccard, Failing and Berry, 1997; Edwin, 2003) (Walker, 2008; Evans and Clarke, 2010) (Van Alstine, 2014) (Darby, 2006) (Mendes, Ioakimidis and Ferrão, 2011) (Benko and McFarlan, 2003) (Seyfang *et al.*, 2014) (Radtke, 2014)
2	**BUSINESS MODEL EFFICIENCY DETERMINANTS** 1. Management structure 2. Board structure 3. Shareholding size 4. Management style 5. Membership size	(Bagdadioglu, Price and Weyman-Jones, 1996; Zheng, Liu and Bigsten, 1998; Callen, Klein and Tinkelman, 2003; Davies, Hillier and McColgan, 2005; Thapar, Sharma and Verma, 2017)

As can be seen from the list of factors above, the great strength of what the community energy sector has is the type of people involved in the project and their approach to locally delivering the project. As reported by Richter (2013a), common approach to measuring the efficiency of a CEBMoD is in its level of acceptance and popularity, and in its successful CREP delivery track record. So far, the cooperative and development trust models seem to be the two most widely used amongst the five models identified in this research (CES, 2016; CEE, 2017). The reasons for this will be clearer when expert opinion is gauged in chapter 8.

However, there are suggestions for how various aspects of incumbent and emerging CEBMoDs could be innovated to complement the popular and widely-deployed ones (Seyfang *et al.*, 2014). For instance, the trustee members of the community energy groups (CEGs), their management responsibilities, duties and structures, can be reconfigured to specifically address increasing sector demand (Richter, 2013a).

The list of factors in Table 4.1 covers the efficient management and organisational structure, competency, skill-set and administrative requirements for effective trustee directors and community members. These factors will form items on the questionnaire used for primary data collection in the next chapter.

As emphasized in the introductory section, the next vital point of this investigation is to empirically identify stakeholder expectations of CREP development and the common factors influencing overall project success. The intention being to test whether a particular CEBMoD management structure and approach to CREP delivery contributes to its success and impact.

4.4 Assessing CREP success/performance

A number of studies have been carried out on the various factors that affect project performance and success (Belassi and Tukel, 1996; Chan, Ho and Tam, 2001; Iyer and Jha, 2005b; Andersen *et al.*, 2006b; Liu and Farris, 2010; Liu and Farris, 2012; Liu and Cross, 2016). Many of these studies are particularly focused on addressing specific indicators of project performance from many perspectives, and for different project types.

From a conventional project environment point of view, common indicators of project performance include: cost (Baloi and Price, 2003), inter-organisational teamwork (Chan, Ho and Tam, 2001), project objectives (Chua, Kog and Loh, 1999), budget performance (Chua *et al.*, 1997), team commitment, coordination, competence (Jha and Iyer, 2007) and client roles in project management (Thompson, 1991), to mention but a few. Unlike conventional projects, CREPs are particularly focused on how local engagement can facilitate renewable energy project (REP) delivery processes and ownership structures.

Bolinger (2001) discovered some common challenges faced by CREPs, including reductions in forecasted revenue and poor local incentives which, according to him, could result in low CREP adoption rates. In a related study, Sovacool (2013) reported that most CREP issues are prevalent at the initial stage, and include poor stakeholder identification, post-installation staffing and land ownership. Further work by Andersen *et al.* (2006a) reported that every project is different and, as such, requires distinctive planning, implementation and operational routes.

This justifies the need to investigate what could go wrong in major phases of the CREP delivery process (Table 4.2; Bhat and Prakash, 2009). Table 4.2 shows the factors known to impede CREP success/performance, as obtained from extant literature.

Table 4.2: Factors that may hinder CREP success in the development phases

Sn	Factors	Sources
1	**PLANNING PHASE** 1. High project start-up cost for poor communities and groups 2. Inconsistent project feasibility studies and business case 3. Misleading investment information 4. Insufficient renewable resource assessment data and tools 5. Inconsistent front-end engineering and technical systems design 6. Inconsistent and compromised bidding process 7. Inadequate quantification of project investment risks 8. Premature local energy market 9. Lack of access to project financing 10. Lack of guaranteed loan programs for poor communities 11. Setting over ambitious project goals 12. No prioritisation and alignment of project goals to local needs	(Carnes *et al.*, 1998; Hiremath, Shikha and Ravindranath, 2007; McLaren Loring, 2007; Wolsink, 2007; Mendes, Ioakimidis and Ferrão, 2011; Forrest and Wiek, 2014; Lam and Law, 2016; Steffen, 2018)
2	**IMPLEMENTATION PHASE** 1. Lack of local skills and expertise 2. Having the wrong team for the job 3. Poor project information management 4. Failure to screen site for project development 5. Not using experts for evaluation of project cost estimates 6. High rates of accidents, injuries, fatalities and near-misses on site 7. Time and cost overruns 8. Looming/unresolved conflicts among participants 9. Inability to effectively service project loans 10. Bankruptcy and insolvency 11. Unforeseen eventualities and externalities 12. Poor relationship and communication management	(Breukers and Wolsink, 2007; Pinto and De Oliveira, 2008; Mondal, Kamp and Pachova, 2010; Doukas *et al.*, 2012; Liu, Perng and Ho, 2013; Palit, 2013; Ardizzon, Cavazzini and Pavesi, 2014; Forrest and Wiek, 2014)
3	**OPERATIONAL PHASE** 1. Poor knowledge of technological performance and reliability indicators 2. Insufficient/no benefit of the project to locals 3. Unequal subsidies payment and taxes for community groups 4. Prolonged grid integration barriers 5. Poorly executed project 6. Lack of installations and maintenance supports 7. Continuous market monopoly by bigger energy companies 8. Ineffective/no government regulations and legislation 9. No research and development programs to support project	(Jahn and Nasse, 2004; Patel, 2005; Eltawil and Zhao, 2010; Weaver, 2012; Bauwens, Gotchev and Holstenkamp, 2016; IqtiyaniIlham, Hasanuzzaman and Hosenuzzaman, 2017; Parra *et al.*, 2017c)
4	**DISPOSAL PHASE** 1. Lack of information on project reinvestment capacity for the community 2. Lack of information on expert solutions across the whole life of the project 3. Lack of information on long-term preparatory plans to support future sector changes 4. Poor projections of future sector demands 5. Ineffective feedback system 6. Insufficient information on final project evaluation report	(Spadaro, Langlois and Hamilton, 2000; Ingram, Willis and McIntyre, 2006; García-Valverde *et al.*, 2009; Branker, Pathak and Pearce, 2011; Ferrell and DeVuyst, 2013)

4.4.1 *CREP planning phase hindrances to success*

Traditionally, the planning phase of any project is one of the most demanding, because this is where every question concerning project success and failure must be addressed (Dvir, Raz and Shenhar, 2003). In RE projects, this phase involves the detailed exploration of project ideas through formal and informal consultations (Kerzner, 2013). Furthermore, issues relating to land ownership, RE technology, perceived resistance and funding are carefully identified and addressed.

Therefore, hindrances to planning phase success were assessed using the following twelve possible factors: high project start-up cost for poor communities and groups, inconsistent project feasibility studies and business cases, misleading investment information, insufficient renewable resource assessment data and tools, inconsistent front-end engineering and technical systems design, and inconsistent or compromised bidding processes.

Other factors include inadequate quantification of project investment risks, premature local energy markets, lack of access to project financing, lack of guaranteed loan programs for poor communities, setting overly-ambitious project goals, and lack of prioritization and alignment of project goals to local needs. While these factors are not an exhaustive list of CREP planning phase success hindrances, they can be relied upon for questionnaire development.

4.4.2 *CREP implementation phase hindrances to success*

In large developmental projects, this phase is often known as the *development and implementation* or *execution phase*. The former entails the identification and assembling of potential contractors, subcontractors, material suppliers and other specialist service providers as may be deemed necessary. The latter involves the coordination of human and material resources to accomplish actual construction works and, according to Pinto and Mantel (1990), it is important to sustain the pace of activities and progress.

However, like every project, the momentum of CREP implementation can be hindered by some or all of the following: lack of local skills and expertise, having the wrong team for the job, poor project information management, failure to screen sites used for project development, not using experts for evaluation of project cost estimates, and high rates of accidents, injuries, fatalities and near misses on site. Other factors include time and cost overruns, looming/unresolved conflicts among participants, inability to effectively service project loans, bankruptcy and insolvency, unforeseen eventualities and externalities, as well as poor relationship and communication management.

However, the extent to which these factors explain hindrances to CREP implementation phase success is subject to expert rating and ranking of these factors.

4.4.3 CREPs operational phase hindrances to success

As can be seen from Table 4.2, above, poor knowledge of technology performance and reliability indicators, insufficient/no benefits accruing from the project to the locals, and unequal subsidies payments and taxes for community groups, could slow down the operational performance of CREPs. Furthermore, prolonged grid integration barriers, poorly executed projects, lack of installation and maintenance supports, and continuous market monopolies by bigger energy companies, could also be hindrances. It was also discovered that unpopular or lacking government regulations and legislation, and lack of research and development programs to support projects, could be major concerns to CEGs.

4.4.4 CREP disposal phase hindrances to success

Rogers (2012) posits that the close-out phase of every project is as important as every other phase and suggests that it should be treated as a work package and allotted the required budget and schedule. This phase of project delivery has often been neglected. The implication for this negligence is that some aspects of CREPs cannot be fully assessed. These are: project reinvestment capacity for the community, expert solutions across the whole life of the project, long-term preparatory plans to support future sector changes, projections of future sector demands, and information on final project evaluation reports. These are variables that will be captured in the questionnaire.

4.5 Assessing CREPs' impacts on their stakeholders

Generally, stakeholder management is a broad research area and cannot be exhaustively covered in this thesis; however, it is important for project participants to understand and adopt established tools and theories related to stakeholder management (Savage *et al.*, 1991; Harrison and Freeman, 1999). These tools can be adopted and used to check and control the possible impacts that unmet stakeholder expectations could have on the project.

According to Chinyio and Akintoye (2008), stakeholders are persons with different expectations from organisations, projects or business activities. El-Gohary, Osman and El-Diraby (2006) added that every project will affect lives, and that those whose lives are affected have the right to express their opinions, which must be used to redirect project or business decisions. This includes those within and outside the project organisation or environment.

Stakeholder identification, status assessment and management, therefore, have become regular and essential strategies incorporated into the development processes of many projects (Chinyio and Akintoye, 2008). Wheeler and Sillanpa¨a¨ (1998) revealed that stakeholders are keen to know the long-term positive/negative benefits of a new expansion and/or closure of a business activity or project.

The above assertion corroborates the core objectives of CREPs, which are to support and empower local people to make decisions based on their needs and, also, to ensure that the system is open to public scrutiny and accountability (DECC, 2014). However, indirect local stakeholder needs are seldom recognised and prioritised in CREPs (Wheeler and Sillanpa¨a¨, 1998). Rather, local investors, volunteers, regulatory bodies, commercial partners, contractors, equipment suppliers, funding organisations, local consumers and employees are the main stakeholders whose needs are recognised and prioritised during the development of most CREPs (Jaccard, Failing and Berry, 1997; Hoffman and High-Pippert, 2010; Bomberg and McEwen, 2012).

It has been argued by Chinyio and Olomolaiye (2009) that every project involves a large number of stakeholders and their expectations, which must be considered holistically rather than isolating a few interest groups based on convenience. Stakeholders are people and people have lifestyles, interests, influences and motivations that cannot be ignored. In other words, socioeconomic and environmental value addition is a major stakeholder expectation that should be assessed at every phase of the CREP lifecycle.

Drawing on the above understanding of who stakeholders are, it could be inferred that successful CREP delivery will largely depend on collaborations among the project teams with direct involvement in the projects, and with others without direct involvement but whose ability to influence project outcomes cannot be summarily dismissed.

Arguments put forward by Soltani *et al.* (2015) suggest that stakeholder identification and engagement has to be robust and should form an integral part of any organisation's corporate and risk management strategy, which must be reviewed periodically.

It can, therefore, be inferred that local stakeholder expectations and CREP objectives are two separate realities (DECC, 2013), but it is practically impossible for projects to satisfy all stakeholder demands and expectations. Rogers *et al.* (2012), however, suggests that the gains of CREPs can be assessed by measuring whether their socioeconomic and environmental outcomes met their aims.

CREP impact assessments, however, depends on the expected outcomes of the project, and the flexibility of the project to accommodate or address new customers' needs, particularly the low-income class (Chua *et al.*, 1997). Furthermore, CREP success and CEBMoD competitive advantages can be assessed according to their ability to meet the socioeconomic and environmental expectations of various categories of stakeholders (Shoaib and Ariaratnam, 2016). According to Zhai *et al.* (2011), social, economic and environmental considerations are the key focus areas of every place-based or community-related scheme. The factors that describe these expectations are outlined in Table 4.3, below.

Table 4.3: Factors that describe the impacts CREPs is expected to generate

Sn	Factors	Sources
1	**ECONOMIC IMPACTS** 1. Increased local job creation 2. Reinvested revenue boosted local economic activities 3. Reinvested revenue diversified the local economy 4. High prospects for local manufacturing 5. Local energy market growth 6. High savings on energy bills 7. Less reliance on conventionally produced energy 8. Affordable and stable energy price	(Akella, Saini and Sharma, 2009; Prakash and Bhat, 2009; Kahia, Ben Aïssa and Charfeddine, 2016; Okkonen and Lehtonen, 2016; Shoaib and Ariaratnam, 2016; Kerr, Johnson and Weir, 2017; Savino *et al.*, 2017; Berka and Creamer, 2018; Larsen, Hansen and Nielsen, 2018)
2	**ENVIRONMENTAL IMPACTS** 1. Health risk from toxic chemical storage near site 2. Severe noise pollution 3. Alterations to the natural environment 4. High rate of wildlife fatalities 5. Conflicts in heritage protected landscapes 6. Reduction in tourism activities 7. High carbon embedded material used during construction 8. Displacement of residential and farmlands 9. Upsetting effects of construction/maintenance traffic	(Devine-Wright, 2005; Akella, Saini and Sharma, 2009; Prakash and Bhat, 2009; Cowell, Bristow and Munday, 2011; Hernandez *et al.*, 2014; Delicado, Figueiredo and Silva, 2016; Tolli *et al.*, 2016; Savino *et al.*, 2017; Liu *et al.*, 2018)

3	**SOCIAL impacts of CREPs** 1. Increased local support 2. Increased local acceptance 3. Increased knowledge of renewable 4. High pro-environmental behavioural change 5. Improved quality of indoor air 6. Greater local resource reliance 7. Scaled up local job creation 8. Reduction in rate of fuel poverty 9. Offers energy choices to the locals 10. Increased in local social activities 11. Local capacity building 12. Enhanced local skills	(Akella, Saini and Sharma, 2009; Rogers *et al.*, 2012; Kalkbrenner and Roosen, 2016; Okkonen and Lehtonen, 2016; Shoaib and Ariaratnam, 2016; Paravantis *et al.*, 2018)

4.5.1 *CREPs Economic Impacts*

Economic growth resulting from business activities in a locality is often measured by the number of jobs generated or lost, or the economic value added locally as a result of that business activity (Bahri et.al. 2011). As argued by Aghion and Howitt (1994), the amount of jobs created by economic growth does not translate to the quality of the employment opportunities. Weisbrod and Weisbrod (1997), therefore, warned that focusing assessments of a project's impacts on economic benefits alone disregards its whole-life impact on the natural environment and on social relations. There is no doubt that economic advancement comes with social cohesion and improvements to the host community.

In as much as these benefits are important, their positive or negative impacts on stakeholders cannot be generalised (Omer, 2008). This is because, while investors are concerned with the functionality (optimal performance) of the project, the consumer, on the other hand, may be concerned about the safety, reliability, social inclusion (or rejection) and whether the general standard of living can be improved by the project (Akorede et al., 2010).

However, by strategic early feasibility studies, different expectations and interests in a project can be identified, incorporated into its risk management programme, and managed using appropriate stakeholder management tools. In the end, what is paramount to each category of CREP stakeholder will be revealed from the expert assessment of these factors.

4.5.2 *CREP Environmental Impacts*

From the CREP point of view, environmental pollution is not supposed to be a major concern to the public. However, the design and appearance of most renewable energy (RE) technical installations have generated some resentment from the public, especially in wind energy projects. Therefore, any measure to reduce the negative impact of these projects on their immediate environments are appreciated.

One major breakthrough in this regard is the introduction of noiseless wind turbines (see Smith and Brake, 2016). The focus of environmental impacts assessments (EIAs) of RE projects should not only be to identify the negative consequences of the business activities, as positive lessons can be derived from EIAs and used to improve future initiatives (Sivongxay, Greiner and Garnett, 2017). To achieve this, however, project participants need to understand that the project environment is not just about the project site, but entails organisational, cultural, political, social factors, as well as the physical environment (Youker, 1992).

Against this background, Foxon *et al.* (2005), reported that most CREP developers in the UK do not rely on local technical equipment but, rather, prefer to import it from the US, Spain, Germany, India, Denmark or France. Often, the installers are dispatched from foreign manufacturers to work abroad, and working in a different country requires an understanding of the local project environment (Crabtree, Zappalá and Tavner, 2014).

Consequently, project organisers rely on the cooperation of local people to understand and address location-specific and environmental concerns, such as the CREP-related activities that can be harmful to wildlife, and the suitability of project locations, especially for wind projects. One clear example of location-specific environmental concerns for CREP delivery is land ownership, although community land ownership-related obstacles are not common in the UK because UK land reform legislation confers rights on communities to own and manage land for the benefit of the community (Dwyer, 2011).

4.5.3 *CREP Social Impacts*

One of the main reasons community groups engage in RE initiatives is the potential tangible social benefit the project offers (Curtin, McInerney and Gallachóir, 2017; Sperling, 2017b).

Social impact is a common performance measure used in evaluating most sustainability-related endeavours and forms part of the three pillars of sustainable development (Kates et al., 2005).

As confirmation of the validity of social impacts factors, there have been obvious reductions in rates of fuel poverty (Walker, 2008a) and unemployment (Hoffman and High-Pippert, 2010) in certain CREPs, because contractors engaged for the development of CREP schemes are expected to train and recruit as many local people as possible. Furthermore, access to clean energy supplies, human security (Aitken, 2010), energy bill savings (Jaccard et al., 1997), and wider community development (Wilkinson et.al, 2009) have incentivised and attracted more local engagement to RE initiatives.

4.6 Conceptualising Efficient CEBMoD and CREP Performance

There are many grounds for postulating that the performance and success of REPs is a function of the business model deployed in its delivery (Boons *et al.*, 2013; Visnjic, Wiengarten and Neely, 2016), regardless of whether the REP involves conventional or local energy systems. Firstly, as observed by Bouffard and Kirschen (2008), and Richter (2012b), conventional utilities systems and their delivery models are becoming unpopular with the emergence of clean energy agendas and policies such as CREPs and their delivery models. Secondly, for any emerging scheme to gain market acceptance, it requires a value-focused and -driven BM (Hiteva and Sovacool, 2017). Thirdly, CEBMoDs are gradually filling this gap at the local level by fast becoming a strategic platform to achieve full or substantial diffusion of CREPs (Karakaya, Nuur and Hidalgo, 2016).

Successful sustainable innovations, especially in the area of introducing new technologies in the market, are traceable to the introduction and application of new BMs (Boons *et al.*, 2013; Richter, 2013a; Funkhouser *et al.*, 2015b; Zhang, 2015). Considerable research has been carried out to investigate the factors that drive or impede the efficiency of BMs, and how this impacts various aspects of a firm's performance (Armstrong *et al.*, 2012; Brettel, Strese and Flatten, 2012; Visnjic Kastalli and Van Looy, 2013; P?t?ri and Sinkkonen, 2014; Ben Romdhane Ladib and Lakhal, 2015; Guo *et al.*, 2016; Karimi and Walter, 2016; Visnjic, Wiengarten and Neely, 2016).

It is not yet clear the extent to which a CEBMoD configuration determines how community groups deliver CREPs in line with their underlying objectives of ensuring local participation, benefits and ownership without compromising socioeconomic and environmental considerations. That notwithstanding, the factors for CEBMoD improvement and CREP success and impacts revealed above are combined to establish a link between them in the form of a conceptual framework (Figure 4.1).

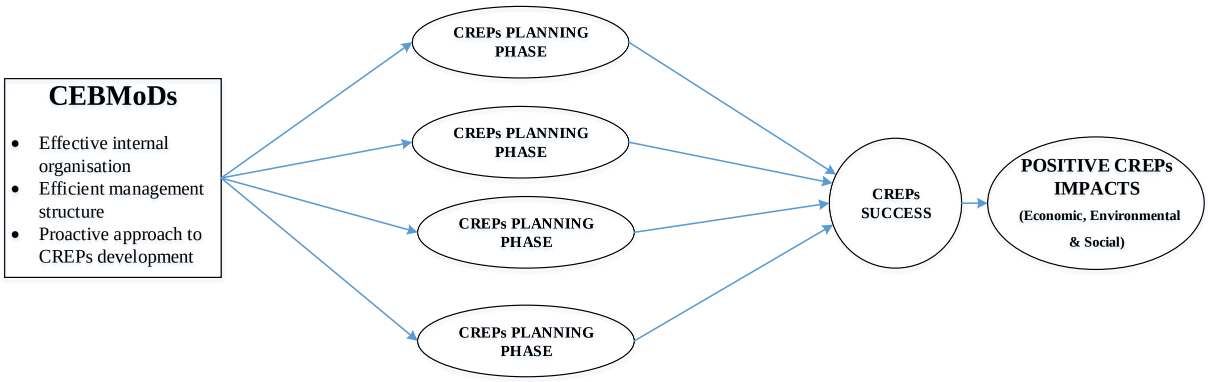

Figure 4.1: A conceptual framework linking effective/efficient CEBMoDs to CREP success

As can be seen from the proposed framework in Figure 4.1, which was conceptualised to address the research aim, a relationship between effective internal organisation, efficient management structure, a proactive approach to CREPs development, overall project success and positive impacts is hypothesised. These relationships could be direct or indirect; for instance, the level of CEBMoD influence on each of the phases in CREP delivery may or may not be significant, but only statistical tests can prove this.

Successful CREPs have contributed to CO_2 reductions, lower energy bills, development of local skills on energy issues, and increases in local employment and revenue generation (DECC, 2014). These positive contributions are not accidental but are an attainment of the underlying goals set out by community organisations prior to the commencement of the projects.

4.7 Summary

Drawing on the literature, the factors that lead to effective internal organisation and efficient management structures in CEBMoDs, and their proactive approaches to CREP development, were combined with factors that may impede or enhance overall project success to develop a simple conceptual framework. The framework aids the understanding of the dynamics of the various incumbent CEBMoDs identified earlier in this research, and how these eventually impact on CREP overall performance. It is believed that the key aspects of the ownership models can only be enhanced when the various enhancement indicators are holistically considered and responded to by project organisers. Clearly, CREPs with sufficient value to investors will generate sufficient profits for service providers, and it all begins with deploying a viable model. This theoretical framework, therefore, is based on considerations for setting up ownership models that can overcome the challenges that inhibit the optimal efficiency of incumbent CEBMoDs, as identified from extant literature. The next chapter outlines the data collection and analysis methods that address the research aims, objectives and questions.

CHAPTER 5: RESEARCH METHODOLOGY

5.1 Introduction

Generally, the importance of research in any degree-awarding course cannot be overemphasised, as it offers the researcher the opportunity to legitimately pursue and have a measure of control over, and a deeper understanding of, a chosen course of study. Much more, the PhD degree, being a wholly research-based study, involves a rigorous process of ethical, credible, methodical and systematic knowledge contribution and problem-solving investigation. Therefore, for the research aims to be achieved, a research design is necessary. This chapter, therefore, addresses this necessity by highlighting the importance of research methodology and further explores the various philosophical assumptions associated with research with a view to exposing the strengths and drawbacks of each. The chapter briefly describes the many influences these assumptions have on the act of research, and then presents the researcher's research design, strategies and methods deemed appropriate in investigating CEBMoD impacts on CREPs.

5.2 The principle of Research Design

Research design is a decision-making process backed by a convincing empirical justification of why such a process is best for the research (Hakim, 1987). Furthermore, it requires thinking about the research and all the various dynamics and control mechanisms needed to carry it out acceptably (Blaikie, 2009). According to Easterby-Smith et al. (2012), there are several approaches to finding answers to research problems, one such approach is the review of literature, which happens to be an effective guide for researchers on how to identify gaps in the research field and signposts the research's importance academically.

After research gaps have been identified, the researcher still has a responsibility to choose and justify the various approaches and vital elements that can be adopted for use in achieving the research aims (Creswell, 2007, Hatch and Farhady, 1982, Groenewald, 2004). Matthews and Ross (2010) posits that novice researchers usually make a common mistake of focusing attention on designing a method for the research problem, rather than focusing on the research problem and tailoring the methods (structure a plan) to fit the research aims, and as well answer the research question.

The importance of Research Question was further elucidated by Cooper et al. (2006), as a major consideration when choosing research method(s) to use because asking the right question will always attract the right answers which in turn will lead to a reliable research outcome. For the purpose of identifying an appropriate methodology, approach and strategy for this research; four different models of research design are examined. The specific features of all the elements in each model are carefully considered, discussed and in the end, some modification is made where and when necessary to fit one of the models into the type of question established for the study.

The four models to be examined are Saunders et al.'s (2011) research onions, Creswell's (2013) research design framework, Blaikie's (2009) research choices and Kagioglou et al.'s (2000) nested model. The next section captures the strengths and weaknesses of these models in their approach to research.

5.2.1 *The nested model*

The nested model of research design, illustrated in Figure 5.1, is a layered design approach. The outer layer (*research philosophy*) focuses theoretically on the premise on which the research strategy is designed. The middle layer (*research approaches*) covers everything from the general assumptions to the specific methods of theory formulation and testing, while *research techniques and procedure elements* of research design occupy the last (third) layer in the model. The three layers within this hierarchical model are further explained in subsequent subsections.

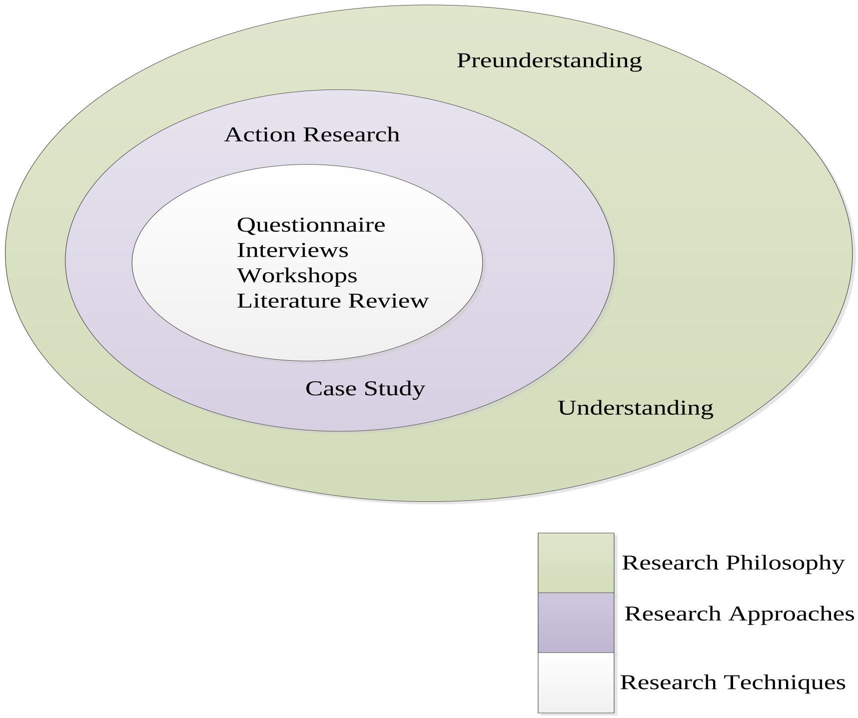

Figure 5.1: Nested model (Kagioglou et al., 2000)

5.2.2 *Research Choices Model*

The next model for consideration is Blaikie's (2009) *research choices* (Figure 5.2). It provides the researcher with the flexibility to traverse endlessly between research questions, strategies and paradigms. This is because of the interdependence of each element on the others (as indicated by the two-way arrows).

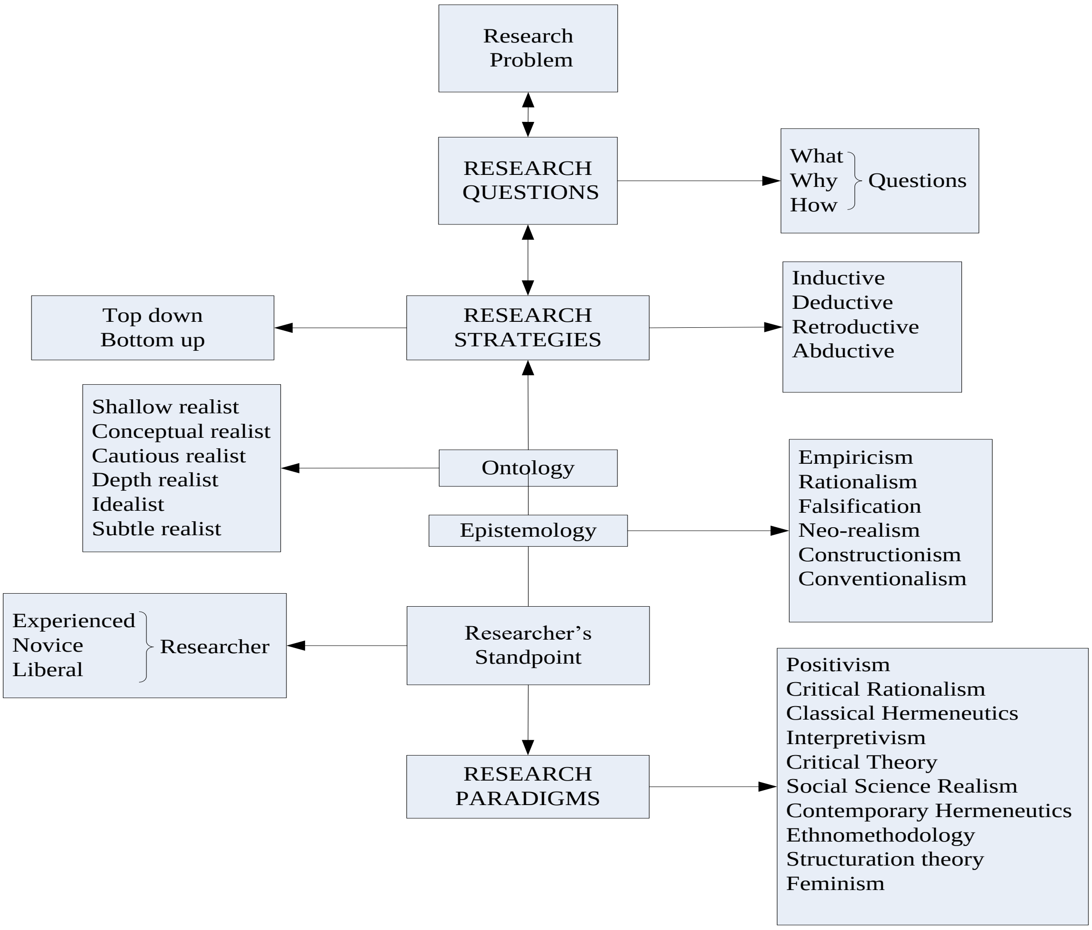

Figure 5.2: Research Choices (Blaikie, 2009)

Blaikie (2009) explained that good research topics, problems and outcomes can be arrived at by carefully exploring the various research design elements (strategies and paradigms). Furthermore, ignoring or omitting any aspect of the elements outlined in above model may amount to compromising the overall plan of the study. The interdependency of Blaikie (2009)'s *element of research* design offers the researcher the flexibility to evaluate and combine as many compatible features as possible before settling for an appropriate research design.

5.2.3 *Research Design Framework*

Creswell (2013), on the other hand, emphasised that it is important for researchers to always follow a research strategy and method that aligns with their ontological and epistemological positions. This is clearly depicted in the framework for research design shown in Figure 5.3. The double arrow in the framework signifies the flexibility of choosing and combining elements or group of elements in the proposed strategy with the methods, as influenced by one's philosophical worldview.

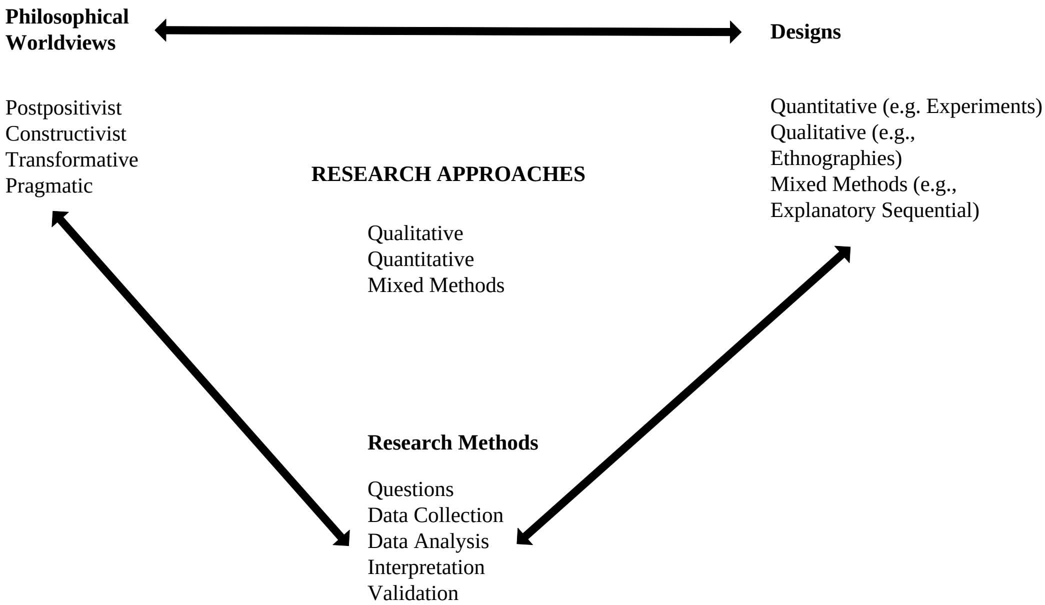

Figure 5.3: Research Design Framework (Creswell, 2013)

5.2.4 *Research Onion Model*

The fourth model to be considered is the *research onion* model, which is a layered representation of six basic guiding steps (Figure 5.4) that a researcher can navigate in the research design process. The first two layers provide options of the philosophical underpinnings available to researchers seeking to deductively or inductively approach research. *Research strategies* are captured by Saunders et al. (2011) in the third layer of the onion, with experiment, survey, case study and action research as the sub-elements.

Depending on the research problems and questions, some research can be carried out within a shorter or longer duration. Consequently, Saunders et al. (2011) went a step further to consider the importance of time in research design—as the fifth layer in the research onion design process. Research techniques and procedural elements of research design form the last (sixth) layer in the model. The layer deals with various data collection tools, such as focus group observations, questionnaires and surveys, interviews, documentation and records. To date, various researchers have developed their methods and strategies successfully by peeling through the layers of this model (Toloie-Eshlaghy *et al.*, 2011; Johnston, 2014; Saunders *et al.*, 2015).

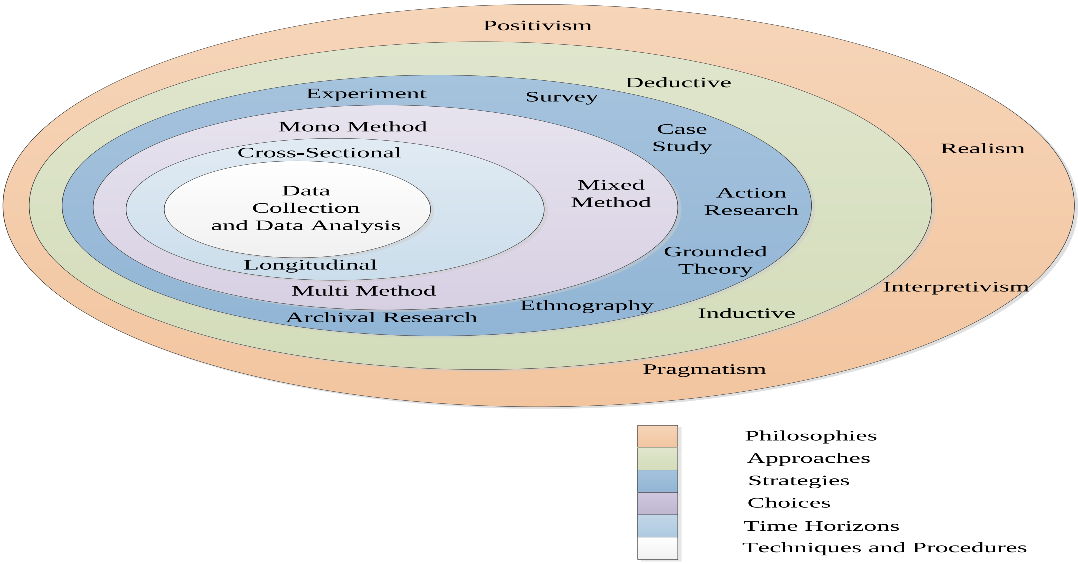

Figure 5.4: The Research 'Onion' adapted from (Saunders et al., 2011)

According to Bryman and Bell (2011), there are complexities associated with any chosen model, because the best and worst approaches for undertaking research can exist together. The ability to design an appropriate approach from any of the models presented above depends on the research problems and the ability of the researcher to scientifically prove their effectiveness and practicality, and in bringing about some acceptably convincing research outcomes (Clark et al., 2008). For instance, the techniques, methods and procedures for collecting and analysing data are described in the nested, research framework and onion models of research design, but from a different perspective.

Furthermore, while Creswell recognised the importance of the choice of research methods (qualitative, quantitative, and mixed methods) at the centre of the research framework design, Saunders et al. (2011) considered it to be the fourth control procedure in the research onion (see Table 5.1). The second control procedure in the research approaches is, however, missing in Creswell and Blaikie's research design models, but is captured by Saunders et al. (2009) and Kagioglou et al. (2000).

The four models reviewed above consider the philosophical standpoint to be the first control procedure in research design, although with different terminologies, such as *philosophical worldview*, *research paradigm* and/or *philosophies*. Irrespective of the names assigned to this over-arching research element, its underlying emphasis is on the fact that the basic beliefs of every researcher will eventually influence their actions, decisions and research directions.

Worthy of note, however, is the fact that no single philosophy is superior to another (Saunders et al., 2011; Easterby-Smith et al., 2012) but their relevance depends largely on the questions on the researcher's mind. Creswell (2009) posits that there are attempts by many researchers to supress the philosophical assumptions that underpin their research and argued that it is almost impossible to dismiss the importance and influence of the way a researcher thinks about the world (their philosophical standpoint) in the act of carrying out research.

As shown in the four models reviewed, there are diversities and contradicting schools of thought on what makes up each layer in the models. This stems from the fact that ownership of truth about any given circumstance or subject matter is not an exclusive right of any model or researcher. Instead, a careful consideration of the control procedures (see Table 5.1), available to each model reviewed is what translates into a practical research design.

Table 5.1: Four research design models and the control procedure [Adapted from Blaikie, (2007), Creswell, (2009), Kagioglou et al., (2000) and Saunders et al., (2009)]

Models of Research Design	**Research Procedures and Control Process**					
	1st Procedure	**2nd Procedure**	**3rd Procedure**	**4th Procedure**	**5th Procedure**	**6th Procedure**
Blaikie, (2007) Research Choices	Research Paradigms Ontology Epistemology		Research Strategies Inductive Deductive Retroductive Abductive			
Creswell, (2009) Framework for Research	Philosophical Worldviews Postpositivist Constructivist Transformative Pragmatic		Design/Strategies Experiments Ethnographies Explanatory Sequential	Design /Choice Qualitative Quantitative Mixed Methods		Methods/Techniques Questions Data Collection Data Analysis Interpretation Validation
Kagioglou et al., (2000) Nested Research Model	Research Philosophies Preunderstanding Understanding	Research Approaches Case Study Action Research				Research Techniques Questionnaire Interviews Workshops Literature Review
Saunders et al., (2009) Research Onions	Research Philosophies Positivism Realism Interpretivism Pragmatism	Approaches Deductive Inductive	Strategies Experiment Survey Case Study Action Research Grounded Theory Ethnography Archival Research	Choices Mono Method Mixed Method Multi Method	Time Horizons Cross-Sectional Longitudinal	Techniques/Procedures Data Collection Data Analysis

Therefore, the appropriateness of one research design over another lies in its use. Based on the nature of the research problem, the researcher's philosophical views, personal experience and the study's significance, the onion model was adopted for this research. Drawing on its robustness, each layer in the onion model is considered and, in the end, the researcher can settle for a research design congruent to the aims and objectives set out in the introductory chapter. The first layer in the onion model is considered next.

5.3 Understanding Research Philosophies and Approaches

While methodology describes the practical perspectives and strategies involved in the planning and organisation of research, the philosophical aspects describe, theoretically, the critical premise by which the research strategy is designed. There are, however, various research methodologies and theories to choose from. Burke (2007) holds that philosophical assumptions play a major role on *what to research* and the process of *researching what* and, by implication, if the methods and strategy adopted are incompatible with the researcher's original aims and research problems, the final research outcome (results) may be inconsistent and unreliable.

The understanding of philosophy is, therefore, an essential characteristic of research practice (Clough and Nutbrown, 2012). Also, Miller and Salkind (2002) maintain that the novice researcher's mind is limited to his or her educational and research experience and would, in turn, result in inappropriate methodological choices.

Understanding these philosophies, therefore, opens the researcher to new research potentials and confidences. According to Holden and Lynch (2004), every research study is underpinned by a set of beliefs or understandings about the world, and these are primarily associated with the researcher's ontological (personal understanding and interpretations of how the world works) and epistemological assumptions (what informs the individual's ontology about the world).

The combination of these elements also further influences research directions and, most importantly, the researcher's approach to it, as the richness of research depends on the approach adopted by the researcher. It is, therefore, important to understand how people view the world (ontological beliefs).

5.3.1 *Ontology*

The definition of *ontology*, as given by Lapan et al. (2011), is knowledge about what exists, the form it exists in, and how both interact to make sense of reality. Ontology emphasises the nature of reality (Bryman and Bell, 2011) and examines researchers' assumptions about how the world works in reality. It describes these realities from objectivist and subjectivist points of view (Matthews and Ross, 2010).

Easterby-Smith et al. (2012) and Saunders et al. (2011) reported that objectivists believe that the existence of social entities does not depend on external social factors. The subjectivist, on the other hand, maintains that a social phenomenon originates from recognition of actions and a corresponding reaction towards those social factors concerned with their existence. Bryman and Bell (2011) noted that everyone has certain degrees of inherent ontological beliefs which influence their perceptions, interpretations and understandings of what is real and what exists.

It, therefore, means that ignoring these essential beliefs as a researcher will amount to partial consideration of relevant questions and discussions (Easterby-Smith et al., 2012). Having established ontological assumptions about reality, it is also important to understand what the knowledge of this reality is and how to measure it; in other words, the epistemological assumptions about reality.

5.3.2 *Epistemology*

As highlighted by Burke (2007), epistemology deals with understanding the best approach to explore the nature of the world. It seeks to give clarity to what knowledge is, its scope, bounds and origin (Matthews and Ross, 2010).

Saunders (1987) holds that epistemology is the science of knowledge, which helps researchers ascertain the authenticity and validity of their work. According to Eriksson and Kovalainen (2008), epistemology makes a favourable case in favour of how knowledge can be created, while Saunders et al. (2009) describes it as a study of what represents acceptable knowledge.

In summary, it could be concluded that epistemology seeks to answer some basic underlying questions about the researcher and the research. Questions such as: What is the nature of knowledge a researcher intends to create through his or her research? What approach was followed in knowledge generation? Is the knowledge scientific or not? And: what is the worth of the knowledge created? (Moustakas, 1994). This brings the discussion of ontological and epistemological philosophies into perspective.

5.3.2.1 Pillars of Research Philosophy

According to Patton (2005), positivism, critical realism and interpretivism are common philosophical positions associated with the epistemological philosophy. The standpoint of the positivist researcher is to statistically test and analyse hypotheses against established knowledge in a particular field of study (Easterby-Smith et al., 2012). The realist views, on the other hand, are closely related to the positivist ones in terms of research process (Saunders, 1987).

However, they strongly critique scientific research methods on the grounds of imperfection (Moustakas, 1994). They emphasise that a researcher is supposed to keep an open mind to embrace emerging research methods, because this is the only way to change certain age-long scientific beliefs. The interpretivist holds the view that the understanding of people’s ideas and thoughts is central to the social and cultural existence of such people, while the objectivist, constructivist and pragmatist researchers’ beliefs work better under ontological assumptions.

The objectivists are strong proponents of the separate existence of social phenomena and social actors. The constructivist standpoint contradicts the views of the objectivists, the constructivists argue that social phenomena and actors are dependent on each other, they believe that social phenomena are not only related to social actors but are also created by them.

Pragmatism argues that both constructivism and objectivism are valid ways to approach research. Pragmatism, however, allows a researcher to view the topic from either or both points-of-view regarding the influence or role of social actors, and use these to create a practical approach to research. This may be used to find solutions to problems based on the research approach followed (Groenewald, 2004).

5.4 Research Approaches

Research generally involves the use of theory, which may or may not be explicitly required in the overall research design. However, when reporting the findings and conclusions of any research, it is important to highlight the underpinning theories. Theory definition at the beginning of any research, according to Saunders et al. (2011), is what defines the direction of the research design.

This is because approaches to research involve either testing to confirm an already developed theory/ hypothesis (deductive approach) or generating and analysing data in order to develop a theory (inductive approach). Furthermore, there is an age-long belief within the research community that positivist researchers are inclined to approach research deductively, whereas interpretivists approach it inductively.

This notion of attaching a research approach to someone's philosophical position without justifiable and convincing empirical evidence can be very misleading and, hence, remains a subject of great debate (Gollin, 1998, Overmars and Verburg, 2007, Shaffer, 1989). Consequently, it is important to briefly explain what deductive and inductive researchers do.

Deductive research is a renowned approach in natural sciences, which explains the impression natural science researchers have about scientific research. They achieve these by developing a theory and meticulously testing it. In practical terms, two or more variables are subjected to a series of statistical tests to ascertain relationships between them (Eisenhardt and Graebner, 2007). The outcomes of the tests are examined and compared to the initial theory developed by the researcher. Expectedly, the outcome will either confirm or deviate from the researcher's theory proposition.

At this point, it becomes necessary to revise or modify the theory by collecting new sets of data and subjecting them to another round of similar tests. The deductive research approach has been widely criticised as being too rigid and not allowing enough room for the explanation of phenomena (Hyde, 2000).

Inductive research tends to address how the social world is perceived by an individual. In other words, this class of researcher usually approaches research from a real-world context by interacting directly with people in a bid to understand the problem, and the effects of the problem on the people. They try not to think *for* the people but form an opinion from people's thoughts about an occurrence.

Unlike the deductive approach, the inductive approach relies on a smaller number of samples to examine the context of an occurrence. According to Easterby-Smith et al. (2012), this type of approach sits well with researchers that seek an understanding into *why* something is happening.

Some significant differences between deductive and inductive approaches to research were captured in Saunders et al. (2011) and are presented in Table 5.2. However, researchers can choose to combine both approaches in a single study (Gollin, 1998). Saunders et al. (2011) emphasised that such a combination is not only possible but is of great advantage to the researcher because the errors, omissions and any form of risk involved in one approach can be minimised and compensated for by the other.

For instance, a low questionnaire return rate (quantitative data for deductive approach) can be complemented by a variety of qualitative data (inductive approach; e.g. interviews, focus groups, observations, etc.).

Table 5.2: Main differences between deductive and inductive approaches to research (Adapted from Saunders et.al, 2011)

Deduction emphasises	**Induction emphasises**
Importance of following methodical research principles	The need to understand the meanings an individual attach to occurrences
Progress from theory to data	A careful understanding of the research context
Ways to explain underlying connection amongst variables	The collection of qualitative data
The collection of quantitative data	A more complex structure to permit changes of research emphasis as the research progresses
The application of controls to ensure validity of data	A realisation that the researcher is part of the research process
The operationalization of concepts to ensure clarity of definition	Less concern with the need to generalise
A highly structured approach	
Researcher independence of what is being researched	
The necessity to select samples of sufficient size in order to generalise conclusions	

5.5 Research Strategies

The research strategy offers insight into the many ways research questions can be tackled by detailing data collection sources, their strengths and drawbacks, which often is based on the research approach adopted (deductive or inductive). The sevenfold contemporary strategy expounded by Saunders et al. (2011) includes experiment, survey, case study, action research, grounded theory, ethnography and archival research strategies.

Saunders et al. (2011) further explained that any or a combination of these strategies can be employed to predict, explain, explore or describe a phenomenon. It is, however, important to clearly state that a supposedly good or bad research outcome is not a function of the research strategy per se, but owes much to the researcher's philosophical standpoint, level of experience, research objectives, questions and resource availability. These, according to Holden and Lynch (2004), should be the primary considerations of the researcher. The following sections provide discussions on each of Saunders et al. (2011)'s sevenfold contemporary research strategies

5.5.1 *The Experiment Research Strategy*

The experimental research strategy is commonly used by natural science researchers to explore and explain the behaviours of independent and dependent variables. The independent variable is manipulated to determine its effects on the dependent variable with a view to establishing a relationship between them (Saunders et al., 2011). Experiments are judged to be the best research strategy for ascertaining cause and effect relationships between variables (Cooper et al., 2003; Hakim, 1987; Campbell and Stanley, 2015).

The experimenter employs a regulated technique and procedure to control the dependent variable, say (x), to ensure internal validity, and then manipulates and observes an independent variable, say (y), to understand its impacts on (x). Internal validity is emphasised because the experimenter believes that the higher the internal validity, the higher the confidence of a causal link between (x) and (y). However, this type of research strategy has been criticised for not giving much credence to external validity (Verschuren, 2003, Patzer, 1996, Steffe, 1983, Christensen, 2004).

5.5.2 *The survey research strategy*

The survey research strategy is a popular and efficient method for collecting significant amounts of data from a target population through questionnaire administration. This can be done in a relatively inexpensive way (either by email or post; McAvoy and Kaner, 1996). Surveys are commonly used by business and management researchers in conjunction with the deductive approach to explore and describe phenomena (De Vaus, 2013).

The strategy is systematically designed to allow for easy collection, comparison, explanation and understanding of quantitative data. Survey data can be analysed to predict behavioural pattern of studied population (Stack, 1995). Baruch and Holtom, (2008) emphasised the need for the researcher to ensure that the response rate is adequate, and representative of the population studied before results can be generalised.

Data collection constraints associated with this strategy include limits to the number of questions to be included in the questionnaire, and delays on the part of respondents in answering the survey (Coughlan et al., 2009). Other data collection tools under the survey strategy include structured interviews and observations.

5.5.3 *The Case Study Research Strategy*

Case study remains a very controversial topic in the social research domain; this is because the argument about whether case study belongs in the quantitative and qualitative research strands, or relies on a particular data collection method, has been well debated (Gillham, 2000, Flyvbjerg, 2006, Noor, 2008, Verschuren, 2003, Woodside and Wilson, 2003). According to Yin (2011), the case study research strategy can be used to conduct both qualitative and quantitative research.

He further emphasised that in qualitative research, case study provides an in-depth description of phenomena from many angles by employing numerous data collection tools. To date, there has been little agreement on whether case study is best suited for qualitative or quantitative research, or both (Yin, 2012). However, there has been a growing confidence in its use to answer the *who* and *why* research questions, especially in situations where the boundaries between context and phenomena are not evident or where the researcher has no control over the study population (Matthews and Ross, 2010).

Furthermore, Gillham (2000) claims that case study derives its evidence from one or a combination of the following: participant observation, library records, official statistics, diaries, documentation, group interviews and observations. Drawing on the above assertions, the case study strategy can be said to be versatile as it employs techniques that collect both qualitative and quantitative data. It must also pay careful attention to the researcher's level of control over the behaviour of the study population and the number of cases selected. Case selection is further detailed in Section 5.15.2

5.5.4 *The Action Research Strategy*

While a variety of meanings have been suggested for *action research* (Brydon-Miller et al., 2003, Reason and Bradbury, 2001, Huang, 2010). Saunders et al. (2011) identified four abilities that might be subsumed under action research. Firstly, it is a strategy whose main focus is on the product, and not the process that leads to the product. In other words, the purpose for embarking on the research is what drives the process, and not the other way around. Secondly, it is a comprehensive and participatory research strategy that allows both researchers and practitioners to collectively drive the research. Thirdly, it follows a cyclic nature of diagnosing a research problem in detail, planning its solution, and acting on the plans, as well as evaluating the process (Figure 5.5).

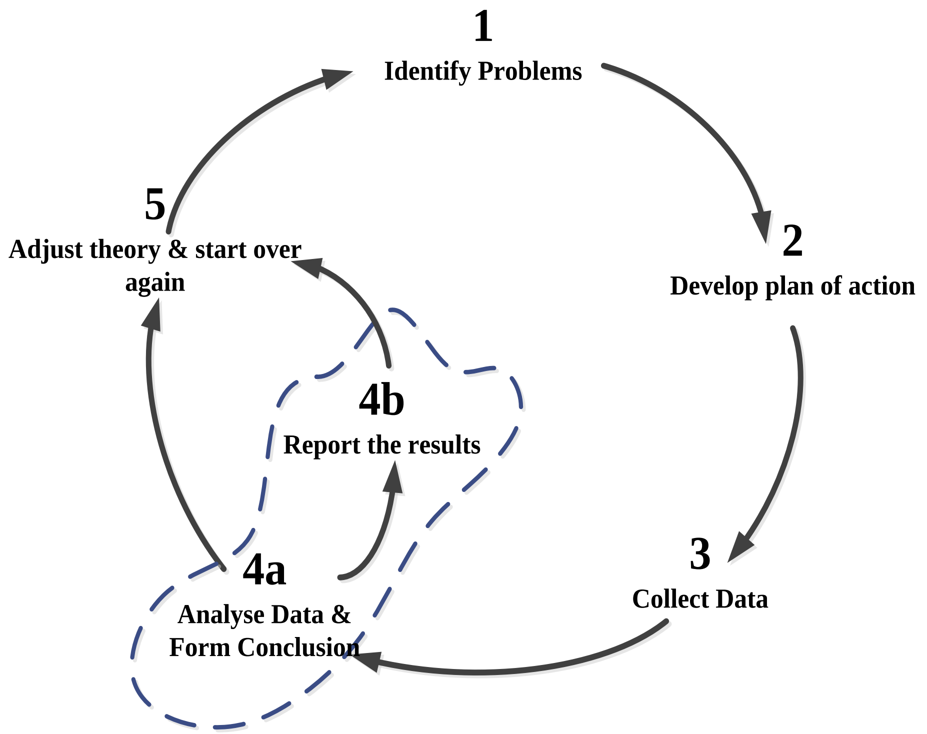

Figure 5.5: Cyclic processes of Action Research Strategy (Source: Saunders et al., (2011))

5.5.5 *Grounded Theory Research Strategy*

The grounded theory strategy, according to Backman and Kyngäs (1999), has an inclination towards behavioural prediction and explanation within the management and business research domains. Researchers adopting this strategy have the leverage to commence data collection and analysis to test the initial predictions on the researcher's mind. Depending on the outcome of such predictions, a theory can be formulated, but this must be done with continuous reference to data.

More often than not, grounded theory strategy has been misconstrued on the grounds that it presents findings only from raw data and neglects existing literature and theories that underpin the selected field of study (McCallin, 2003). Furthermore, Locke (2002) asserts that reporting the word counts of a positivist researcher's assumptions as a grounded theory strategy can be misleading and, therefore, should be discouraged. Another key point researcher must understand is that this strategy requires a lot of creativity to deal with its messy but overly-simplistic nature (Charmaz and Smith, 2003).

5.5.6 *The Ethnography Research Strategy*

The origin of the ethnographic research strategy is traceable to anthropology research (i.e. the comparative study of human behaviour, origins, society and culture). This strategy requires the researcher to, if possible, live within the society and among the studied population for the period of the research. Being a naturalistic strategy, there is no single data collection technique to be adopted, but the researcher needs to decide what data and techniques are appropriate for capturing the natural context of every useful occurrence (Blomberg and Burrell, 2009).

This strategy is particularly useful in explaining a phenomenon from the viewpoint of those involved or affected by it (Holden and Lynch, 2004). As a fundamental requirement for adopting this strategy, the researcher must understand the setting and the people, and gain their trust and cooperation to be able to exhaustively address the research question. Furthermore, a researcher must be understanding and willing to cope with the cost, time and place-based demands of engaging in this type of research.

5.5.7 *The Archival Research Strategy*

As the name implies, data from archives (i.e. a place containing administrative records, documents, or other materials of historical interest) are collected and analysed to answer previously pending and emerging societal questions (L'Eplattenier, 2009). The limitation with archival data is that it may be inaccessible, incomprehensive and incomplete and, therefore, inadequate for providing answers to the many questions on the researcher's mind. Hence, it is important for the researcher to, first and foremost, ascertain what data is available and accessible before designing a strategy congruent to it (Saunders et al., 2011). Because these data are collected and stored for different purposes, it is, therefore, wrong to classify the archival research strategy as secondary data analysis (Ventresca and Mohr, 2002).

5.6 Research Choices

The research choice offers insight into data collection tools and methods of analysis. Again, based on Saunders et al.'s (2011) research onion model, a researcher can choose the qualitative or quantitative methods or combine both as mixed methods.

For instance, a researcher whose goal is to collect data from a population within the same social environment (for example, interviewing a group of homeless people) can adopt the qualitative method (Cassell and Symon, 2004). On the other hand, quantitative methods are deployed by researchers interested in obtaining numerical data from a wider population for the purposes of objective measurement and use of statistical analysis tools (Gorard, 2003).

However, within these individual (mono) methods lie subsets of methods that a researcher can streamline choices to. For instance, data obtained through questionnaires and analysed using appropriate statistical tool can be likened to a mono-method quantitative research design (Saunders et al., 2011; Tashakkori and Teddlie, 1998). Again, the researcher may decide to conduct an interview and then narrate his/her experience and the interview outcome. This approach is known as the *mono-method qualitative research design* (Tashakkori and Teddlie, 1998).

By implication, it is not enough to choose a mono method, but the type of data collected, and corresponding analysis tools deployed should be justified. Furthermore, both methods can be designed from a multiple approach, as either a multi-method quantitative or multi-method qualitative research design. The former explains a process where two sets of quantitative data are obtained from different data collection techniques and analysed (Feilzer, 2010). For example, data obtained from questionnaire distribution and observation are analysed with quantitative analysis tools.

The latter follows a similar process, but this time, qualitative data obtained by more than one technique (e.g. interview and data from diaries/records) are analysed qualitatively. The mono-method approach to research has been faulted for not giving sufficient insight to complex phenomens, unlike multiple methods which offer deeper understandings and enhance the researcher's confidence in the final outcome of the research (Simons, 2009).

Mixed methods can lend further credibility to research findings and outcomes (Johnson and Onwuegbuzie, 2004). A mixed-method research design involves the combination of qualitative and quantitative data collection and analysis techniques (Hanson et al., 2005). Although mixed-method research designs have been criticised for being time- and money-consuming (Driscoll et al., 2007), it still offers the researcher the opportunity to investigate a phenomenon in more depth and from multiple perspectives, and robust qualitative data can be analysed and used to strengthen inconsistencies found in survey responses.

According to Johnson and Onwuegbuzie (2004), it allows for the verification of corresponding or conflicting findings from qualitative and quantitative methods. Table 5.3 and Figure 5.6 illustrate the characteristics of the main and secondary methodological choices available to researchers.

Table 5.3: Showing research choices and their characteristic[Adapted from Bhattacherjee (2012)]

Qualitative Methods	Mixed Methods	Quantitative Methods
▪ Evolving/Flexible methods ▪ Flexible questions ▪ Data collection sources include: Interviews, observations, archival document and audio-visual data ▪ Data can be analysed as themes, and or pattern interpretation	▪ Both an evolving, flexible, procedural and predetermined methods ▪ Both close and open-ended questions ▪ Multiple source of data collection techniques ▪ Data can be analysed and interpreted according to both quantitative and qualitative standard of practice	▪ Procedural and predetermined methods ▪ Structure and instrument-based questions ▪ Data collection sources includes: Performance, observation and census data ▪ Data can be analysed and interpreted statistically

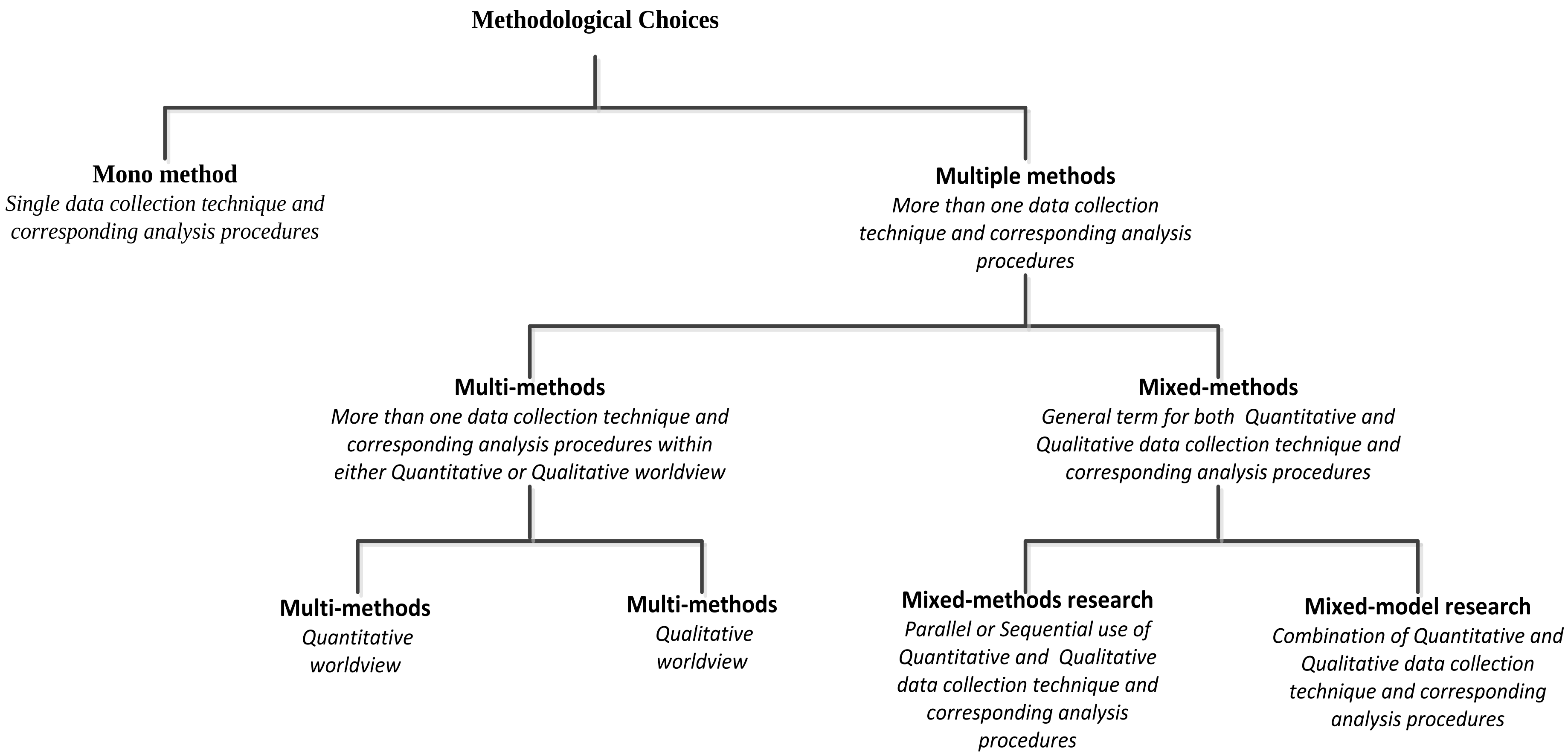

Figure 5.6: showing main and subset of methodological choices [Adapted from Yin (2011)]

5.7 Time Horizons

Sitting on the fifth layer of the onion model is *time horizons*, which gives consideration to the timeframe within which a study is to be carried out. In as much as the direction a research follows depends on the research questions, the aim and, equally, the objectives, there must as matter of necessity be a definite completion time (Saunders, 1987). For instance, a PhD researcher is normally expected to hand in a completed thesis after three or six years, for full and part-time research, respectively.

Saunders et al. (2011) classified research of this nature under the cross-sectional time horizon, while extended research covering a given period of time is classified under a longitudinal time horizon. An example of longitudinal research is periodic study on how staff relationships in a workplace affects the organisation's productivity; in other words, it is like keeping a diary record of periodic changes and development in a place. The last layer in the onion model is addressed in the next section.

5.8 Data Collection and Analysis

Research is not complete without data collection, and data collected erroneously will affect the authenticity of the research findings and outcome (Stack, 1995). Therefore, the innermost and final layer in the onion models highlights the many processes a researcher can adopt for the collection and analyses of primary data from a selected population.

These processes are many, and the choice of what is appropriate for a particular study depends largely on the array of questions on the researcher's mind, and the expected quality and nature of the research (Creswell, 2013). In no particular order, the following are common data collection techniques: questionnaires, experiments, observations, interviews and document review. The technique adopted in this thesis is discussed in detail in the following sections.

5.9 Adopted Research Design – The Onion Model

As already emphasised in the introductory chapter, the aim of this research is to examine the impact of community energy business model (CEBMoD) effectiveness on the nature and performance of community renewable energy projects (CREPs). In order to achieve this aim, five main objectives, which double as research milestones, were set. The first was to review literature on the UK community energy sector with a view to understanding the nature and performance of CREPs.

As a follow-up to the outcome of the first objective, some CEBMoDs in the UK were identified and critically appraised in order to understand their capacity to effectively manage CREPs. Drawing on this understanding, a theoretical framework that links CEBMoDs, CREPs and the social, environmental and economic considerations of the project, in all its phases, are suggested.

The framework particularly highlights specific aspects of local ownership that enhance or undermine CEBMoD efficiency. The relationships between CEBMoDs/CREPs and their social, environmental and economic considerations will be modelled and developed into a more comprehensive framework for assessing both CEBMoD effectiveness and CREP performance in Chapter 9.

The framework will undergo validation to test its effectiveness and applicability to selected CREPs in the UK. The main stages in achieving all these include a review of the literature (see Chapters 2 and 3), questionnaire survey administration, case study interviews, and process modelling. In particular, the review was focused on the UK energy sector and renewable energy projects, with a main focus on CREPs.

One peculiar outcome of the review was that while two similar CEBMoDs can be deployed for development of two different projects under the same market and regulatory conditions, the outcome of these projects depends largely on the innovative solutions introduced based on value created, delivered and obtained by the organisers.

In other words, an understanding of the composition, type and board characteristics of the various business models deployed for performing a project will help in developing a tool for assessing and improving the performance and management of new and existing CREPs.

Consequent upon this, the research focus became clearer and the need to adopt methods for collecting data, as well as corresponding analyses tools, became imminent. A pilot study was then conducted.

Having satisfactorily fulfilled the initial research requirements of identifying a problem and asking the right questions, the next most important requirement is to adopt one of the models earlier discussed. In this case, the onion model was adopted. Many researchers have developed their methods and strategies successfully by peeling through the layers of Saunders et al.'s (2011) onion and adopting appropriate approaches and strategies, thereby making choices within specific time horizons before settling for the techniques and procedures that reflect their overall research objectives. However, before identifying what element(s) in each layer of the adopted model are necessary for this research, the credibility of the research design needs to be addressed. The next section is dedicated to this.

5.10 Research Design Credibility

The credibility of research lies in ensuring that the findings reported remain valid when subjected to critical examination. It, however, starts with asking the right question, in particular, this research is examining the following questions: What impact (if any) does CEBMoD type have on the choice of CREP? Do particular CEBMoDs enhance or undermine the attractiveness of CREPs? What impact (if any) does the type of CEBMoD have on the operation and performance of CREPs? How does a CEBMoD board structure influence the effectiveness and performance of CREPs? How does a CEBMoD affect how CREP performance is assessed? What are the implications for communities and groups investing in renewable energy projects? In the real sense of above questions, the researcher does not have clear answers but can explore and identify possible ways to prevent incorrect answers.

One such way is to ensure the reliability and validity of the research design adopted. Mitchell and Jolley (2012) posit that as a key requirement for every study, the data collected and analysed, as well as its interpretation, must be subjected to validity and reliability tests.

5.10.1 *Reliability*

Reliability describes the degree of consistency in findings resulting from the data collection and analysis tools deployed by the researcher. The researcher, however, must always reflect on the following reliability assessment questions, as expounded by Golafshani (2003):

- Would similar procedures produce similar outcomes on a different occasion?
- Can another observer come up with similar observations?
- Were the data analysis, interpretation and discussion devoid of all forms of ambiguity?

Next to reliability assessment questions, the researcher needs to watch out for subject/participant errors and bias, as well as observer errors and bias. According to Grafton et al. (2011), these are possible threats that can impede the reliability of the research design. To overcome these threats, Leeds, Long and Mitchell (2000) advised researchers to always choose a time that is most convenient for survey respondents and interviewees, and also ensure anonymity of participants. Furthermore, the researcher must use high quality data collection and interpretation procedures to overcome observer error and bias.

5.10.2 *Validity*

Validity in research is concerned with the soundness and trustworthiness of the research findings (Eikeland, 2006); in other words, it assesses the comprehensiveness of the research design in achieving the research aims and objectives. This can be done internally and externally. *Internal validity* refers to the extent in which the data collection techniques deployed can effectively collect the desired data and, also, how the corresponding analysis tools can correctly measure the data (McDermott, 2011). It is basically a process of ensuring that the right "peg" is put in the right "hole". *External validity*, on the other hand, refers to wider believability of the research findings (Steckler and McLeroy, 2008; McDermott, 2011).

This means that for any research to be externally valid, the outcome must be consistent and applicable beyond the sample studied. Validity, however, is not without some threats, which include history (working with outdated information), testing (participants anticipating to be disadvantaged by the research outcome) and instrumentation (participants trying to create a different impression than reality; Trochim, 2005). Other common threats are mortality (demise of the researcher), maturation (sudden change in circumstances of the sampled population) and ambiguity about causal direction (Klink and Smith, 2001). Drawing on the onion design model, the components of the model found suitable for guiding the investigation of the impacts of CEBMoDs on the performance of CREPs in the UK are presented in Figure 5.7 and discussed in following sections.

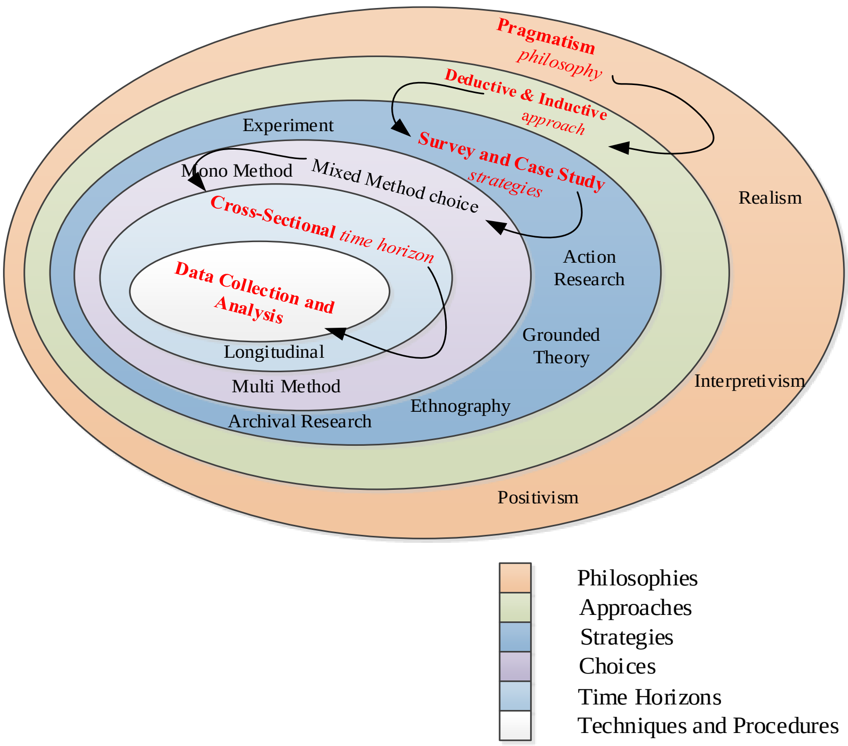

Figure 5.7: Research Design adopted for this research [Adapted from Saunders et al., 2011]

5.11 Adopted Philosophy

From the first layer in Figure 5.7 (philosophy), the pragmatic paradigm is adopted as the philosophical footing for the study.

This is because pragmatist researchers place emphasis on the research question (West, 1989). Pragmatists employ every technique there is (qualitative, quantitative or mixed methods) to the answering of research questions (Morgan, 2007). Furthermore, pragmatic philosophy emphasises understanding of real problems (e.g. the actions of community energy project organisers and their impacts) faced by real people (e.g. CREP stakeholders in the UK; Joas, 1993). In addition, pragmatists are strong proponents of using combinations of two or more research paradigms in order to make up for the drawbacks of individual paradigms (Rescher, 1999). By this, a more appropriate approach, strategy and choice for research can be adopted (Feilzer, 2010).

5.12 Adopted Approaches

Based on the above philosophical paradigm, inductive (qualitative), deductive (quantitative) or a combination of both approaches can be used to advance the research (Ali and Birley, 1999). Therefore, in order to approve or disprove the hypothesis set out in Chapter 4, the socioeconomic and environmental outcomes of CEPs in relation to their expectations were subjected to statistical tests (deductive approach). These variables were derived from literature as well as from the responses to questionnaires administered to various CEGs in the UK.

Furthermore, qualitative case study interviews were conducted for selected CREPs in Scotland alone (inductive approach). The opinion of a small sample of practitioners and local stakeholders were gauged regarding the negative and positive impacts that CREPs have on the local economy. The inductive approach focuses on interpreting the meanings each individual affected by the projects holds about the project, and cares less about generalisation (Bryman, and Bell, 2015). This is a divergent point of the inductive approach, which necessitates a combination of case study and surveys to strengthen the overall research design.

5.13 Adopted Strategy

Surveys and a case study were chosen as the appropriate strategy for this study for the following reasons. The survey research strategy, being a popular and efficient method for collecting significant amounts of data from the target population through questionnaires, was cost-effective for the researcher (Andersson, Karlehagen and Jonsson, 1987).

The case study strategy is an effective way of answering the *how* questions of research (Gillham, 2000). While questionnaires were administered UK-wide, the cases selected for this research were restricted to Scotland. Since this research seeks to answer the question of how to assess the impacts of CREPs on local stakeholders in the UK, this restrcition will allow for an in-depth study of CREP impacts.

This corroborates Woodside and Wilson's (2003) reminder that case study can be used to explain, explore and/or describe the complexities of phenomena for the purposes of analytical generalisation. Contrary to this standpoint, Noor (2008) argued that single cases cannot be generalised, while Hancock and Algozzine (2015) explained that the case study is an integral aspect of social science research and one of its underlying purposes is to generalise research findings. Yin (2012) further asserted that depending on the nature of research, case study can be used for pilot studies but not for the entire research process.

A similar view was expressed by Swanborn (2010), that case studies rely primarily on researchers' assumptions about phenomena and, because of such subjectivity, most case study conclusions may be too weak to be generalised. In contrast, however, Flyvbjerg (2006) pointed out that it is rather misleading for anyone to believe that an in-depth analysis of a single case cannot be generalised. There is, however, consistent evidence in most empirical arguments that case study is deep and detailed in its approach to real life studies. The choice of case or cases to investigate constitutes a vital process in the case study research strategy.

Regarding the selection of cases, Woodside and Wilson (2003) believe that there is no sharp distinction between the selection criteria for research methods and cases, and that a case is selected to either expound evolving concepts, bridge knowledge gaps, or support or oppose a proposition resulting from earlier cases. On the other hand, Swanborn (2010) maintains that the researcher must select a case (single) or cases (multiple) that facilitates the achievement of the research aim within the allotted time of study.

According to Simons (2009), the researcher is not restricted to a certain number of cases, but the chosen cases must be as realistic as possible to achieve the aim, objectives and questions set for the research. Yin (2012) presented five underlying principles for choosing single cases, these are: criticality, extremity, representativeness, and the revelatory and longitudinal natures of the case.

Criticality means analytically testing a unique concept, while *extremity* has to do with making a clearer representation of a misunderstood fact. *Representative* cases entail painting a picture of a conventional occurrence, and *revelatory* cases involve a known complicated case. The last principle is the *longitudinal case*, which emphasises the evolution of the case, and the patterns and underlying mechanisms that influenced this evolution.

However, the single case research strategy is said to be susceptible to inconsistency between eventual and expected case outcomes (George and Bennett, 2005, Yin, 2013, Stake, 2013). That notwithstanding, selection of multiple cases can make up for these inconsistencies because multiple case studies are useful when the researcher's aim is to achieve a more convincing result that supports hypothetical generalisation.

Usually, the anticipated confidence level of the researcher about multiple case outcomes determines the numbers studied. Based on the multiple natures of community ownership models in the UK, multiple cases are well-suited for achieving the research purpose. Therefore, multiple cases, reinforced by data from several sources, forms the qualitative strategy employed for this study. Data collection techniques for these strategies are fully discussed in Section 5.15

5.14 Adopted Choices

To make up for the limitations associated with using either quantitative or qualitative methods, a combination was employed. In addition, studies that have used a combination of these choices are highly rated. The tools used for collecting quantitative and qualitative data are outlined in the sections below.

5.15 Adopted Techniques and Procedures

A combination of quantitative and qualitative methods was adopted for this study, and specific data collection techniques for each method are briefly explained below.

5.15.1 *Quantitative Data Collection Techniques*

The questionnaire survey was the quantitative data collection instrument deployed and, as a fundamental requirement, questionnaires should be designed particularly with the aim of drawing robust data through a good response rate. To achieve this, the researcher has to consider the capacity of the respondents in providing not just answers, but useful ones. The processes of effective survey design and subsequent improvement starts with conducting a pilot study, as explained below.

5.15.1.1 Pilot study

In order to ensure that the data collection tools are adequately designed, such that respondents can easily understand the questions and provide exhaustive answers, a pilot study is necessary (Hakim, 1987). It involves testing the data collection instruments among a smaller number of participants with a view to assessing the wording and clarity of the questions, and its ability to generate robust data that can effectively address the research objectives.

In addition, the respondents were expected to provide comments on how the tools can be further improved, in terms of time spent answering the questions, and their compliance with standard design (Matthews and Ross, 2010). Consequent upon the above, a pilot study was conducted for this research and below are some useful comments from the participants.

- Three respondents observed that the font used was too small and advised that the time the survey will take should be given in the invitation rather than in the survey. They complained of too much scrolling being required to answer some questions, which they said made the process cumbersome.

- In addition, four other respondents observed spelling mistakes and obvious ambiguities in the wording of the questions. They particularly picked out the question that addresses business model attractiveness and advised that the words "enhance" and "undermine" are two contrasting expectations; hence, some answers may be based on either of them. Hence, this question was further simplified for easy understanding.

The pilot study reinforced the importance of keeping survey questions concise and clear. The literature was very helpful in this regard as it assisted the researcher in narrowing down the number of items. On the whole, the comments were very useful to the researcher in improving the main questionnaire.

5.15.1.2 Sampling size and techniques

As suggested in Marshall, (1996), sampling is essential when the timeframe and funding available for carrying out research is limited. Therefore, the target population for this research comprised the over 5000 CEGs in the UK (see chapter 2, section 2.8.5), in addition to public members and third party supporting groups/experts such as construction and installation, government/regulatory agencies, and relevant support service providers. Drawing on Gilem and Gilem (2003b)'s sampling formula, the sample size for this study was determined from the target population. The formula is given as;

$$ss = \frac{z^2 \text{ x } p(1-p)}{c^2}$$

Where:

ss = sample size

z = Z value

p = percentage picking a choice, expressed as decimal

c = confidence interval, expressed as a decimal

To establish a balance between the accuracy level, availability of resources and practicality of the findings (Marshall, 1996; Tashakkori and Teddlie, 1998), the following assumptions have been made;

z = 1.96 for 95% confidence level)

p = 0.5 used for sample size needed

c = 0.05 = ±5)

The assumptions and the formula given above were used in computing the sample size thus;

$$ss = \frac{1.96^2 \times (0.5) * (1-0.5)}{0.05^2}$$

ss = 384.16

In other words, 384 respondents drawn from the over 5000 CEGs in the UK, in addition to public members and third party supporting groups/experts will make adequate sample for this study (Noor, 2008). To correct for finite populations as postulated by Yin, (2012), the following formula applies.

$$\text{new ss} = \frac{ss}{1 + \frac{ss-1}{pop}}$$

Where: pop = population (CEGs in the UK), therefore, the new ss =

$$\frac{384.16}{1 + \frac{384.16-1}{5000}}$$

new ss = 357

Historically, questionnaire survey response rate in most construction management related research stands at 20% - 30% (Wong, 2004; Bassioni, Price and Hassan, 2004; Iyer and Jha, 2005a). It is therefore important to anticipate similar scenario for this research and equally account for possible non-response. Consequently, 30% response rate was anticipated for, and a new survey sample size was calculated as;

Survey ss = 30% x 357 = 107

A random selection of CREPs stakeholders from Community Energy England, Scotland, Wales and Northern Ireland Community Energy websites was thus made to provide a list comprising at least 107 CEGs and third-party organizations by generating random numbers in Microsoft Excel 2010.

5.15.1.3 Questionnaire Survey and Design

In the main survey design, the questions were divided into four groups covering the main themes under investigation. Group A gave answers to some general demographic questions, while Groups B and C were asked about CREP performance in the UK, and their social, economic and environmental implications for investors and local communities, respectively.

Respondents were asked to answer the questions according to a 5-point Likert scale to the best of their recollection based on their most recent involvement in community energy projects. A Likert scale was chosen because it is widely used, easy for respondents to understand, and makes quantification of responses easy (Laerhoven, Zaag-Loonen and Derkx, 2004). In other words, responses to a particular question are combined such that respondents who agree with a question are assigned higher scores, whereas those who disagree are assigned lower scores (Gliem and Gliem, 2003b).

The survey utilised the *Lime Survey* online survey tool, and access was provided by the university. The survey was activated on the 12th May 2016 and the link was emailed in batches to a total of 357 randomly selected community energy stakeholders. This was so that the contact details of the prospective respondents were not all obtained at once. Although it is generally believed that distributing or sending survey links through organisations or people that respondents are familiar with increases the response rate (Bush and White, 1985), the researcher did not know any sources familiar to the respondents.

After three reminders, a total of 111 responses (31% participation) were recorded. Some 102 responses, representing 92% of the total received, were complete. As expected, respondents were made by people from a broad range of backgrounds and, in order to ensure that the responses came from professionals and were suitable for analysis, a question was included in the early part of the survey to filter out participants with no experience in CEPs or related activities. Seven respondents fell into this category and were automatically filtered out from further participation after answering “no” to the question. They were dropped from the 102 complete responses, leaving only 95 responses for analysis. The survey was closed on 31st October 2016, with incomplete survey responses discarded.

5.15.1.3.1 Respondent profile

Of the 95 respondents that completed the survey, only 63.08% provided the address of where their project is sited. Based on the above statistics, and in terms of geographical distribution, England, Scotland and Wales accounted for 51.22%, 46.34% and 2.44%, respectively, of responses from all stakeholders contacted. The profile of the respondents' years of experience in the sector, academic qualifications and professional memberships are detailed in Chapter 6.

5.15.2 *Qualitative Data Collection Techniques*

The second phase of empirical qualitative data collection for this research was the case study. For some kinds of qualitative research, case sampling is usually not a concern because, according to Curtis et al. (2000), there are no laid-down principles for achieving it. However, extant literature on renewable energy-related research acknowledges the importance of both qualitative and quantitative research methods.

To validate the qualitative strand of this research, case study sampling must be addressed, although the relevance of the sampling methods used in qualitative research are seldom justified compared to the data collection and analysis methods.

According to Marshall (1996), cases can be *collective*, *intrinsic* or *instrumental*. Collective cases entail selection of a case or cases from set of alternatives, in order to rigorously examine a research problem (i.e. collection of multiple instrumental cases). Intrinsic cases refer to prescribed cases which also relevant to the research question. Instrumental cases, on the other hand, are cases selected and studied in order to better understand something else. It is obvious that sampling cannot be based on probability theory alone (Marshall, 1996). However, an acceptable principle for qualitative sampling is still a subject of debate among qualitative research scholars (Neuman, 2002; Cooper, Schindler and Sun, 2003)

This research requires cases of CREPs to be selected from a pool of possible alternatives (in terms of alternative technologies and BMs deployed by CEGs). Therefore, the research explored various rationales of case selection principles, particularly their suitability to the general research concept of analytical generalisation.

Although these principles are contestable, Curtis et al. (2000) argue that some aspects of the many sampling principles available can be distilled for general applicability. The case sampling used for this research adopted the sampling criteria proposed by Miles and Huberman (1994) and is presented in Table 5.5.

Table 5.5: Miles and Huberman's (1994) case sampling criteria

SN	CASE SAMPLING GUIDELINES	COMPLIANT WITH GUIDELINES?	HOW?
1	Is the selected case related to the established conceptual framework?	Yes	Cases whose business models had obvious impacts on CREP performance were selected
2	Can substantial amounts of useful information be drawn from the case?	Yes	Cases that can provide useful information on all aspects of the framework were considered, moreover the cases provided opportunity to interact with real people on the real project
3	Is there a high possibility of achieving analytical generalisation from the case?	Yes	Focus was on the areas with higher concentrations of CREPs in Scotland
4	Is there a high possibility of generating convincing discussions from the case?	Yes	As a basis for validating sampling strategy, credible public opinions on CREP performance were considered
5	Does the sampling strategy emphasise ethical considerations?	Yes	It was a consideration during the interview, but was not relevant in case selection
6	Is the sampling strategy practicable in terms of resource (time and money) availability?	Yes	Cases restricted to Scotland based on limited study time and finances

5.15.2.1 Interviews

Semi-structured interviews were conducted for this study because of their flexibility and ability to draw expected and unexpected but useful insights from interviewees (Creswell, 2007). The questions were designed to draw information about the operational efficiency of incumbent CEBMoDs in the UK. Eleven CREP experts drawn from community energy cooperatives, development trusts and third-party organisations were interviewed. Further details and corresponding analyses are presented in Chapter 8.

5.15.3 *Quantitative Data Analysis procedures*

Several analytical tools were employed to analyse and interpret the quantitative and qualitative data. For the quantitative data, the *R* programming language for statistical computing and graphics was used to analyse the data descriptively, inferentially, and for the development of a hypothesised model. *R* is known for its robustness and is freely available (R Core-Team, 2015). In addition, the package is flexible, user friendly, interactive and allows for easy data manipulation. The various statistical tests carried out with *R* are described next.

5.15.3.1 Descriptive Statistics

One of the first tasks of the researcher in the data analysis process is to carefully screen the data to ensure they meet the assumptions of statistical tests (Oja, 1983). Descriptive statistics, therefore, is a detailed description of the dataset before inferential statistics. It is carried out to determine if the data are normally distributed and if they can be compared to a larger population.

Furthermore, the process organises and summarises the dataset in the form of percentages, tables, charts, frequency distributions and reports as measures of central tendency (Weiss and Weiss, 2012). Descriptive statistics were calculated for the quantitative data collected from the questionnaire survey. The means, standard deviations, percentages and relative importance indexes of the data were determined by this method and are reported in Chapter 6.

5.15.3.2 Principal Component Analysis (PCA)

The responses from the surveys were randomly listed and were from different groups of professionals. About 105 variables were measured. In order to simplify the process of data analysis, Jolliffe (2002) recommends that the variables can be combined to derive new components which will produce a simpler description of the dataset, by carrying out principal component analysis (PCA). PCA is a statistical technique used to expose patterns in a dataset by identifying relationships among variables. Although not a rule of thumb, PCA deploys basic mathematical concepts to compress data to a smaller size without losing any vital information. (further detail in Chapter 6).

5.15.3.3 Correlation Analysis

The relationship between CEBMoD effectiveness, their management structures, and CREP development was assessed using exploratory factor analysis. Pearson product-moment correlation coefficient (PPMCC) analysis was conducted to ascertain the strength of linear relationships (Cohen *et al.*, 2013).

5.15.3.4 Multiple Regression

Multiple regression (MR) explains whether a relationship exists between independent (explanatory or predictor) variables and dependent (or outcome) variables. It provides answers to what best predicts an outcome of anticipated occurrences by (i) multiplying a combination of all the variables by their corresponding coefficients, (ii) then, a residual term is added to predict the coefficients of both independent and dependent variables.

Since the fourth objective of this research is to develop and evaluate a framework for the selection of appropriate CEBMoDs for particular CREP development, it was important to, first and foremost, examine whether a relationship existed between these components and CREP overall success as well as anticipated economic, environmental and social impacts. Therefore, multiple regression analysis was used to predict the probability of achieving the above and how an effective CEBMoD and management structure contributes to achieving the same. Further details are presented in Chapter 8.

5.15.4 *Qualitative Data Analysis procedures*

The qualitative data was collected from a population within the same social environment as the quantitative data (members of community energy organisations overseeing live projects in Scotland under selected BMs) through semi-structured interviews. The following were the key steps followed in the interview data analysis procedure. The first step was to transcribe the interview with the aid of an Olympus AS-2400 professional transcription kit, and afterwards, read through the transcripts more than once, observing and making notes about key themes.

To facilitate the analysis of data, the NVivo 12 qualitative data analysis (QDA) computer software package was employed for coding, organising, linking, and exploring the transcripts and notes(Welsh, 2002). The steps highlighted above are practically demonstrated in chapter 8 of this thesis.

5.15.5 *Framework development and validation*

The principal issues and suggestions which arose from the quantitative and qualitative data will be used in Chapter 9 to develop a framework for the selection of appropriate CEBMoDs for the development of particular CREPs. The framework will be subjected to expert evaluation to test its effectiveness and application on selected CREPs in the UK. This is presented in Chapter 9 of the thesis.

5.16 Summary

This chapter addressed the importance of various research designs and methodologies by examining four different research design models. Based on the nature of the research problem, the researcher's philosophical views, personal experience and the study's significance, the onion model was adopted for this study. Each layer in the model was carefully explored and, in the end, the researcher was able to extract the philosophy, approaches, strategies, choices, time horizon and data collection parameters, as well as the analysis techniques that can be used to address the aims and objectives set out in the introductory chapter. In particular, the pragmatic paradigm was adopted as the philosophical footing for the study, while survey (for the quantitative phase) and case study interviews (for the qualitative phase) were chosen as the appropriate strategies. To make up for the limitations associated with using either quantitative or qualitative methods alone, a combination of both was employed. Furthermore, the chapter addressed the sample size and sample techniques deployed for the research. The next chapter will discuss the findings from the questionnaire survey administered to CREP practitioners.

CHAPTER 6: QUESTIONNAIRE SURVEY ANALYSIS AND DISCUSSION

6.1 Introduction

This chapter presents the findings of the questionnaire survey administered UK-wide to community renewable energy project (CREP) practitioners. This relates to the second aspect of the research strategy from the third layer of the onion research design model (Chapter 5). Chapter 6 discusses the scale reliability and validity of the survey instrument, the sample characteristics and the internal consistency of the data. To evaluate the capacity of various community energy business models (CEBMoDs) to effectively manage CREPs, simple descriptive statistics are calculated for the quantitative dataset, followed by a more complex analysis that reveals the existence of multivariate relationships between variables. Discussions of the outcomes of the various analyses are also included in this chapter.

6.2 Scale Reliability and validity

According to Curtis et al. (2000), *reliability* explains the degree of consistency in the outcomes of the techniques employed for collecting and analysing raw data. For this research, Cronbach's α coefficient was employed to determine the scale reliability for ranking possible performance hindrances to each CREP phase, their outcomes and impacts, as well as some selected types of CEBMoDs, their attractiveness and influences on CREP outcomes. Cronbach's alpha assesses the strength of internal consistency of the measurement concept adopted for this research.

As a rule of thumb, an alpha value of 0–0.4 means that the scale items are not correlated and are usually not acceptable. In other words, the higher the number of items analysed and the covariance among them, the higher the alpha value. The recommended α-values according to Santos (1999) should range from 0.65–0.80; however, any value above 0.50 is still acceptable depending on dimensionality (Peterson and Kim, 2013). As can be seen in Table 6.1 that the α-values for each category of factors examined were 0.63–0.87, which implies that the scales are reliable.

Table 6:.1 Reliability statistics

Item Description	Cronbach's coefficient (α)	Number of items
CREPs Planning Phase Hindrances	0.633	12
CREPs Implementation Phase Hindrances	0.770	12
CREPs Operational Phase Hindrances	0.623	09
CREPs Disposal Phase Hindrances	0.718	06
CREPs Economic outcome and impacts	0.600	08
CREPs Environmental outcome and impacts	0.831	09
CREPs Social outcome and impacts	0.767	12
CEBMoD frequency of use	0.670	9
CEBMoD attractiveness	0.852	20
CEBMoD influence	0.630	5

Other Reliability and validity of research design have been extensively addressed in chapter 5 and 8.

6.3 Sample Characteristics

In order to present detailed findings from the questionnaire survey, it is first and foremost important to explain the instruments, tools and techniques deployed for quantitative data collection. The survey utilised the LimeSurvey online survey tool, and access was provided by University. The survey was activated on the 12th May 2016 and sent in three batches to respondents across the UK. This was so because the contact details of prospective respondents were not all obtained at once. Although it is generally believed that distributing or sending survey links through organisations or people that respondents are familiar with could increase the response rate (Bush and White, 1985), the researcher had no such contacts.

Therefore, the survey covering letter and link was emailed directly to 357 respondents. After three reminders, 111 valid responses were received. As expected, respondents comprised people from a broad range of backgrounds. To ensure that the responses were from professionals and suitable for analyses, a question was included in the early part of the survey that was intended to filter out participants with no experience in CREPs. Seven respondents had no experience in CREPs and were eliminated from further participation, leaving 104 responses for analysis.

The survey was closed on the 31st of October 2016, after a careful look at how each question in the survey was responded to, it was observed that 9 responses were incomplete and therefore discarded from the final data. In the end only 95 responses were complete and deemed appropriate for used in further analyses. The survey samples for this research cuts across various Community Energy Groups (CEGs) selected and compiled from the Community Energy Projects database of Community Energy Scotland, England, Northern Ireland and Wales. This is important because these four Nations make up the United Kingdom. Also, various type of Renewable Energy projects engaged in by the selected CEGs was considered to give wider perspectives to phenomena under investigation.

6.4 Respondent Profile/Demographic Information

The first section of the questionnaire summarizes vital information about the respondents' backgrounds and the nature of the responses received. Of the 95 completed responses recorded, only 63% provided the address where their project is sited and consequently, England, Scotland and Wales accounted for 51%, 46% and 3% respectively of respondents/projects geographical locations. A summary of respondents' years of experience in the sector, professional memberships and job categories is presented in Table 6.2.

Table 6.2: Respondent experience, qualifications, memberships and job categories

Category	Classification	Frequency	Percentage
Years of Experience	From 1 to 5	40	42%
	From 6 to 10	19	20%
	From 11 to 15	11	12%
	From 16 to 20	07	7%
	From 21 and above	10	11%
	No answer	08	8%
	Total	**95**	**100%**
Academic Qualification	PhD/D.Eng.	04	4%
	M.Eng/M.Tech/P.Dip	34	36%
	HND/HNC/B.Sc.	45	47%
	ND/NC	03	3%
	Others	10	10%
	Total	**95**	**100%**
Professional Membership	Various Professional Bodies	31	33%
	Non-Members	64	67%
	Total	**95**	**100%**
Job Category	Support Service Providers	13	14%
	Government/Regulatory Agencies	12	13%

Research, Planning and Development	12	13%
Operations and Maintenance Experts	03	3%
Volunteering	20	21%
Construction and Installation	03	3%
Technical Designs and Equipment Manufacturing	03	3%
Others	29	30%
Total	**95**	**100%**

It is apparent from above table that majority of the respondents (42%) had between 1 to 5 years of experience in the community energy sector. This further supports the growing body of literature that describes Community Energy (CE) as an emerging system of energy governance that is gradually gaining relevance in the larger renewable energy market (Walker *et al.*, 2007; Walker and Devine-Wright, 2008; Munday, Bristow and Cowell, 2011; Seyfang, Park and Smith, 2013). There were also respondents with more than 10 and 20 years of experience in the larger energy sector.

In terms of Academic Qualifications, 47% of the survey participants held bachelor's degree and its equivalent in various field of their endeavour. 36% and 4% of respondents read up to the Masters and Doctorate degree levels respectively. Furthermore, 33% of all the respondents are members of their various professional bodies and are actively discharging professional and volunteer duties in the community energy projects. This implies that respondents are knowledgeable in the CE sector, hence the data obtained from them can be relied upon for further analysis.

6.5 Data Exploration and Cleaning

According to Field (2005), before any useful inference can be drawn from raw data obtained from field work, it is important to explore both sample characteristics and the underlying features of the data. One of the first tasks is to carefully screen the data to ensure it meets required assumptions for a more robust statistical test, since it is not just enough to perform a statistical tests but doing it correctly (Oja, 1983). Simple Descriptive Statistics therefore was performed on the data set before the more complex inferential statistics; Descriptive Statistics is carried out to determine if sample have a normal distribution or not and if it can be compared to larger population. Triola (2006) submits that the analysis is necessary when the intention of the researcher is to find the mean, mode, median, and standard deviation of the data set, and the purpose for these are further expounded on in the sections below:

6.5.1 *Mean and Standard Deviation*

To ensure it is the data expected that was collected, mean and standard deviation (SD) were computed to measure out the spread of the data. According to Wohland, Rigler and Vogel (2001), the SD of very large spread connotes lots of error in data whereas small spread may mean lack of variance which is equally not a good sign. Furthermore, depending on the scale of the data, it may be impossible to run statistics with zero variance (Jamieson, 2004). As for the mean, if the mean of a question is 1.2 in a 1-7 scale, it simply indicates that everyone respondent picked 1 in the Likert scale. All these procedures are geared towards ascertaining the normality of data distribution before embarking on a more complex inferential statistical analysis.

6.5.2 *Accuracy checks*

Before data is said to be ready for analysis, it must be cleaned up to avoid any bias (Rahm and Do, 2000). In other words, the categorical and continuous items in the survey must be checked for consistency in coding and labels. In particular, the continuous items were checked for typo errors, value range (high/low). This is to ensure that in a Likert scale of 1-5 used in the survey, a value greater than 5 or lesser than 1 is not included in the analysis. Also, other column scale that must not be exceeded was checked to ensure that the right logic is used for the right columns. Logical operations were employed to check for these likely discrepancies in quantitative data but fortunately none was found.

Based on its open-source nature, robustness and coding flexibility, the researcher adopted the *R* programming language (R Core-Team, 2015) and its relevant packages for the above checks and subsequent analyses deemed necessary for the quantitative aspects of the research. On completion of all accuracy checks, a quick run through the data showed that the minimum and maximum number ranges and, in this case, the maximum figures, did not exceed the largest figure in the scale used. However, some values were missing.

6.5.3 *Missing Values and Replacement*

It is almost impossible to collect quantitative data without some data missing (Graham, 2009; Graham, 2012; Little and Rubin, 2014) and there are many explanations for this.

For instance, some respondents may forget to enter data, or enter it in an incorrect format (Enders, 2010). Another reason is that some people do not feel comfortable answering certain questions and therefore skip them (Schlomer, Bauman and Card, 2010).

According to Graham (2012), data can be missing randomly or not at random. Randomly missing data appears across a dataset, but if everyone misses a specific question, then that is not random. According to Dodeen (2003), only data missing completely at random should be replaced, and the amount of data to be replaced depends on the sample size. In large datasets, $< 5\%$ missing data is replaceable, but anything $> 5\%$ should not be replaced. Rather, the researcher is advised to collect more data. Replacement of missing data can be done by deleting people/variables with missing values before data is used for analysis.

Other replacement methods commonly used are *pairwise* (i.e. excluding responses with missing values from a particular analysis) or *list-wise* (i.e. excluding respondents with missing data from all analyses). Data collection is not an easy exercise and, therefore, deleting respondents with missing data may not the best option, especially when the initial response rate is very low. Consequently, several other alternative estimation methods to "fill in" missing data were explored. This included mean substitution and multiple imputation/expected maximisation.

Mean substitution is one of the oldest ways to enter missing data. It is done by calculating the mean value of a variable and using it to fill in any missing values. This approach has been widely criticised (Bakan, 1966; King, Fogg and Downey, 1998; Raaijmakers, 1999; Dodeen, 2003) for being too conservative in the sense that the variance of that column remains same even after replacement. According to Bakan (1966), this may affect tests of significance.

Multiple imputation/expected maximisation, on the other hand, is an advanced method of missing data replacement. It uses matrix algebra to estimate the probability of each value and picks the highest value to fill in the missing data (Buuren and Groothuis-Oudshoorn, 2011). The method is considered the best at replacing missing data because it creates an expected value set for each missing point. This study employed a special *R* programme package known as *Multivariate Imputation by Chained Equations* (MICE) for the computation and replacement of missing data.

This concludes all forms of data cleaning and missing data replacement exercise necessary to qualify the data for further analysis. The subsequent sections describe the analysis of the questionnaire survey items.

6.6 Analysis of Questionnaire Items

This section presents the analysis of each questionnaire item and all useful inferences drawn, with a view to suggesting research conclusions, limitations and areas requiring further investigation.

6.6.1 *Respondent involvement in CREPs*

In the survey administered for this research, a question probing the level of awareness or involvement of participants in CREPs was introduced. The intention was to obtain responses only from participants with high levels of experience in the sector. Some 89% of the completed responses received indicated knowledge of the CREP sector (see Table 6.3) and participation in one or more projects.

Table 6.3: Respondent's involvement in CREPs

		Frequency	**Percentage**	**Cumulative Percentage**
Valid	Yes	95	86%	86%
	No	07	6%	92%
	Incomplete	09	8%	100%
	Total	**111**	**100%**	

This is consistent with Baruch and Holtom (2008), who posit that in selecting survey participants, the researcher must ensure they have adequate knowledge of the area being studied.

6.6.2 *Types of CREPs participants were involved in*

After screening out participants with no knowledge of, or participation in, CREPs, the remainder of the respondents were asked to choose the types of project they had been involved in out of the following categories: solar, wind, hydroelectricity, geothermal, tidal, wave, biomass and nuclear power.

As can be seen in Figure 6.1 below, solar power projects dominated the responses, with 66.15% of survey participants having been part of this type of project.

This was closely followed by wind power projects, with 49.23% of respondents being experts in them. Only 1.54% of respondents had been involved in anaerobic digester projects, and none had experience in nuclear power projects.

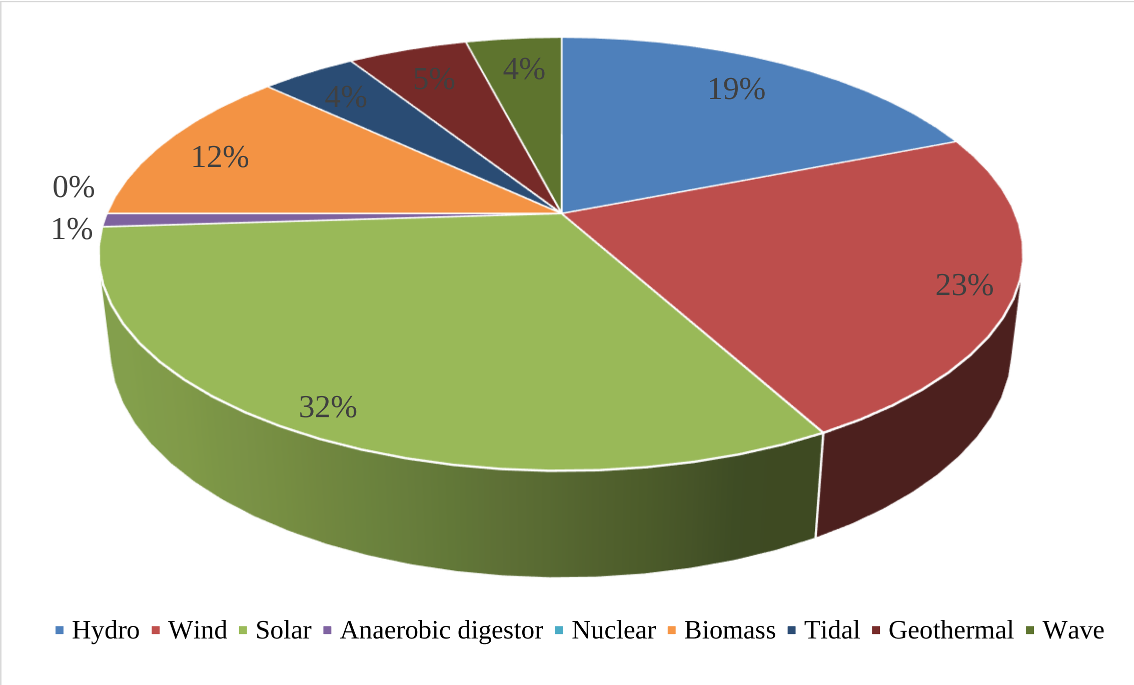

Figure 6.1: Community renewable energy project types survey respondents were involved in

This reflects the current trend in the UK community energy sector, where solar and wind energy resources are readily available to be harnessed. Also, funding and planning consent can be easily arranged for these projects.

6.7 Internal Consistency Test

To test for internal consistency of the data used for further analysis, item-correlation tests were performed on the 102 factors to test if any item in the set of tests lacked consistency when compared to the average behaviour of other items in the set (see Appendix B, Table 1). This analysis is necessary to ensure that only underlying factors that depict the construct are extracted, while inconsistent ones are discarded from further analysis (Streiner, 2003).

In terms of deciding what factor load cut-off points are adequate for item to total correlation, several researchers have recommended different factor loads. In particular, Cristobal et al. (2007), Loiacono et al. (2002), Francis and White (2002) and Kim and Stoel (2004) posit that a factor load of 0.30, 0.40 or 0.50, respectively, is acceptable. On the contrary, Gliem and Gliem (2003a) suggest that for acceptable internal consistency of test items, the alpha value from its item-to-total correlation must be between 0.50–0.80, while items < 0.50 should be discarded.

As can be seen in Appendix A, Table 1, the lowest alpha value obtained for all factors was 0.857, which indicates a strong correlation and internal consistency of the test items. Therefore, all items are worthy of retention for further multivariate analysis. Having tested the internal consistency of test items, it is also reasonable to examine the basic features of the CEBMoD efficiency factors and, later, the CREP performance factors

6.8 Determining CEBMoD approaches to CREP development and indicators of CREP success

In order to identify trends in the quantitative data indicating i) possible performance hindrances (PPH) to the planning, implementation, operational and disposal phases of CREPs, and ii) expected environmental, economic and social outcomes / impacts expected from the projects, several statistical analyses were conducted, starting with simple descriptive statistics and then multivariate data analyses such as factor and correlation analyses. The analysis procedures and outcomes are detailed in the sections that follow.

6.9 Ranking of CREP Impacts and Common Influences of Success

6.9.1 *Possible Planning Phase Hindrances*

Respondents were required to rate their level of agreement or disagreement, on a scale of 1 to 5, to statements in Section B of the questionnaire (see Appendix A). It is clear from the mean rating of responses (Table 6.4) that all of the statements grouped under planning phase hindrances are statements of fact.

Table 6.4: Descriptive statistics of possible planning phase hindrances

POSSIBLE PLANNING PHASE HINDRANCE FACTORS	N	MEAN	SE	SD	G/MEAN
					3.198
PPH1a. - High project start-up cost for poor communities and groups	95	3.347	0.118	1.146	
PPH1b. - Flawed project feasibility studies and business case	95	3.126	0.116	1.132	
PPH1c. - Insufficient investment information	95	3.253	0.109	1.062	
PPH1d. - Insufficient Renewable resource assessment data and tools	95	3.105	0.117	1.144	
PPH1e. - Inconsistent front-end engineering and technical systems design	95	3.074	0.110	1.074	
PPH1f. - Compromised bidding process	95	3.032	0.100	0.973	
PPH1g.- Inadequate quantification of project investment risks	95	3.316	0.103	1.003	
PPH1h. - Premature local energy market	95	3.032	0.107	1.046	
PPH1i. - Lack of access to project financing	95	3.474	0.110	1.070	
PPH1j. - Lack of guaranteed loan programs for poor communities	95	3.253	0.114	1.111	
PPH1k. - Setting over ambitious project goals	95	3.316	0.111	1.084	
PPH1l. - No prioritization and alignment of project goals to local needs	95	3.053	0.104	1.014	

Within the UK CREPs sector, some projects have been labelled "dead on arrival" because of the inability of the project initiators to scale through planning phase constraints, thereby being refused consent to proceed (CEE, 2017).

6.9.2 *Possible Implementation Phase Hindrances*

Implementation-phase hindrances were assessed using the factors shown in Table 6.5. Here too, the mean response scores reflect respondents' agreement to the fact that the process of converting project plans to tangible physical facilities suitable for purpose is not without complexities.

Table 6.5: Descriptive statistics of possible implementation phase hindrances

POSSIBLE IMPLEMENTATION PHASE HINDRANCE FACTORS	N	MEAN	SE	SD	G/MEAN
					3.221
PPH2a. - Lack of local skills and expertise	95	3.347	0.122	1.192	
PPH2b. - Having the wrong team for the job	95	3.526	0.115	1.119	
PPH2c. - Poor project information management	95	3.411	0.095	0.928	
PPH2d. - Failure to screen site for project development	95	3.411	0.109	1.067	
PPH2e. - Not using experts for evaluation of project cost estimates	95	3.042	0.122	1.184	
PPH2f. - High rate of accidents, injuries, fatalities and near misses on site	95	2.621	0.130	1.265	
PPH2g. - Time and cost overrun	95	3.358	0.113	1.100	
PPH2h. - Looming/unresolved conflicts among participants	95	3.242	0.112	1.089	
PPH2i. - Inability to effectively service project loans	95	3.137	0.110	1.068	
PPH2j. - Bankruptcy and insolvency	95	2.884	0.120	1.166	
PPH2k. - Unforeseen eventualities and externalities	95	3.358	0.125	1.220	
PPH2l. - Poor relationship and communication management	95	3.316	0.112	1.094	

6.9.3 *Possible Operational Phase Hindrances*

The satisfaction of respondents with possible hindrance factors at the operational phase of CREPs was also assessed. As evident from Table 6.6, 98% of the mean ratings were above 3. Hence, by implication, the respondents were satisfied with the fact that these factors are possible barriers to the success of the operational performance of CREPs if not addressed.

Table 6.6: Descriptive statistics of possible operational phase hindrances

POSSIBLE OPERATIONAL PHASE HINDRANCE FACTORS	N	MEAN	SE	SD	G/MEAN
					3.199
PPH3a.- Poor knowledge of Technology performance and reliability indicators	95	3.137	0.103	1.006	
PPH3b. - Insufficient/no benefits accrued from the project to the locals	95	3.095	0.107	1.042	
PPH3c. - Unequal subsidies payment and taxes for community groups	95	3.168	0.102	0.996	
PPH3d. - Prolonged Grid integration barriers	95	3.442	0.108	1.049	
PPH3e. - Poorly executed project	95	3.221	0.107	1.044	
PPH3f. - Lack of Installations and Maintenance supports	95	3.168	0.111	1.078	
PPH3g. - Continuous market monopoly by bigger energy companies	95	3.337	0.110	1.068	
PPH3h. - Ineffective/no Government regulations and legislation	95	3.221	0.106	1.033	
PPH3i. - No Research and Development programs to support project	95	3.000	0.102	0.989	

This finding is quite significant and consistent with ongoing debates on some CREP operational challenges faced by CEGs. Among them are the removal of renewable energy subsidies by the UK Government and its impacts on the distribution of community benefits (Mirzania *et al.*, 2017)

6.9.4 *Possible Disposal/Close-Out Phase Hindrances*

Disposal phase hindrance were assessed by asking respondents to indicate, on a scale of 1 to 5, the factors that could impede the potential for CEGs to reinvest in similar initiatives at the close-out of current projects. Among the factors rated are: lack of project reinvestment capacity for the community, lack of expert solutions across the whole life of the project, lack of long-term preparatory plans to support future sector changes, and poor projections of future sector demands.

Moreover, ineffective feedback and insufficient information management system on final project evaluation report also formed part of the factors. The mean ratings on Table 6.7 show an overwhelming level of agreement with all the factors identified.

Table6.7: Descriptive statistics of possible disposal/close-out phase hindrances

POSSIBLE CLOSE-OUT PHASE HINDRANCE FACTORS	N	MEAN	SE	SD	G/MEAN
					3.182
PPH4a. - Lack of project reinvestment capacity for the community	95	3.179	0.111	1.082	
PPH4b. - Lack of expert solutions across the whole life of the project	95	3.116	0.110	1.071	
PPH4c. - Lack of long-term preparatory plans to support future sector changes	95	3.168	0.098	0.953	
PPH4d. - Poor projections of future sector demands	95	3.284	0.104	1.018	
PPH4e. - Ineffective feedback system	95	3.200	0.106	1.038	
PPH4f. - Insufficient information on final project evaluation report	95	3.147	0.106	1.031	

Apart from the assessment of performance hindrance factors, the socioeconomic and environmental impacts/outcomes of CREPs were assessed. The following section reports the basic descriptive statistics of these groups of factors.

6.9.5 *Economic Outcomes and Impacts*

The knock-on effects of CREPs on the local economy are enormous, among them are: increased local job creation, reinvested revenue-boosted local economic activities, reinvestment of revenue to diversify the local economy, increased prospects for local manufacturing, local energy market growth, high savings on energy bills, less reliance on conventionally produced energy, and affordable and stable energy prices. Based on the mean ratings in Table 6.8, there was a high level of agreement amongst respondents regarding the existence of substantial economic impacts by CREPs.

Table 6.8: Descriptive statistics of economic outcome and impacts

ECONOMIC OUTCOMES AND IMPACTS	N	MEAN	SE	SD	G/MEAN
					3.307
POI1a. - Increased local job creation	95	3.200	0.105	1.027	
POI1b. - Reinvested revenue boosted local economic activities	95	3.547	0.110	1.070	
POI1c. - Reinvested revenue diversified the local economy	95	3.484	0.113	1.100	
POI1d. - High prospects for local manufacturing	95	2.937	0.111	1.080	
POI1e. - Local energy market growth	95	3.295	0.110	1.071	
POI1f. - High savings on energy bills	95	3.168	0.112	1.088	
POI1g. - Less reliance on conventionally produced energy	95	3.474	0.110	1.070	
POI1h. - Affordable and stable energy price	95	3.347	0.108	1.050	

6.9.6 *Environmental Outcome and Impacts*

Under this category of CREP impacts and outcomes are the following: health risks from toxic chemical storage near the site, severe noise pollution, alterations to the natural environment, high rates of wildlife fatalities, and conflicts in heritage protected landscapes.

These were considered to have generated public outcry and empirical debate. In addition, reductions in tourism activities, use of high carbon embedded materials during construction, displacement of residential areas and farmlands, and upsetting effects of construction/maintenance traffic were significantly rated by respondents.

Table 6.9: Descriptive statistics of environmental outcomes and impacts

ENVIRONMENTAL OUTCOMES AND IMPACTS	N	MEAN	SE	SD	G/MEAN
					2.904
POI2a. - Health risk from toxic chemical storage near site	95	2.600	0.131	1.275	
POI2b. - Severe noise pollution	95	2.632	0.110	1.072	
POI2c. - Alterations to the natural environment	95	3.137	0.103	1.006	
POI2d. - High rate of wildlife fatalities	95	2.853	0.124	1.211	
POI2e. - Conflicts in heritage protected landscapes	95	3.168	0.117	1.136	
POI2f. - Reduction in tourism activities	95	2.716	0.127	1.235	
POI2g. - High carbon embedded material used during construction	95	3.021	0.112	1.091	
POI2h. - Displacement of residential and farmlands	95	2.863	0.117	1.145	
POI2i. - Upsetting effects of construction/maintenance traffic	95	3.147	0.113	1.101	

6.9.7 *Social Outcome and Impacts*

The responses obtained for this category of factors suggest that increased local support, increased local acceptance, increased knowledge of renewable, high pro-environmental behavioural change, improved quality of indoor air, and greater local resource reliance were tangible impacts generated by CREPs in the UK. It further indicates that CREPs have scaled up local job creation, reduced the rate of fuel poverty, offer energy choices to the locals, as well as boosted local social activities, capacity building, and skills.

Table6.10: Descriptive Statistics of Social Outcome and Impacts

SOCIAL OUTCOMES AND IMPACTS	N	MEAN	SE	SD	G/MEAN
					3.451
POI3a. - Increased local support	95	3.589	0.100	0.973	
POI3b. - Increased local acceptance	95	3.642	0.109	1.061	
POI3c. - Increased knowledge of renewable	95	3.589	0.111	1.087	
POI3d. - High pro-environmental behavioural change	95	3.358	0.111	1.081	
POI3e. - Improved quality of indoor air	95	3.158	0.101	0.982	
POI3f. - Greater local resource reliance	95	3.421	0.092	0.894	
POI3g. - Scaled up local job creation	95	3.284	0.099	0.964	
POI3h. - Reduction in rate of fuel poverty	95	3.305	0.097	0.946	
POI3i. - Offers energy choices to the locals	95	3.379	0.106	1.033	
POI3j. - Increased in local social activities	95	3.432	0.103	1.007	
POI3k. - Local capacity building	95	3.674	0.102	0.994	
POI3l. - Enhanced local skills	95	3.579	0.091	0.882	

The mean ratings reported above seem to be significant for the four categories of common factors influencing CREP success, as well as on the three categories of CREP impacts (Tables 6.4–6.10). It must, however, be noted that generating a list of significantly rated means does not in any way explain the underlying dimensions between measured variables and latent constructs (Onwuegbuzie, 2016). However, either factor analysis (FA) or principal component analysis (PCA) can be undertaken to achieve this. The next section is dedicated to this.

6.10 Principal Component Analysis (PCA) of common factors influencing CREP success

Factor analysis is a multivariate statistical technique that can be used to interpret self-reporting questionnaires (Kieffer, 1999). It is often described as a data reduction tool used in explaining the order in a phenomenon. It further explains the variance between a set of observed variables by a set of smaller amount of unobserved factors (Comrey and Lee, 2013). According to Child (1990), FA is conducted on data to get rid of duplicated or redundant variables contained in a set of correlated variables by extracting only a few factors that exhaustively describe the set.

As highlighted by Fabrigar and Wegener (2011), FA can be applied to variables in two distinct ways, the first is to explore the dimension of the variables with the intention of generating a theory. Secondly, based on the assumption that certain factors fit into a theory better than others, it can be used to confirm or test an established or proposed theory. As with every other statistical technique, FA has faced a lot of criticism, particularly the exploratory approach to it. Most research methodologists (Gerbing and Hamilton, 1996; Hayton, Allen and Scarpello, 2004; Jamil *et al.*, 2014) believe that the results obtained from exploratory factor snalysis (EFA) are subject to the researcher's interpretation and, as such, are prone to bias.

Henson and Roberts (2006), however, dismissed these criticisms on the grounds that if the researcher applies a lot of skill, tact and care in carrying out the analysis, the outcome can be useful. Again, sample size has been at the forefront of the FA debate, and to-date there has not been a consensus on what is considered adequate by research methodologists. Hence, various sample sizes have been suggested (see Hogarty et al., 2005; Gorsuch, 1983; Hair et al. 1995, Tabachnick and Fidell, 2007).

These studies, however, failed to recognise the fact that FA involves a complicated process before restricting the analysis to certain number of cases. Based on the high correlation coefficients (> 0.80) recorded in Section 6.7 (see Appendix B, Table 1), the 95 cases used for this research are adequate for FA. In line with Guadagnoli and Velicer's (1998) standpoint, such a high correlation coefficient will require a smaller sample size. Principal component analysis (PCA), on the other hand, is a statistical technique used in exposing patterns in a dataset by highlighting relationships amongst factors and variables. Although not as a rule of thumb, PCA employs basic mathematical concepts to compress data to a smaller size without losing any vital facts.

PCA was therefore adopted as the statistical technique for exploring underlying dimensions in CREP factors. The researcher followed a systematic approach in deciding whether the data was suitable for component extraction and has considered the mode and criteria of factor extraction, choice of rotation technique, as well as its coding and interpretation.

6.10.1 *Tests of suitability of CREP common influencing factors and success indicators*

To further test the factors in Tables 6.4 – 6.10 for suitability for PCA, it is important to carry out Kaiser-Meyer-Olkin's (KMO) measure of sampling adequacy (MSA) and Bartlett's test of sphericity. According to Fabrigar and Wegener (2011), only samples with KMO's MSA of 0.50 and above should be considered appropriate for PCA. It must, however, not exceed a stipulated index range of 1. As for Bartlett's test of sphericity, it is assumed that there is a uniform variance across factors in each table when the p-value is > 0.05, otherwise this assumption is invalid (Wiley and Pace, 2015).

6.10.2 *Principal components extraction criteria and rotation*

The basic criteria of extracting components with eigenvalues greater than one was adopted. In line with Kaiser (1960)'s assertions, there is a high level of negative reliability of components with lesser eigenvalues. Furthermore, an alternative method for component extraction was employed to confirm the validity of the Kaiser criterion, and the output was consistent. This alternative method is known as the Cattell Scree test and involves plotting eigenvalues against their components.

The plot is usually displayed in form of an elbow and only components at the upper side of the elbow (before the bend) are retained as the most parsimonious set of components. However, in order to make the interpretation of the extracted components easier and obtain a more meaningful inference from it, Akhtar-Danesh (2017) opined that the component loading matrix needs to be rotated so that each component is represented by a smaller number of variables. The purpose of rotation is not to invalidate components earlier extracted by PCA but to ensure that only variables with significant loadings on the components are extracted (Rowsey, Belisle and Dixon, 2015).

However, the outcome of rotation can result in uncorrelated (orthogonal rotation) or correlated (oblique rotation) components. The purification of the components (varimax rotation) is strongly recommended because it produces a more refined set of variables (Abdi, 2003). An important point to note about variable rotation is that some variables may load significantly on more than one component. According to Akhtar-Danesh (2017), such variables should not form part of the components' interpretations, because they do not clearly measure any single construct. To further satisfy the interpretability of each rotated component, Jolliffe and Cadima (2016) posit that for a component to be retained, there must be:

i. a minimum of three variables with significant loadings on that component
ii. similarity in the construct that each loaded variable is measuring and
iii. the variable must have a high loading on one component and a low, near-zero or zero loading on another component.

The tests of suitability, principal component extraction criteria and rotation described above were performed on the four categories of common factors influencing CREP success, as well as on the three categories of CREP impacts, in the sections below.

6.10.2.1 Common influencing factors to CREP success at the planning phase (PPH)

The 12 common influencing factors to CREP planning phase success (Table 6.4) were tested for suitability for PCA. As can be seen from Table 6.11 below, for these factors, the KMO MSA was significant at 0.568, while Bartlett's test of sphericity K-square was 5.684, an indication that the population matrix is an identity matrix.

Table 6.11: KMO and Bartlett's test of sphericity for CREP planning phase factors

Test		Values
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.568
Bartlett's Test of Sphericity	K-squared	5.684
	Df	11
	Sig.	.894

The outcome of the initial PCA indicated that two variables, "PPH1a - high project start-up cost for poor communities and groups" and "PPH1l- non-prioritization and alignment of project goals to local needs" had commonalities less than 0.50 and, as opined by Olive (2017), it is necessary to eliminate such variables before performing another PCA. The result of repeated PCA without the above-mentioned factors indicates that four components accounting for 64% of the total variance had eigenvalues greater than 1 (see scree plot in Figure 6.2 and Table 6.12).

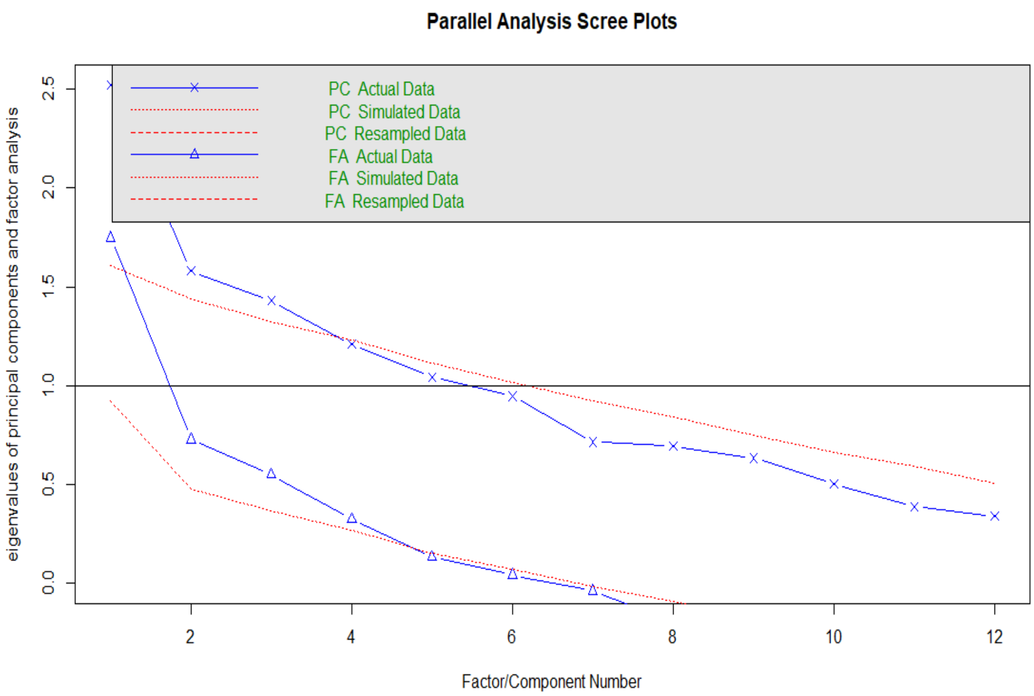

Figure 6.2: Scree plot showing CREP planning phase component extraction criterion

Table 6.12: Total variance explained by extracted CREP planning phase influencing factors

Component	Eigenvalues	Proportion of Var	Cum Var	Proportion Explained	Cum Proportion
1	2.38	0.24	0.24	0.37	0.37
2	1.51	0.15	0.39	0.24	0.61
3	1.36	0.14	0.53	0.21	0.82
4	1.15	0.11	**0.64***	0.18	1.00

A follow-up varimax rotation was performed on the four principal components extracted and reported in Table 6.13 below; however, variables with less than 0.40 loading are supressed and excluded from the result (Liu and Mason, 2014).

Table 6.13: Retained rotated component matrix for CREP planning phase influencing factors

	ROTATED COMPONENTS			
	1	2	3	4
PPH1c. - Insufficient investment information	**0.803**			
PPH1d. - Insufficient Renewable resource assessment data and tools			**0.796**	
PPH1e. - Inconsistent front-end engineering and technical systems design	0.661			
PPH1f. - Compromised bidding process		0.675		
PPH1g.- Inadequate quantification of project investment risks			0.791	
PPH1h. - Premature local energy market		**0.718**		
PPH1i. - Lack of access to project financing				**0.878**
PPH1j. - Insufficient loan programs for poor communities		0.584		
PPH1k. - Setting over ambitious project goals	0.703			

Based on the level of significance of loading after rotation, the factors “insufficient investment information”, “insufficient renewable resource assessment data and tools”, “lack of access to project financing” and “premature local energy market” were selected to represent common planning phase factors influencing CREP success. These factors were also significantly rated by survey respondents (see Table 6.4).

6.10.2.2 Common influencing factors to CREPs success at the implementation phase (IPH)

This category of common influencing factors to CREP success comprised 12 factors and, as can be seen from Table 6.14 below, the KMO MSA was significant at 0.719, which is good. The Bartlett’s test of sphericity K-square was 13.009, which indicates that there was a uniform variance across the 12 factors, hence PCA can be performed on them.

Table 6.14: *KMO and Bartlett's test of sphericity for CREP implementation phase influencing factors*

Test		Values
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.719
Bartlett's Test of Sphericity	K-squared	13.009
	Df	11
	Sig.	.293

In the operational phase PCA, some variables returned less than 50% communalities. In this case, the following had similar issues "PPH2c – Poor project information management", "PPH2d – Failure to screen site for project development", "PPH2e – Not using experts for evaluation of project cost estimates", "PPH2f – High rate of accidents injuries fatalities and near misses on site" and "PPH2g – Time and cost overrun". Another PCA performed without these variables showed an improved communalities range of 0.620 to 0.770. Furthermore, three components accounting for 68% of the total variance had eigenvalues greater than 1 (see scree plot in Figure 6.3 and Table 6.15).

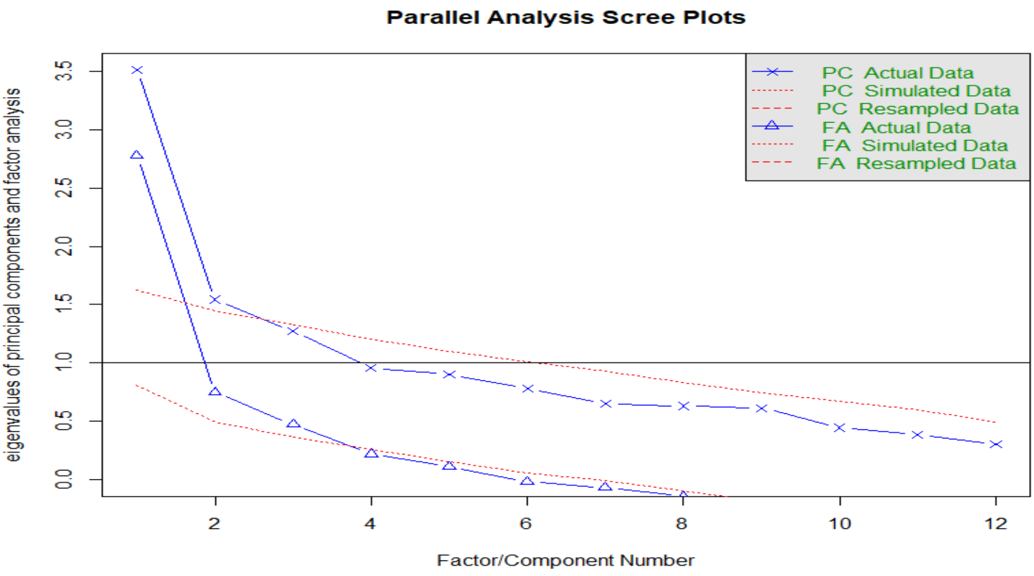

Figure 6.3: Scree plot showing CREP operational phase component extraction criterion

Table 6.15: *Total variance explained by extracted CREP implementation phase influencing factors*

Component	Eigenvalues	Proportion of Var	Cum Var	Proportion Explained	Cum Proportion
1	2.61	0.37	0.37	0.55	0.55
2	1.20	0.17	0.55	0.25	0.81
3	1.01	0.13	**0.68**	0.19	1.00

To show the correlation between CREP implementation phase influencing factors and their principal components, a rotated component matrix was obtained (see Table 6.16). The factors "shortage of local skills and expertise", "looming/unresolved conflicts among participants", and "bankruptcy and insolvency" had significant component loadings. Apart from "bankruptcy and insolvency", which had a mean rating of 2.88, the other two factors were rated high by survey respondents (see Table 6.5).

The results from Table 6.16 suggest that the three significantly loaded factors adequately represented common implementation phase factors influencing CREP success.

Table 6.16: Retained rotated component matrix for CREPs implementation phase influencing factors

		ROTATED COMPONENTS		
		1	**2**	**3**
PPH2a. -	Shortage of local skills and expertise			**0.779**
PPH2b. -	Inefficient project team			0.735
PPH2h. -	Looming/unresolved conflicts among participants	**0.700**		
PPH2i. -	Inability to effectively service project loans		0.780	
PPH2j. -	Bankruptcy and insolvency		**0.862**	
PPH2k. -	Unforeseen eventualities and externalities	0.669		
PPH2l. -	Poor relationship and communication management	0.734		

6.10.2.3 Common influencing factors to CREP success at the operational phase

The nine common influencing factors to CREP operational phase success (Table 6.6) were tested for suitability for PCA. As can be seen from Table 6.17, these factors had KMO MSAs of 0.634, while Bartlett's test of sphericity K-square was 1.348, which indicates that there was uniform variance across the nine factors; hence, PCA can performed on them.

Table 6.17: KMO and Bartlett's test of sphericity for CREP operational phase influencing factors

Test		Values
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.634
Bartlett's Test of Sphericity	K-squared	1.348
	Df	8
	Sig.	0.995

Again, when PCA was performed on CREP operational phase factors, the following variables returned less than 50% communalities; "PPH3d - prolonged grid integration barriers", "PPH3e – poorly executed project", and "PPH3i – Lack of research and development programs to support project". The analysis was repeated without these variables and the total variance is presented in Table 6.18.

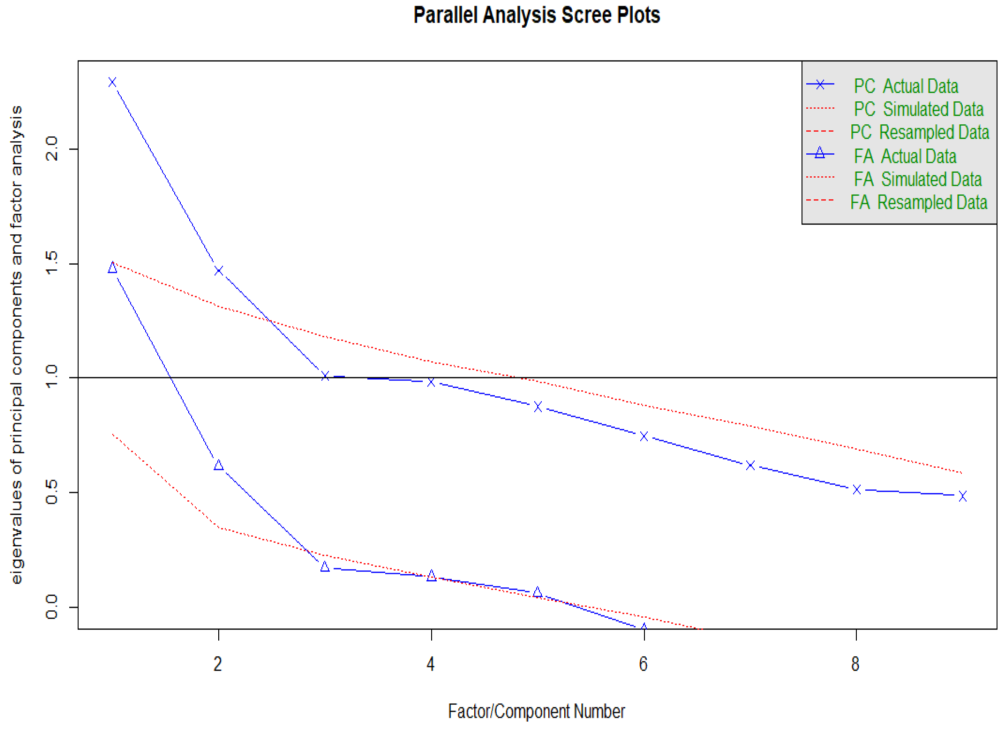

Figure 6.4: Scree plot showing CREPs operational phase component extraction criterion

Table 6.18: *Total variance explained by extracted CREPs operational phase influencing factors*

Component	Eigenvalues	Proportion of Var	Cum Var	Proportion Explained	Cum Proportion
1	1.72	0.29	0.29	0.43	0.43
2	1.32	0.22	0.51	0.33	0.76
3	1.00	0.16	**0.67**	0.24	1.00

As can be seen from Table 6.18 above, the three most representative and parsimonious sets of components extracted accounted for 67% of the total variance and had eigenvalues greater than 1. A follow-up varimax rotation was performed on the three principal components extracted and the results shows that "Insufficient knowledge of technical performance and reliability indicators", "Insufficient/no benefits accrued from the project to the locals" and "Ineffective/no government regulations and legislation" were variables with higher loadings on the rotated components (Table 6.19). These variables were accepted as operational phase common influencing factors to CREP success, as they were rated highly by respondents, as reported in Table 6.6.

Table 6.19: *Retained rotated component matrix for CREP operational phase influencing factors*

	ROTATED COMPONENTS		
	1	2	3
PPH3a.- Insufficient knowledge of Technical performance and reliability indicators			**0.796**
PPH3b.- Insufficient/no benefits accrued from the project to the locals	**0.833**		
PPH3c.- Unequal subsidies payment and taxes for community groups		0.654	
PPH3f.- Lack of Installations and Maintenance supports	0.740		
PPH3g.- Continuous market monopoly by bigger energy companies		0.633	
PPH3h.- Ineffective/no Government regulations and legislation		**0.793**	

6.10.2.4 Common influencing factors to CREP success at the disposal phase

This cluster of common factors influencing CREP disposal phase success comprised six variables (Table 6.7), which were subsequently tested for suitability for PCA. As can be seen from Table 6.20 below, the KMO MSA was significant at 0.743, while Bartlett's test of sphericity K-square was 1.863, which indicates that the population matrix is an identity matrix.

Table 6.20: *KMO and Bartlett's test of sphericity for CREPs disposal phase influencing factors*

Test		Values
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.743
Bartlett's Test of Sphericity	K-squared	1.863
	Df	5
	Sig.	0.868

The outcome of the CREP disposal phase PCA indicated that the variable "PPH4d - Poor projections of future sector demands" had less than 50% communalities. Therefore, PCA was repeated without this variable and the total variance is presented in Table 6.21.

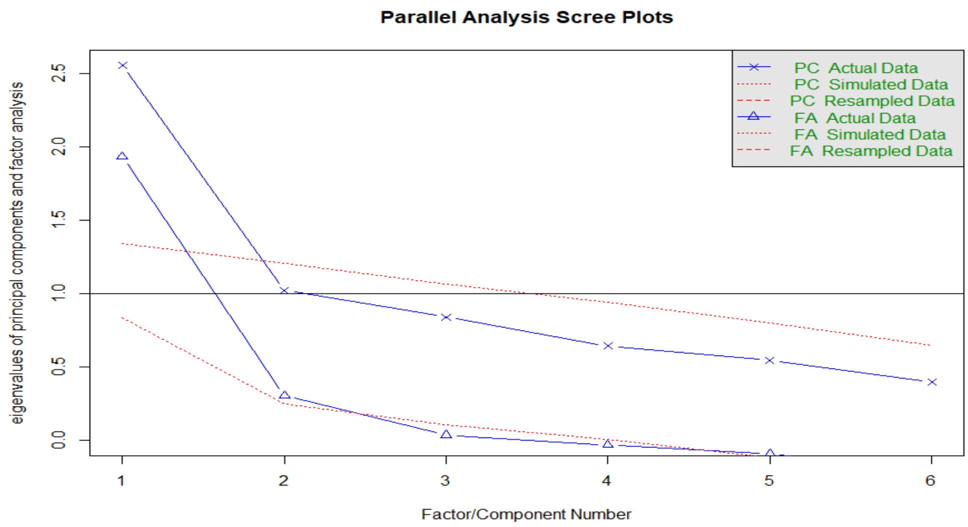

Figure 6.5: Scree plot showing CREPs disposal phase component extraction criterion

Table 6.21: Total variance explained by extracted CREPs disposal phase influencing factors

Component	Eigenvalues	Proportion of Var	Cum Var	Proportion Explained	Cum Proportion
1	2.39	0.48	0.48	0.70	0.70
2	1.02	0.20	0.68	0.30	1.00

To show the correlation between CREPs disposal phase influencing factors and their principal components, a rotated component matrix was obtained (Table 6.22). The factors "inconsistent feedback system" and "insufficient information on final project evaluation report" had significant component loadings.

Table 6.22: *Retained rotated component matrix for CREP disposal phase influencing factors*

	ROTATED COMPONENTS	
	1	**2**
PPH4a. - Lack of project reinvestment capacity for the community	0.539	
PPH4b. - Lack of expert solutions across the whole life of the project		0.598
PPH4c. - Lack of long-term preparatory plans to support future sector changes	0.786	
PPH4e. - Inconsistent feedback system		**0.898**
PPH4f. - Insufficient information on final project evaluation report	**0.890**	

These factors were also significantly rated by survey respondents (see Table 6.7) and thus qualify to be labelled as common disposal phase factors influencing CREP success.

6.10.2.5 CREPs Economic Impact and outcome factors

There are eight factors under the CREP economic impact cluster (see Table 6.8). The KMO MSA of these factors was significant at 0.642, which is good. The Bartlett's test of sphericity K-square was 0.586, while the degrees of freedom and *p*-value were 7 and 0.999, respectively (Table 6.23 below). This indicates that there is a uniform variance across the eight factors, hence PCA can be performed on the factors.

Table 6.23: *KMO and Bartlett's test of sphericity for CREP economic impact factors*

Test		Values
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.642
Bartlett's Test of Sphericity	K-squared	0.586
	Df	7
	Sig.	0.999

Out of the eight variables that make up the CREPs economic impact cluster, one was dropped after the initial PCA because it had less than 50% communality. The variable was “POI1a-Increased local job creation” and was therefore not part of the second PCA that produced the results in Table 6.24, below.

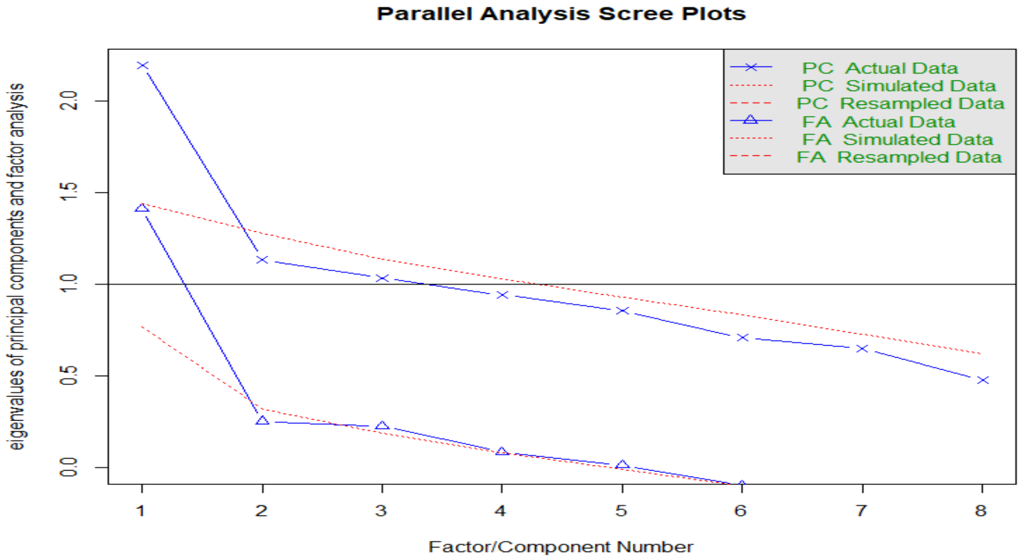

Figure 6.6: Scree plot showing CREPs economic impact component extraction criterion

Table 6.24: Total variance explained by extracted CREPs economic impact factors

Component	Eigenvalue	Proportion of Var	Cum Var	Proportion Explained	Cum Proportion
1	1.95	0.28	0.28	0.39	0.39
2	1.13	0.16	0.44	0.22	0.61
3	1.02	0.15	0.59	0.20	0.81
4	1.00	0.13	0.72	0.19	1.00

Four components, accounting for 72% total variance, had eigenvalues greater than 1 (Table 6.24). In addition, an improved communalities range of 0.630 to 0.860 (see Appendix B, Table 2-8) was obtained from the second PCA.

Table 6.25: *Retained rotated component matrix for CREPs economic impact measures*

	ROTATED COMPONENTS			
	1	2	3	4
POI1b.- Reinvested revenue boosted local economic activities	**0.872**			
POI1c.- Reinvested revenue diversified the local economy	0.663			
POI1d.- High prospects for local manufacturing			**0.930**	
POI1e.- Local energy market growth	0.547		0.485	
POI1f.- High savings on energy bills				0.760
POI1g.- Less reliance on conventionally produced energy				**0.810**
POI1h.- Affordable and stable energy price		**0.926**		

After performing varimax rotation on the four extracted principal components, it was discovered that four variables, namely, “Reinvested revenue boosted local economic activities”, “High prospects for local manufacturing”, “Less reliance on conventionally produced energy “and “Affordable and stable energy price” loaded significantly on the rotated components (see Table 6.25).

Apart from the factor “high prospects for local manufacturing”, with a mean rating of 2.94, three other factors were also significantly rated by survey respondents (see Table 6.8). These factors were therefore selected to represent CREP economic impact factors.

6.10.2.6 CREP Environmental Impact and outcome factors

This cluster—CREPs environmental impact and outcome—comprises nine variables (see Table 6.9), which were tested for suitability for PCA. As can be seen from Table 6.26 below, the factor KMO MSA was significant at 0.833, which is good. The Bartlett’s test of sphericity K-square was 8.411, while the degrees of freedom and *p*-value were 8 and 0.394, respectively. By implication, there is a uniform variance across the nine factors; hence, PCA can performed on them.

Table 6.26: KMO and Bartlett’s test of sphericity for CREP environmental impact factors

Test		Value
Kaiser-Meyer-Olkin measure of sampling adequacy		0.833
Bartlett’s test of sphericity	K-squared	8.411
	Df	8
	Sig.	0.394

The PCA results, as shown in Table 6.27 below, indicate that three components were extracted because they had eigenvalues of 3.87, 1.06 and 1.01, respectively. Together, these components account for 66% of the total variance in this cluster. Furthermore, their communalities range between 0.570 to 0.760, which is quite significant.

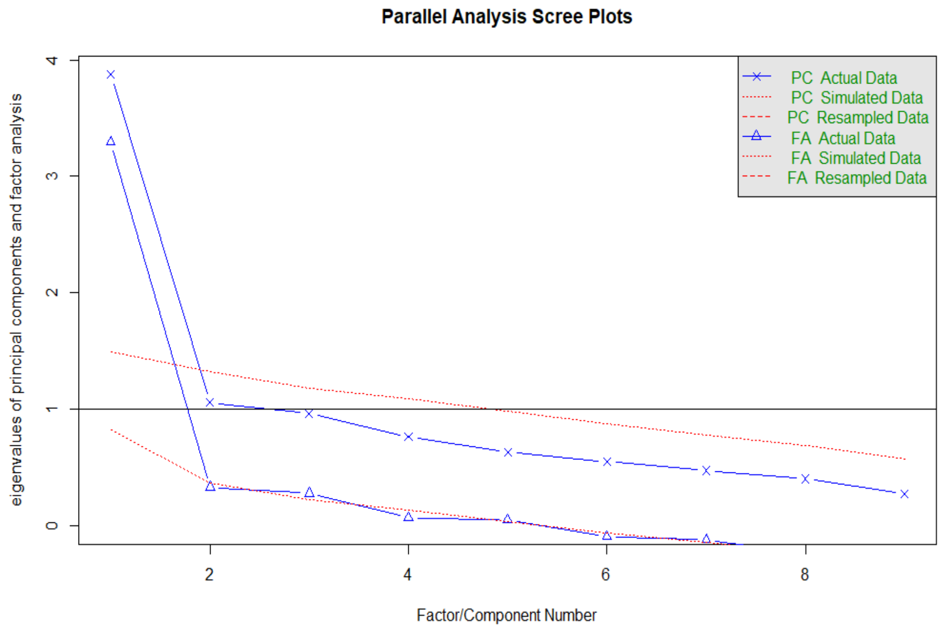

Figure 6.7: Scree plot showing CREP environmental impact component extraction criterion

Table 6.27: Total variance explained by extracted CREP environmental impact factors

Component	**Eigenvalues**	**Proportion of Var**	**Cum Var**	**Proportion Explained**	**Cum Proportion**
1	3.87	0.43	0.43	0.66	0.66
2	1.06	0.12	0.55	0.18	0.84
3	1.01	0.11	0.66	0.84	1.00

It is apparent from the rotated component matrix produced in Table 6.28 that the following factors, “health risk from toxic chemical storage near site”, “alterations to the natural environment” and “high carbon embedded material used during construction”, were significantly loaded under the three rotated components.

Table 6.28: Retained rotated component matrix for CREP environmental impact measures

	ROTATED COMPONENTS		
	1	**2**	**3**
POI2a.- Health risk from toxic chemical storage near site	**0.804**		
POI2b.- Severe noise pollution		0.620	
POI2c.- Alterations to the natural environment			**0.790**
POI2d.- High rate of wildlife fatalities	0.645		
POI2e.- Conflicts in heritage protected landscapes			0.660
POI2f.- Reduction in tourism activities		0.608	
POI2g.- High carbon embedded material used during construction		**0.747**	
POI2h.- Displacement of residential and farmlands	0.796		
POI2i.- Upsetting effects of construction/maintenance traffic		0.633	

Apart from the factor “alterations to the natural environment”, with a mean rating of 3.14, two other factors were not significantly rated by survey respondents (see Table 6.9). This, however, does not undermine their contribution to CREP environmental impacts; hence, all three highly loaded factors in the table were retained to represent the CREP environmental impacts cluster.

6.10.2.7 CREPs Social Impact and outcome factors

The cluster *CREP social impact and outcome factors* comprises six variables (see Table 6.10), which were subsequently tested for suitability for PCA. As can be seen from Table 6.29, below, the factors KMO MSA was significant at 0.716, while Bartlett’s test of sphericity K-square was 9.278, which indicates that the population matrix is an identity matrix.

Table 6.29: KMO and Bartlett’s test of sphericity for CREP social impact factors

Test		Value
Kaiser-Meyer-Olkin measure of sampling adequacy		0.716
Bartlett’s test of sphericity	K-squared	9.278
	Df	11
	Sig.	0.596

Out of the twelve variables that make up the CREP social impacts, two were dropped after the initial PCA because they had less than 50% communality. The variables were “OI3f- greater local resource reliance” and “POI3i- offers energy choices to the local”, and were excluded from the second PCA that produced the results in Table 6.30, below.

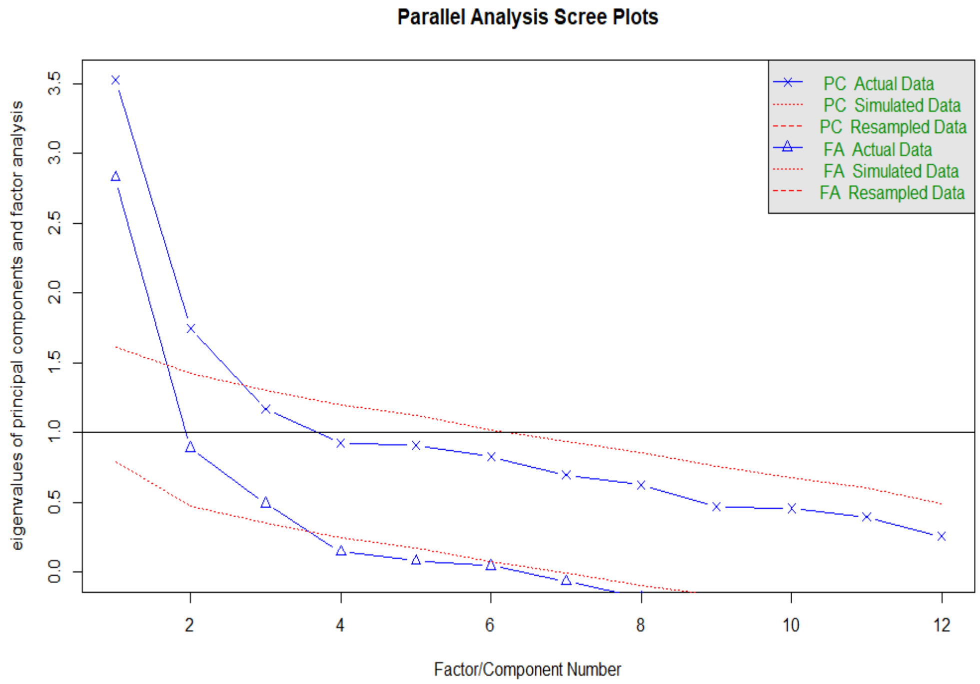

Figure 6.8: Scree plot showing CREP social impact component extraction criterion

Table 6.30: Total variance explained by extracted CREPs social impact factors

Component	Eigenvalues	Proportion of Var	Cum Var	Proportion Explained	Cum Proportion
1	3.21	0.32	0.32	0.47	0.47
2	1.56	0.16	0.48	0.23	0.70
3	1.16	0.12	0.59	0.17	0.87
4	1.00	0.09	0.69	0.13	1.00

Four components accounting for 69% of the total variance had eigenvalues greater than 1 (Table 6.30). In addition, an improved communality range of 0.550 to 0.840 was obtained from the second PCA.

Table 6.31: Retained rotated component matrix for CREP social impact measures

	ROTATED COMPONENTS			
	1	**2**	**3**	**4**
POI3a.- Increased local support		**0.782**		
POI3b.- Increased local acceptance		0.739		
POI3c.- Increased knowledge of renewable			0.506	
POI3d.- High pro-environmental behavioural change		0.476		
POI3e.- Improved quality of indoor air			0.624	
POI3g.- Scaled up local job creation			**0.844**	
POI3h.- Reduction in rate of fuel poverty				**0.771**
POI3j.- Increased in local social activities				0.503
POI3k.- Local capacity building	**0.908**			
POI3l.- Enhanced local skills	0.80599			

After performing varimax rotation on the four extracted principal components, it was discovered that the variables "local capacity building", "increased local support", "scaled up local job creation" and "reduction in rate of fuel poverty" loaded significantly on the rotated components (see Table 6.31). These factors were also significantly rated by survey respondents (see Table 6.10) and were, therefore, selected to represent the CREP social impact cluster.

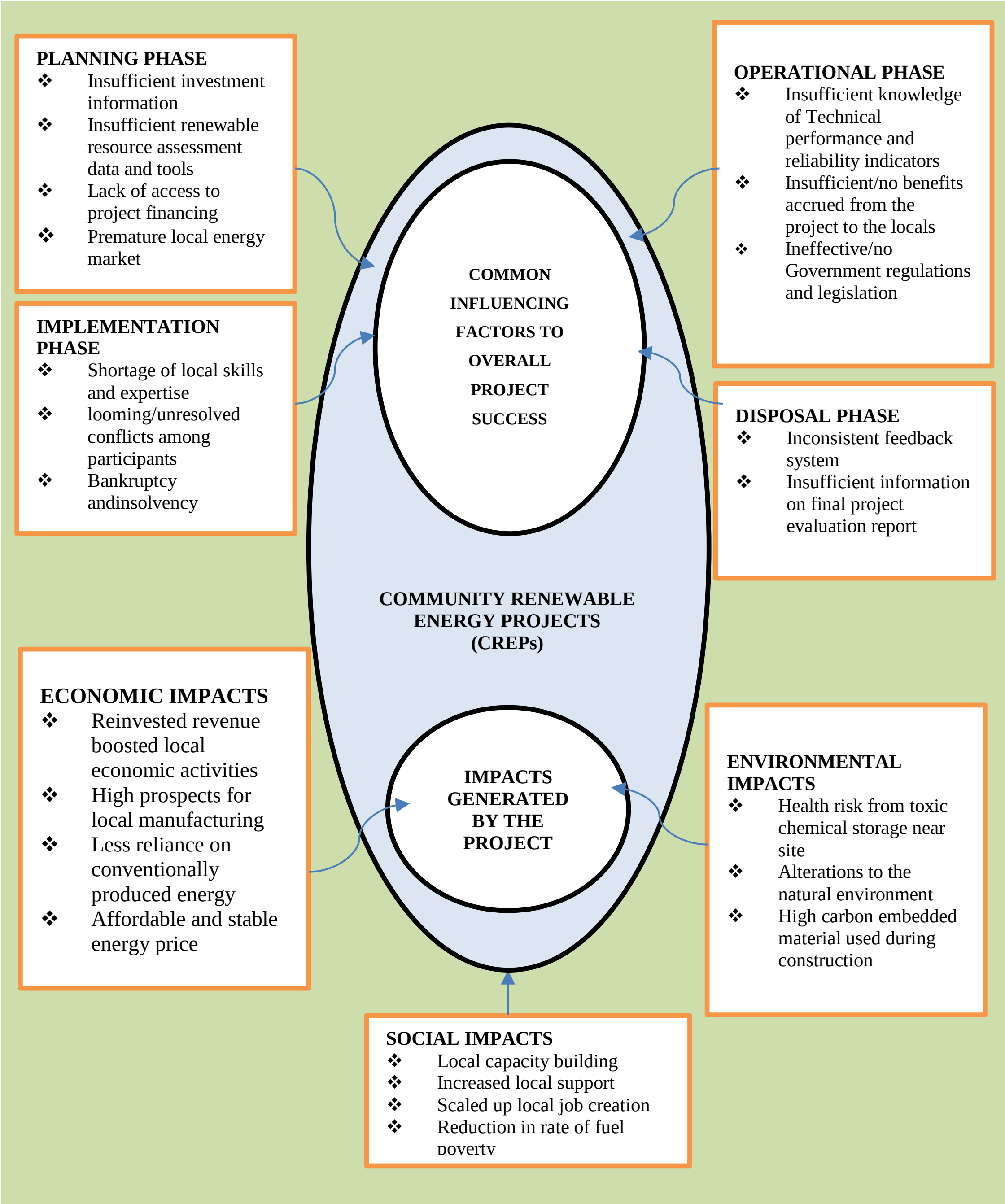

Figure 6.7: CREP impact/success and their underlying factors

An examination of Figure 6.7 reveals that there is no need to relabel the seven CREP clusters analysed above (Sections 6.9.1-6.9.7) because the variables selected to represent each cluster are highly significant in loading, and can clearly describe the clusters (Vidal, Ma and Sastry, 2016).

The main purpose of this research is to develop a framework for improving incumbent community energy business models (CEBMoDs), for effective delivery of community renewable energy projects (CREPs) in the UK. In doing so, specific objectives were set in Chapter 1, one of which is to identify the impacts stakeholders expect from CREPs and the common influencing factors to overall project success.

The mean ratings and research implications of these factors have been addressed in Section 6.9 according to their respective categorised clusters (Tables 6.4-6.10). PCA was then performed on the clusters to extract factors with the most representative and parsimonious set of components for each cluster. A total of four principal influencing factors were extracted for the CREP planning phase, three for each of the implementation and operational phases, and two for the disposal phase.

Another eleven principal factors focused on testing CREP impacts were also obtained. The Pearson product-moment correlation coefficient (PPMCC) and multiple regression analysis will be used in Chapter 8 to examine which CEBMoD principal factor best predicts CREP success in each of the development phases, as well as the social, economic, and environmental impacts desired by project stakeholders.

Having completed the analysis and discussions on CREP impacts and common influencing factors to overall project success, the next section presents the analysis and discussion on CEBMoDs in the UK, including their effectiveness, management structures and impacts on CREPs development.

6.11 Ranking of CEBMoD factors

Previous sections in this chapter were dedicated to understanding the underlying structure of CREP success and impact factors. The sections that follow move on to consider the underlying structure of CEBMoD effectiveness and efficiency factors. The intention being to reveal the mean ratings and standard deviations of each CEBMoD factor, as well as ascertain the level of significance of the principal components through PCA.

As illustrated in Table 6.32, below, 16 factors showed strong significance in ranking across respondents and, by extension, explain the basic determinants of an effective and efficient CEBMoD, while nine other factors were not strongly significant.

Table 6.32: Descriptive statistics for effective CEBMoD factors

SN	DETERMINANTS	MEAN	SD	RANK	RMK
1	BMAj. Alignment of organisation goal to projects'	3.316	1.214	1	SS
2	BMAi. Financial stability	3.284	1.155	2	SS
3	BMAh. Low administrative and overhead costs	3.263	1.084	3	SS
4	BMAd. Good incentives/rewards to stakeholders	3.221	1.222	4	SS
5	BMAf. Transparency in financial dealings	3.200	1.357	5	SS
6	BMAo. Attainable economic, social and environmental goals	3.168	1.235	6	SS
7	BMIb. Board structure influences project monitoring	3.074	1.094	7	SS
8	BMAt. Capacity to deal with bureaucratic obstacles	3.063	1.183	8	SS
9	BMIe. Membership size influences project outcome	3.063	1.019	9	SS
10	BMAg. Effective internal feedback system	3.053	1.133	10	SS
11	BMAc. Robust internal management	3.042	1.138	11	SS
12	BMAn. Less complicated incorporation process	3.042	1.288	12	SS
13	BMId. Management style affects model efficiency	3.011	1.135	13	SS
14	BMAr. Effective board/management system with professionals	3.000	1.194	14	SS
15	BMIa. Management structure determines risk sharing	3.000	0.978	15	SS
16	BMIc. Shareholders determine board composition	3.000	1.000	16	SS
17	BMAm. Internal administrative efficiency	2.979	1.111	17	NS
18	BMAa. Internal knowledge of evolving technology	2.947	1.124	18	NS
19	BMAb. Zero principal/Agent interest	2.905	1.255	19	NS
20	BMAs. Engaging locals as managers	2.895	1.207	20	NS
21	BMAe. Good staff development programs	2.832	1.318	21	NS
22	BMAl. Flexible membership route	2.800	1.154	22	NS
23	BMAq. Evidence of long-term relevance in the market	2.789	1.184	23	NS
24	BMAk. High risk appetite against externalities	2.684	1.160	24	NS
25	BMAp. Substantial shares in the energy market	2.684	1.323	25	NS

SD = STANDARD DEVIATION, RMK = REMARKS, SS = SIGNIFICANT, NS = NOT SIGNIFICANT

Among the plausible explanations for these findings is that the top five rated attributes of efficient CEBMoDs are “Alignment of organisation goal to projects (BMAj)”, “financial stability (BMAi)”, “low administrative and overhead costs (BMAh)”, “good incentives/rewards to stakeholders (BMAd)” and “transparency in financial dealings (BMAf). On the other hand, the following five attributes “Good staff development programs (BMAe.)”, “flexible membership route (BMAl)”, “evidence of long-term relevance in the market (BMAq.)”, “high risk appetite against externalities (BMAk.)”, and “having substantial shares in the energy market (BMAp.)” received the lowest mean ratings.

The level of significance of each factor's mean rating was derived by finding the average of the question rating scale (1+2+3+4+5)/5, which was 3. Therefore, any mean rating below this is deemed insignificant (see Table 6.33 below).

Table 6.33: Selected factors showing their factors loadings and mean ratings

GROUP	FACTORS		GROUP MEAN	GROUP RANK
BUSINESS MODEL INFLUENCE				
	BMIe.	Membership size influences project outcome		
	BMId.	Management style affects model efficiency		
	BMIc.	Shareholders determine board composition	3.029	1.000
	BMIb.	Board structure influences project monitoring		
	BMIa.	Management structure determines risk sharing		
BUSINESS MODEL ATTRACTIVENESS				
	BMAt.	Capacity to deal with bureaucratic obstacles		
	BMAs.	Engaging locals as managers		
	BMAr.	Effective board/management system with professionals		
	BMAq.	Evidence of long-term relevance in the market		
	BMAp.	Substantial shares in the energy market		
	BMAo.	Attainable economic, social and environmental goals		
	BMAn.	Less complicated incorporation process		
	BMAm.	Internal administrative efficiency		
	BMAl.	Flexible membership route	3.008	2.000
	BMAk.	High risk appetite against externalities		
	BMAj.	Alignment of organisation goal to projects'		
	BMAi.	Financial stability		
	BMAh.	Low administrative and overhead costs		
	BMAg.	Effective internal feedback system		
	BMAf.	Transparency in financial dealings		
	BMAe.	Good staff development programs		
	BMAd.	Good incentives/rewards to stakeholders		
	BMAc.	Robust internal management		
	BMAb.	Zero principal/Agent interest		
	BMAa.	Internal knowledge of evolving technology		

6.12 Principal Component Analysis of CEBMoD Factors

The number of CEBMoD factors was reduced to a set that explains the underlying dimensions between measured variables and latent constructs. Again, PCA was conducted on these groups of factors but not without the necessary suitability tests.

6.12.1 *Test of suitability of CEBMoD Efficiency Factors*

To further test the CEBMoD factors for suitability for PCA, it was important to carry out KMO MSA tests and Bartlett's tests of sphericity. According to Fabrigar and Wegener (2011), only samples with KMO MSAs of 0.50 and above should be considered appropriate for PCA. It must, however, not exceed the stipulated index range of 1.

As for Bartlett's test of sphericity, it was assumed that there was uniform variance across the CEBMoD efficiency factors when the *p*-value was > 0.05, otherwise this assumption is invalid (Wiley and Pace, 2015). Table 6.16, below, shows that the sample is suitable at a significance level greater than 0.05 ($p > 0.05$). The KMO MSA was significant at 0.731, while Bartlett's test of sphericity K-square value was 30.759. This indicates that the population matrix is an identity matrix (see Table 6.34, below).

Table 6.34: KMO and Bartlett's test of sphericity for CEBMoD efficiency factors

Test		Value
Kaiser-Meyer-Olkin measure of sampling adequacy		0.731
Bartlett's test of sphericity	K-squared	30.759
	Df	24
	Sig.	.000

The next stage of analysis was to perform PCA on the CEBMoD factors. The basic criterion of extracting components with eigenvalues greater than one (>1) was adopted. This is in line with Kaiser's (1960) assertions that there is a high level of negative reliability of components with lesser eigenvalues. Furthermore, an alternative method for component extraction was employed to confirm the validity of the Kaiser criterion, and the output was consistent.

This alternative method is known as the Cattell scree test, and involves plotting eigenvalues against their components. The plot is usually displayed in the form of an elbow, and only components at the upper side of the elbow (before the bend) are retained as the most parsimonious set. In this case, there were seven components at the upper side of the elbow. These components had eigenvalues of 5.84, 2.52, 1.86, 1.66, 1.37, 1.29 and 1.08 and, cumulatively, they explain 62% of the total variance (see Table 6.35).

Table 6.35: Total variance explained by extracted factors

Component	Eigenvalues	Proportion of Var	Cum Var	Proportion Explained	Cum Proportion
1	5.84	0.23	0.23	0.37	0.37
2	2.52	0.10	0.33	0.16	0.54
3	1.86	0.07	0.41	0.12	0.65
4	1.66	0.07	0.48	0.11	0.76
5	1.37	0.05	0.53	0.09	0.85
6	1.29	0.05	0.58	0.08	0.93
7	1.08	0.04	0.62	0.07	1.00

The lowest communality obtained for the extracted components was 0.50, which is within the stipulated threshold (Field, 2000) and, therefore, the factor solution is reliable. However, by merely looking at the variances tabulated above, it is somewhat difficult to determine what the extracted components represent.

So in order to make the interpretation of the analysis easier and draw a more meaningful inference from it, purification of the components (varimax rotation) is strongly recommended because it produces a more refined set of variables (Abdi, 2003). Varimax rotation was thus performed on the principal components and the outcome is presented in Table 6.36, below.

Table 6.36: Rotated component matrix for CEBMoD efficiency factors

	COMPONENTS						
	1	**2**	**3**	**4**	**5**	**6**	**7**
BMAa. - Internal knowledge of evolving technology		**0.586**					
BMAb. - Zero principal/agent interest		**0.618**					
BMAc. - Robust internal management					**0.553**		
BMAd. - Good incentives/rewards to stakeholders					**0.663**		
BMAe. - Good staff development programs		**0.818**					
BMAf. - Transparency in financial dealings						**0.730**	
BMAg. - Effect of shareholder feedback					0.496		**0.558**
BMAh. - Low administrative and overhead costs	**0.727**						
BMAi. - Financial stability						**0.717**	
BMAj. - Alignment of organisation and project goals					**0.715**		
BMAk.- High risk appetite against externalities						-0.430	
BMAl. - Flexible membership route				**0.643**			
BMAm.-Internal administrative efficiency					**0.658**		
BMAn.- Less complicated incorporation process	**0.688**						
BMAo.-Attainable economic, social and environmental goals						0.399	
BMAp.-Substantial shares in the energy market				**0.678**			
BMAq.-Evidence of long-term relevance in the market				**0.656**			
BMAr.- Effective board/management system with professionals	0.538						
BMAs.-Engaging locals as managers				0.656			

BMAt.-Capacity to deal with bureaucratic obstacles		0.458	
BMIa.- Management structure determines risk sharing	**0.703**		
BMIb.- Board structure influences project monitoring	**0.718**		
BMIc.- Shareholders determine board composition			**0.689**
BMId.-Management style affects model efficiency	**0.634**		
BMIe.-Membership size influences project outcome	**0.582**		

The rotated component matrix reported above was further labelled according to the pattern of loading and degree of variability in order to make the interpretations easier. For the purpose of clarity, Kulkarni, Apte and Evangelopoulos (2014) recommend the suppression of loadings less than 0.4 from further analysis. Each rotated component is discussed in detail below.

6.12.2 *Component 1 - Preliminary Research on Project Requirements*

Three variables showed significant positive loadings in component one. Together, these variables describe the critical aspects of the project development process, where feasibility studies are important before CREP implementation. Therefore, component one was labelled *Preliminary research on project requirements.*

Basic project requirements encompass assurances that the incorporation process is less complicated and that, throughout the life cycle of the project, administrative and overhead costs can be kept reasonably low It is widely recognized that assembling a board and management member with expertise and enthusiasm is key to driving successful community initiatives. In Walker's (2008) study on the barriers and incentives to CREPs, high upfront costs were identified as a source of reluctance for various CEGs to engage in CREPs. This highlights the importance of understanding the whole-life cost associated with CREPs.

Unsurprisingly, Owen (2006) suggests that the cost-effectiveness of CREP delivery should start from the choice of project, equipment purchase, installation and operation over the lifespan of the project. There are also some levels of cost associated with CREP operations. In order to drive down these costs, proper information management systems are considered essential (Grover and Malhotra, 2003). Project information is generated, transmitted and used at every phase of the project lifecycle for various activities.

There are measures to overcome high upfront CREP costs for new projects provided by the UK Government's Department for Energy and Climate Change (DECC) and non-government organisations such as Community Energy Scotland, to mention but two. Existing and older projects can still benefit from continuous research on how to save costs in the project environment. For instance, Back and Moreau (2001) demonstrated that a structured database of project information can reduce the amount of paper used, photocopied or filed, with knock-on effects of less man-hours and stationery costs, which is a significant way to reduce administrative costs.

In the course of preliminary research on project requirements, Hannum (2001) recommended local or internet-based staff training instead of attending distant conferences or training sessions. Furthermore, Hood and Dixon (2013)suggest that at the early stage of the project delivery process, there should be absolute control of internet and telephone usage for non-office responsibilities. Also, there should be bulk purchasing of consumables, recycling of used consumables and avoidance of unnecessary travel in company vehicles. Fundamentally, CREP organisers are to show greater commitment towards ensuring returns on investment and save money in trust funds for further community benefit initiatives.

6.12.3 *Component 2 - Special Circumstances*

In component two, the variables "Internal knowledge of evolving technology (BMAa)", "zero principal/agent interest (BMAb)", and "good staff development programs (BMAe)" showed significant positive loadings. This indicates that, together, they tend to explain or measure similar constructs peculiar to unexpected circumstantial demands on CEBMoD boards of directors. This component is, therefore, labelled *Special Circumstances.*

Although the main assumption underlying the organisation and ownership of community energy projects is that the moment there is the right leadership, support and an enthusiastic local group, projects can be set up. Rogerson (2014) finds this standpoint contradictory because there are different types of CREPs, technologies and development processes. In some projects, there might be the need to have a director who is knowledgeable in renewable energy technologies and their evolution to build the right momentum and motivation for local acceptance (Agrawal, 2010).

This does not in any way imply that the technical background of an individual is a prerequisite to becoming a board member and, moreover, there are no "one size fits all" criteria or sufficient empirical evidence and guidelines for becoming a CEBMoD board member. This raises another imminent ethical concern about how to ensure that board members protect and preserve the collective interest of the CEG, and that at no point should personal interest conflict with this. One may want to know why management ethics are relevant to CEBMoD board of directors (BoDs). According to Ford and Richardson (2013), from time to time, every work environment exposes managers to some form of poisonous and self-defeating scenario that may result in acting against or without ethical considerations.

One clear area this is likely to happen is when a board member is expected to make a decision that is of interest to themselves, their family members or their friends. Doran et al. (2015) cited information management as a sensitive ethical issue most managers face. According to them, it is ethically wrong to divulge sensitive information that may endanger the organisation to her competitors or any other third party. Information sharing should strictly occur on a "need to know" basis (Galliers and Leidner, 2014).

However, should this happen, or mistakes be made that can negatively impact the organisation's reputation and finances, the defaulting manager or employee is ethically obliged to own up to these mistakes. It has been noted in Williams and Schaefer (2013) that it is the values that govern a person's life that are reflected in the person's management behaviour, and it is on this premise that management style is assessed. CEBMoD directors therefore require occasional special training. This is important because there are high expectations from investors and stakeholders.

6.12.4 *Component 3 - Participative Management*

The following four variables, "Management structure determines how project risk is shared (BMIa)", "Board structure can influence how project is monitored (BMIb)", "Management style can affect the model's efficiency (BMId)", and "The influences of membership size on project outcome (BMIe)", were significantly loaded under component three. This implies that they vary together and collectively they explain the importance of *participative management* in the CREP delivery process.

This is consistent with Pires, Fidélis and Ramos's (2014) study, which reveal that participative management is the underlying foundation for any community improvement initiative, be it fuel poverty reduction, home insulation, or energy generation. Similarly, Marroni and Asmus (2013) added that the success of local initiatives is built on the trust and support of local participants.

The management style and trustee board composition vary according to ownership model deployed and, in most CREP-related literature reviewed, it was observed that management boards, shareholders, funders and other classes of CREP stakeholders are not usually part of the daily operations of the projects (Walker and Devine-Wright, 2008; Walker and Simcock, 2012; Fiona and Kalina, 2015). That notwithstanding, these groups of people have the right to contribute ideas and influence major decisions. With regard to the allowable size of membership, Bolinger (2001) submitted that there is no strong evidence in the literature to either support or dismiss whether it has anything to do with project outcomes.

Chaddad and Cook (2004), however, believe that commitment to implementing change can only be achieved when those affected by the change are integrated into the change process. They further cautioned that the limit of authority must be clearly defined. From a practical point of view, participative management has proven to be effective in limiting local resistance and impacts positively on the model’s operational efficiency.

6.12.5 *Component 4 - Overcoming Local Resistance*

Component four had five variables with positive significant loadings and, cumulatively, they explained the strategies that can be deployed by CREP organisers to win over the support and loyalty of locals for smooth CREP operations. These variables were labelled *overcoming local resistance*. Due to the location-based nature of CREPs, local resistance is common and peculiar to individual projects (Hargreaves et al., 2013).

Common observable resistive behaviours displayed by local people include open criticism, stalling activities, faulting progress, sabotage, reluctance and doubts about the project (Hyland and Bertsch, 2017). Owens and Driffill (2008) traced local resistance to the way local people think about projects and their relevance to them individually and collectively.

Breukers and Wolsink (2007) further added that local resistance could be triggered by how local people react to their thoughts which, in turn, appears as resistive behaviour. Admittedly, overcoming local resistance follows a complex process; however, strategies such as simplified membership processes (BMAl) for local people could curb resistance (Hindmarsh and Matthews, 2008). This is consistent with Cass, Walker and Devine-Wright (2010), who posit that project organisers should show evidence of long-term commitment in the sector by way of the amount of shares owned (BMAp), backed by a good business reputation and relevance in the market (BMAq).

So far, based on performance reports of most incumbent CREPs, it could be inferred that CEGs alone cannot effectively implement change or overcome local resistance. Rather, they have to depend on the support of various CREP-supporting organisations such as Community Energy Scotland, Community Energy England, DECC, and so on (DECC, 2014). These organisations and agencies are knowledgeable in CREP-specific deliverables and processes. On the whole, small-scale REPs tend to encounter less resistance than larger projects because the goals and objectives of these projects are people-focused and not profit-oriented.

6.12.6 *Component 5 - HRM Aspects*

The following four variables, "Robust internal management (BMAc)", "attractive incentives/rewards to stakeholders (BMAd)", "Alignment of organisation goal to projects (BMAj)" and "Internal administrative efficiency (BMAm)", were significantly loaded under component five. This implies that they vary together and, collectively, they explain how human and other organisational resources could be managed, and how these could contribute to sustainable organisational competitive advantage.

The importance of human and other resource management (HRM) in organisations, as well as research into it, has a long history (Legge, 1995; Becker and Gerhart, 1996; Delaney and Huselid, 1996). In recent times, however, HRM has been assumed to be one of the key drivers of organisational performance and an enduring source of competitive advantage (Della Corte, 2014). Sheehan (2014) considered HRM as an elemental pathway to organizational performance drivers and further addressed how skills, innovative solutions and employee motivation impact organisational performance.

There is no doubt that an adequately empowered and motivated workforce can boost an organisation's competitive advantage (Snell, Morris and Bohlander, 2015). It is, however, the responsibility of the organisation (in this case, CEBMoD boards and CREP organisers) to adopt best practices in the recruitment process and create enabling environments and training for employees so that they can perform their functions effectively.

It has been argued that HRM implementation strategies vary according to business organisations and, therefore, their impacts can only be measured within the workplace (Bamberger, Biron and Meshoulam, 2014). In most conventional business environments, employees are rewarded for good performance as a means of encouraging them to be more creative; while in some marketing organisations, profits are shared to outstanding marketers to promote innovative thinking and service delivery.

In other words, HRM implementation timing and strategy across diverse organisations varies, and is still receiving much empirical investigation. Several HRM studies suggest that organisational performance can be improved by developing strategic workplace proficiency through careful selection, engagement and training of employees. CREP implementation processes do not require multiple levels of human resource (HR) integration per se, but one cannot dismiss the impacts that HR systems have on social climates.

Ultimately, the process of recruiting volunteers for CREP delivery is what defines the initial skillset before purposeful training that fits the CEBMoD's needs is provided. It is fair to suggest that providing balance between the promotion of organisational goals and staff well-being is a means of promoting a CEBMoD's competitive advantage.

6.12.7 *Component 6 - Board of Directors Competence*

Component six had negative loading on the variable "High risk appetite against externalities (BMAk)", indicating it varies negatively with "Transparency in financial dealings (BMAf)", "Reasonably financial stable board member (BMAi)", and "Attainable economic, social and environmental goals (BMAo)", which had positive loadings. This implies that the occurrence of external risks is not totally within the capacity of BoDs to control.

The variables with positive loadings were labelled *board of directors' competence.* It has been noted that the level of managerial competence within an organisation will reflect the organisation's competence (Turner, 2014). Competence can be defined as the practical or theoretical skillsets and expertise possessed by individuals, groups or organisations (Cohen *et al.*, 2014; Hellmann and Meyer, 2016).

It encompasses personal, professional and technical capacity developed over time or in the course of discharging specific functions. As simple as it may seem for CEGs to have all necessary support from the government and other third-party organisations, they still require a competent workforce to drive and deliver project economic efficiency and social performance. A competent board director (BoD) is one who can think outside of the box and make positive contributions that promote and do not undermine the goals and visions of the organisation. A CEBMoD-BoD acts on behalf of the CEG as a corporate-level manager.

The expected competence requirements at this level of management include the mobilisation of various individual skills and capacities within the organisation's supply chain to ensure optimal operational performance of available resources, processes and products. According to Faix, Budde and Friedli (2015) competence management is one of the strategies through which an organisation can promote and sustain its efficiency and effectiveness.

6.12.8 *Component 7 - Shareholder Influence*

The last component, which is seven, had two positively loaded variables: "Effect of shareholder feedback (BMAg) and "Shareholders' influence on CEBMoD board composition (BMIc)". Together, they explain the level of influence shareholders have on organisational management and decision making. There are many stakeholders involved in CREP implementation, among them are the shareholders whose major responsibility is to invest in the project and seek returns on their investment.

Glac (2014) describe shareholders as the key drivers of an organisation's management and corporate initiatives. Shareholder involvement and interest in organisations in the last two decades have expanded beyond just financial outcomes (economics) to include social and environmental outcomes.

Bhandari and Arora (2016) submit that shareholder influence in the past was achieved through activism and corporate socially responsible (CSR) activities. In fact, shareholders own substantial parts (shares) of every organisation. Their rights extend to deliberating and contributing to corporate decisions, voting on governance issues, and communicating concerns and interests through proposals to be considered in annual meetings (Hamdani and Yafeh, 2013).

It is not clear, however, which procedural requirements in the CEBMoD structure each stakeholder must meet for his/her proposal to be considered and included in the corporation's annual meeting proxy materials. Conventionally, the common criteria suggest that shareholders must hold a specific percentage of shares in the company's securities, within a specific timeframe, to be qualified to send a proposal (Ferri and Oesch, 2016). In some countries, (e.g. the USA) the state laws within the company's jurisdiction are clear on these procedural criteria, and any deviation from them can result in rejection of the shareholder's proposal.

Another ground on which a proposal can be rejected is in its non-compliance to the corporation's goals, values and ethics; for instance, if it promotes self-interest above the corporation's. The approvals of a proposal by a majority of shareholders does not in any way translate to automatic implementation of its content, as management has the prerogative to accept or reject changes proposed by shareholders. Shareholder influences are symbolic, such that successful and unsuccessful proposals are considered vital feedback processes for continuous operation of the organisation.

To summarise the characteristics of the 34 effective CEBMoD factors initially identified for this study, basic descriptive statistics and a more complex principal component and factor analysis were carried out. Based on the significance of each factor's loading, only 25 factors were retained, and these led to extraction of seven principal measures of an effective CEBMoD. The seven components will be used in Chapter 8 to test for evidence of a relationship between CEBMoD effectiveness and CREP performance.

6.13 Summary

The results of the questionnaire survey administered to CREP practitioners UK-wide were presented in this chapter. In particular, simple descriptive statistics, Kaiser-Meyer-Olkin measures of sampling adequacy and Bartlett's tests of sphericity were used to test which CEBMoD and CREP factors were suitable for factor analysis. Thereafter, principal component analysis was conducted to produce a linear combination of CEBMoD and CREP factors and produce a parsimonious set of components for each of the CEBMoD and CREP factor groups. In the next chapter, these factors form combinations used in the development of a multiple regression model for assessing CEBMoD effectiveness and CREP performance.

CHAPTER 7: ASSESSING THE IMPACTS OF INCUMBENT COMMUNITY ENERGY BUSINESS MODELS ON THE SUCCESS OF COMMUNITY RENEWABLE ENERGY PROJECTS

7.1 Introduction

The factor analysis conducted in the previous chapter led to the extraction of twenty-three (23) sets of principal components that described CREPs success and impact and another seven (7) sets of components that described an effective CEBMoD. There was, however, no evidence of any relationships between the CREPs and CEBMoD principal components from the analysis. This chapter, therefore, examines which CEBMoD principal component best predicts success in CREP planning, implementation, operational and disposal phases, as well as the social, economic and environmental impacts desired by project stakeholders. This is to partly fulfil the third objective of the research and signpost the fourth objective. Pearson product-moment correlation coefficients (PPMCCs) and multiple regression analysis are the two statistical techniques employed to facilitate this analysis.

7.2 Examining the CEBMoD-CREP relationship

Multiple regression analysis and PPMCCs and are the two statistical techniques employed to test for a relationship between CEBMoDs and the principal factors of CREPs. These techniques have been used extensively to determine similar constructs – see (Kissi, Dainty and Tuuli, 2013; Mir and Pinnington, 2014; Popaitoon and Siengthai, 2014; Xiong *et al.*, 2014). Each of these techniques are described next.

7.2.1 *Pearson product-moment correlation coefficient*

In this research, PPMCC was used to test how strong the linear relationship between efficient CEBMoDs and CREP success. According to Cohen et al. (2013), PPMCC is mathematically represented as:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2]\ [n\sum y^2 - (\sum y)^2]}}$$

where r = Pearson correlation coefficient; x = values in first set of data; y = values in second set of data; and n = total number of values.

For more information on the applicability of PPMCC to similar research domains, see Ahmad, Mallick and Schroeder (2013); Wanberg et al. (2013); Weshah et al. (2013); Dongus et al. (2015); and Wang et al. (2015). The PPMCCs obtained for CREP and CEBMoD components are presented in Appendix C and discussed in Section 7.3.

7.2.2 *Multiple Regression*

Multiple regression (MR) analysis dates back to 1908 (Smouse, Long and Sokal, 1986). It explains whether a relationship exists between independent (explanatory or predictor) variables and a dependent (or outcome) variable. MR provides answers to what best predicts an outcome of anticipated occurrences by (i) multiplying a combination of all the variables by their corresponding coefficients, and (ii) adding a residual term to predict the coefficients of the independent and dependent variables. This is expressed in the formula below:

$$\gamma = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3$$

where γ = is the predicted value; a = alpha constant; β1 = beta coefficient for first predictor X1; β2 = beta coefficient for second predictor X2; β3 = beta coefficient for third predictor X3; X1 = first predictor variable explaining the variance in γ; X2 = second predictor variable explaining the variance in γ; and X3 = third predictor variable explaining the variance in γ.

The weighted contributions of each predictor variable to the overall prediction are known as the coefficients. With the coefficients, it is simple to interpret the contribution of each variable in the prediction. The two important take-aways from MR analysis is that it shows the degree of correctness of each prediction and, from the best linear combination of predictors, the percentage of variance of each outcome is known. This approach is consistent with what this research aims to achieve; which is to examine the extent of the impacts that an effective CEBMoD *(independent variables)* can have on the nature and performance of CREPs *(dependent variables)* in the UK.

7.2.2.1 Variable selection techniques in multiple regression

Three major techniques have been used by researchers to decide on the number of variables to be used in MR and how each variable is entered into the model. The first technique is the hierarchal regression techniques, which uses predictors obtained from previous research (Lu and Woo, 2017). The predictors are ranked by their level of importance and entered into the model in the same manner. So far, research on community energy projects is only recent and, therefore, there is no robust and valid empirical evidence on how a type of ownership model contributes to CREP performance. Consequently, this approach is inappropriate for use in this research.

The second variable selection technique, as suggested by Geweke (1996), is the forced entry technique, which relies on only variables that have been demonstrated to have an effect. These variables are entered into the model at the same time.

The last technique for selecting variables is the stepwise technique. It relies on a mathematical formula to determine suitable variables and the sequence of their entry into the model. This technique seems appropriate and was adopted. One of the advantages of adopting the stepwise variable selection technique is because it is simple and reliable in revealing variable relationships. It also allows predictors to be screened for their order of significance before entry into the model, following each other in quick succession (Yuan and Lin, 2006).

Moreover, insignificant predictors already captured in the equation can be removed through a similar process (George, 2000). The screening of variables is discontinued when all the significant and insignificant predictors have been added or removed from the model. With F test significances of ≤ 0.05 and ≥ 0.10, a predictor can be entered into or removed from the equation (see Section 7.3 and Appendix D for a practical demonstration of this technique).

7.2.2.2 Assumptions of Multiple Regressions

Aiken, West and Reno (1991) identified prediction errors, due to omission of basic data characteristics entered into regression models, as likely to affect regression outcomes and interpretations. Furthermore, a lack of strong relationships amongst variables has also been identified as a major source of regression error (Neumeyer and Van Keilegom, 2010). Many researchers (Dielman, 2001; Tabachnick, Fidell and Osterlind, 2001; Aiken, West and Pitts, 2003; Cohen *et al.*, 2013; Keith, 2014) have, however, argued that making certain assumptions can reduce the degree of error. Common assumptions that underpin multiple regression analysis include: linearity, homoscedasticity of errors; independence of residuals and normality.

According to Draper and Smith (2014), estimates of regression coefficients can be biased when these assumptions are violated, leading to incorrect confidence intervals, tests of significance and standard errors. One way to detect assumption violation, as suggested by Maas and Hox (2004), is to plot and analyse the *residuals* (i.e. differences between observed and modelled values).

When the residuals cluster outside the centreline of the plot, it indicates that certain assumptions have been violated. By careful examination of the plots, the most suitable model for multiple regressions is revealed. The four assumptions are briefly discussed below.

Assumption of linearity

In multiple linear regression, it is assumed that a linear relationship exists between the predictor and outcome variables (Tabaei and Herman, 2002; Montgomery, Peck and Vining, 2015). However, in a situation where a non-linear relationship exists, there is a high possibility for error in the modelling (Fox, 2000). Linearity is diagnosed by plotting the dependent variables against the independent variables or by checking a correlation matrix of dependent variables against independent variables for the degree of bivariate outlier influence. In the *R* statistical programme, the package *Companion to Applied Regression* (CAR) was used to obtain the scatter plots (Fox et al., 2017).

Assumption of homoscedasticity of errors

Osborne and Waters (2002) described *homoscedasticity* as a situation in which the variance of error is constant across the values at each level of the explanatory variable. An effective method of assessing homoscedasticity is to plot the studentised residuals (i.e. resultant proportion from the division of a residual by an estimate of its standard deviation) against the predicted outcome (Ai and Norton, 2000). Where the plot of the residuals deviates considerably from the horizontal line, the variance in this case is heteroscedastic.

Assumption for Independence of Residuals

Independence of residuals means that the residual terms (i.e. estimates of experimental error) are independent. This assumption is violated when there is an obvious relationship between succeeding and preceding residual terms (Abadi et al., 2010). However, Ghoudi, Kulperger and Rémillard (2001) suggest that the independence of residuals assumption should not be a major consideration when the dataset is cross-sectional. The researcher deemed it necessary to assess this using the *Global Validation of Linear Model Assumptions* (GVLMA) function in the *R* package (Pena and Slate, 2012).

Assumption of Normality

In multiple regression, the response and predictor variables are assumed to be normally distributed. In other words, the random errors in both classes of variables are expected to be normally distributed. This assumption can be checked by examining the normal probability plot for outliers, and when residuals are not within the confidence band, this implies that outliers are present. The normality assumption has been identified as being the most violated one in statistics (Lumley et al., 2002), although Schmider et al. (2010) believe that violating it does not necessarily translate to an inefficient model, particularly when the sample size is above 200.

The knowledge and correct application of these assumptions to MR analysis are critical to the degree of accuracy of both the model and generalisation of its interpretations. The researcher was careful to ensure that none of the assumptions were violated in the process of generating the model.

A large and growing body of construction management and engineering literature has used MR to predict the effects of project costs (Iyer and Jha, 2005a), contractor attributes (Wong, 2004) and strategic management (Bassioni, Price and Hassan, 2004) on project performance, to mention but a few.

It has been shown by these studies that MR can be an effective tool for use in modelling relationships between response and explanatory variables. This is precisely the main crux of this research.

7.3 The CEBMoD – CREP Correlation

The PPMCC measures the covariance of two variables divided by their respective standard deviations. Appendix C, Tables 1 – 7, present CEBMoD-CREP success and impacts correlation matrices. As can be seen from the planning phase correlation matrix (Table 1, Appendix C), the CEBMoD components *participative management* and *shareholder influence* showed no linear relationship with *information management* (r = 0.000) and *project finance components*, respectively.

However, a weak positive linear relationship was observed between *overcoming local resistance*, *preliminary research on project requirements* and all of the CREP planning phase components. On the other hand, the HRM aspect, as a CEBMoD component, showed a weak negative linear relationship with all of the CREP planning phase components. Furthermore, there were positive linear relationships amongst the following: *special circumstances*, *resource assessment* (r = 0.027) and *project finance* (r = 0.103); *shareholder influence*, *information management* (r = 0.16) and *resource assessment* (r = 0.047).

The results of the correlational analysis obtained for the implementation phase components in Table 2, Appendix C, shows that apart from the *HRM aspect* (r = -0.037) and *overcoming local resistance* (r = -0.031) with weak and negative relationships, other CEBMoD components were positively related to *conflict resolution*. Similarly, the CREP *cash flow* component was positively related to all other CEBMoD components except *board of directors' competence* (r = -0.117), *special circumstances* (r = -0.153) and *HRM aspect* (r = -0.043). There was, however, no linear relationship between the *shareholder influence* and *skill availability* components.

Table 3, Appendix C, shows four positive, two negative and one non-correlated relationship between CEBMoD and *local benefit* components, while the CREP *government regulations* component was negatively related to five but two CEBMoD components. Another four positive and three negative relationships were observed for CREP *technical complexities* and the CEBMoD components.

Apart from the CEBMoD *HRM aspect* component (*r* = -0.054), all other components were positively correlated with the *detailed CREP completion reports* component. On the other hand, the following CEBMoD components: *preliminary research on project requirements* (*r* = -0.008), *board of directors' competence* (*r* = -0.034), *special circumstances* (*r* = - 0.097), and *shareholder influence* (*r* = -0.133) showed weak negative linear relationships with the CREP *lessons learned* component (see Table 4, Appendix C).

The results of the correlational analysis obtained for CREP economic impact components in Table 5, Appendix C shows five negative and two positive correlations between CEBMoDs and CREP *local goods demand* components. Conversely, CREP *energy type switch* and *improved local economy* had five positive and two negative correlations with CEBMoD components.

As can be seen from Table 6, Appendix C, the following CEBMoD components: *board of directors' competence*, *special circumstances* and *shareholder influence* showed negative, while *preliminary research on project requirements* showed a positive relationship with all three CREP *environmental impact* components. However, *health and safety* was positively related with overcoming local resistance (*r* = 0232), while *air pollution*, *overcoming local resistance* and *participative management* were also positively related.

Local acceptance, being an anticipated social benefit from CREPs, was positively related to *board of directors'* competence (*r* = 0.030) and *special circumstances* (*r* = 0.232). Moreover, all of the CREP *social* components were positively related with CEBMoD *special circumstances* components.

Although some positive and negative correlations have been established between the various CEBMoD and CREP components, Bekinschtein et al. (2011) warns that caution must be applied in claiming causality, because there might be a third or confounding variable. That notwithstanding, the overall correlation matrices indicate strong linear relationships among the components; hence, multiple regression can be used to further examine the aspects of CEBMoD efficiency that can lead to CREP success.

7.4 CEBMoD efficiency and CREP success models

The following sections will discuss the various regression models examined, the model selection techniques and regression assumptions.

7.4.1 *Test of Regression Assumptions – CREPs success models*

To detect violations of assumptions in the CREP planning, implementation, operational and disposal phase variables prior to carrying out regression analysis, a plot and analysis of the residuals (i.e. difference between observed and modelled values) was obtained (Appendix E, Figures 1 – 36).

There is a strong evidence that the assumption of normality was not violated, as can be seen on the bell-shaped distribution of the residuals in Appendix E (Figures 1 – 4, 13-15, 22-24 and 31-32). In addition, Appendix E (Figures 5 – 8, 16-18, 25-27 and 33-34) show points forming a roughly straight line, which appears to be a safe assumption that both sets of quantiles truly come from normal distributions.

Th assumption of linearity in this case was also not violated, as the residuals in Appendix E (Figures 9–12, 19-21, 28-30 and 35-36) are uniformly distributed with no clear pattern. These figures show horizontal lines with randomly spread points, which implies that residuals are spread equally along the ranges of predictors; hence, the assumption of equal variance (homoscedasticity) is not violated.

For the multicollinearity tests, a maximum variance inflation factors (VIF) of 1.141 was obtained from the coefficient analysis of all the CREP success predictors (see Table 7.1). The minimum VIF was equally significant at 1.000, an indication that the data was free of collinearity. However, there were models with one predictor and, by default, VIFs cannot be obtained from a single predictor (Mansfield and Helms, 1982).

Table 7.1: Assumption for collinearity and autocorrelation for CREP success models

Sn	Model	VIF	D-W statistic
1	Information management model	1.000	1.543
2	Market maturity model	1.140	2.154
3	Resource assessment model	0.000	2.049
4	Project finance model	0.000	1.789
5	Conflict resolution model	0.000	2.055
6	Cash flow model	0.000	2.078
7	Skill availability model	0.000	2.063
8	Local benefits models	0.000	1.698
9	Government regulations models	1.024	2.161
10	Technical complexities models	0.000	2.042
11	Detailed completion reports models	1.264	2.092
12	Lessons learned models	1.008	2.082

Similarly, the use of Durbin-Watson statistical tests to detect autocorrelation in residuals (in other words, tests of independence of residuals) resulted in a normal value range of 1.54–2.16 for all the CREP success predictors (Table 7.1). By implication, the independence of error terms assumption has not been violated. Having met the assumption for multiple regression, the following sections presents the results and discussion of the planning, implementation, operational and disposal phase sub-models.

7.4.2 *CREP planning phase models*

The four components that exhaustively describe the CREP planning phase were *information management*, *market maturity*, *resource assessment*, and *project finance*. These are the dependent variables to be used individually against CEBMoD components as independent variables in a follow-up regression analysis.

7.4.2.1 Information Management Model

The first regression model estimates the probability of increasing CREP success rates through the effective management of project information at the planning phase of the project. All seven CEBMoD components were included as predictors, while *information management* was the response variable in the multiple regression analysis. The main features of the model’s fitness are reported in Table 7.2.

Table 7.2: Regression analysis results for CREPs planning phase information management

Residuals				
Min	**1Q**	**Median**	**3Q**	**Max**
-2.07479	-0.65766	-0.09368	0.73407	2.26970
Coefficients:				
	Estimate	**Std Error**	***t*-value**	**Pr(>|t|)**
(Intercept)	2.19466	0.40671	5.396	5.26e-07 ***
Overcoming_Local_Resistance	0.19114	0.08046	2.376	0.0196 *
Shareholder_Influence	0.17225	0.10605	1.624	0.1077

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				

Residual standard error: 1.028 on 92 degrees of freedom
Multiple R^2: 0.082, Adjusted R^2: 0.062
F-statistic: 4.11 on 2 and 92 DF, *p*-value: 0.01951

As can be seen from the table above, *overcoming local resistance* and *shareholder influence* are the only predictors that are significantly associated with *effective management of project information* at the planning phase of CREPs. The measure of the relationship between the predictor variables and response variable resulted in an R^2 of 0.082. Furthermore, the *F*-statistic was 4.11 on 2 and 92 DF, *p*-value: 0.01951, indicating that the explanatory variables, collectively, affect the response variable.

The expected mean value of the response variable when all predictor variables equal zero was 2.19466, while the regression coefficient estimates for *overcoming local resistance* and *shareholder influence* were 0.19114 and 0.17225, respectively. Therefore, the complete regression equation for the CREP *information management* model is:

INFORMATION MANAGEMENT = 2.19466 + 0.19114 (OVERCOMING LOCAL RESISTANCE) + 0.17225 (SHAREHOLDER INFLUENCE)

The predictor variables *HRM aspects*, *participative management*, *preliminary research* on *project requirements*, *board of directors' competence* and *special circumstances* were eliminated from the final model through stepwise regression (see Appendix D, Table 1).

7.4.2.2 Market Maturity Model

The second regression model estimates the probability that CREPs could have more success in their planning phases in more mature and regulated markets. Again, all seven CEBMoD components were included as predictors, along with *market maturity* as the response variable in the multiple regression analysis. The main features of the model fitness are reported in Table 7.3, below.

Table 7.3: Regression analysis results for CREP market maturity

Residuals **Min**	**1Q**	**Median**	**3Q**	**Max**
-2.09576	-0.57161	-0.04093	0.69671	1.82825
Coefficients:	**Estimate**	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	3.06168	0.44103	6.942	5.56e-10 ***
HRM_Aspects	-0.19449	0.09982	-1.948	0.0544 .
Overcoming_Local_Resistance	0.14808	0.0814	1.819	0.0722 .
Participative Management	0.15649	0.10443	1.499	0.1375

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1				
Residual standard error: 0.9821 on 91 degrees of freedom Multiple R^2: 0.07154, Adjusted R^2: 0.04094 F-statistic: 2.337 on 3 and 91 DF, p-value: 0.07884				

The following three predictors, *HRM aspects*, *overcoming local resistance* and *participative management* turned out to be significant in the CREP market maturity model. A p-value of 0.05 or less is regarded as adequate for establishing a relationship between dependent and independent variables in regression analysis. However, the three predictors in this model had p-values of 0.05–0.14.

By implication, these predictors did not fit significantly but, at the same time, when human resource development is prioritised at the community level, and the people are integrated into the project as key players, it further reduces resistance to project development. The measure of the relationship between predictor variables and the response variable resulted in an R^2 of 0.072.

Furthermore, the F-statistic: 2.337 on 3 and 91 DF, p-value: 0.0788, indicates that the explanatory variables, collectively, affect the response variable, irrespective of the high p-value and low R^2.

The expected mean value of response variable when all predictor variables equal zero was 3.06168, while the regression coefficient estimates for *HRM aspects*, *overcoming local resistance* and *participative management* were -0.19449, 0.1481 and 0.15649, respectively. Therefore, the complete regression equation for the CREP market maturity model is:

MARKET MATURITY = 3.06168 - 0.19449 (HRM ASPECTS) + 0.14808 (OVERCOMING LOCAL RESISTANCE) + 0.15649 (PARTICIPATIVE MANAGEMENT)

Contrary to expectations, the equation above suggests that a 1% increase in human capacity development will decrease market maturity by 19%. It is expected that the more trained the local people become, the bigger the market grows. On a positive note, the equation further suggests that 1% improvements in *curbing local resistance* and *ensuring all stakeholders participate in decision making* will make the market grow faster by 14% and 15%, respectively.

The following four predictor variables, *preliminary research on project requirements*, *board of directors' competence, special circumstances*, and *shareholder influence*, were eliminated from the final model through stepwise regression (Appendix D, Table 2).

7.4.2.3 Resource Assessment Model

This third planning phase regression model estimated the probability that CREPs have more success in their planning phases if all the resources required are identified and assessed prior to project commencement. Again, all seven CEBMoD components were used as predictors. Backward stepwise regression was the approach used (Appendix D, Table 3). The regression, however, did not return any variable for the resource assessment model. This result may be explained by the fact that other factors not covered in this study are more significant in the prediction of this variable.

7.4.2.4 Project Finance Model

The last, but not least, regression model estimates the probability that accessing finance prior to project commencement could increase CREP success. Using all seven CEBMoD components as predictors with *project finance* as the response variable, the regression did not return any predictors for this model (Appendix D, Table 4).

This type of result is not surprising because there may be possible predictors not considered by the researcher. For instance, for the CREP sector to expand beyond its current level, installations must cover other technologies other than solar and wind and this will require additional financial investments. In the coming two decades, the UK electricity sector will require substantial financial investment (Ofgem, 2010b).

This is based on studies conducted by several organisations, prominent among them are the DECC and National Grid. The importance of access to and availability of sufficient finance prior to commencement of projects is significant to their success, because of the capital-intensive nature of renewable energy projects.

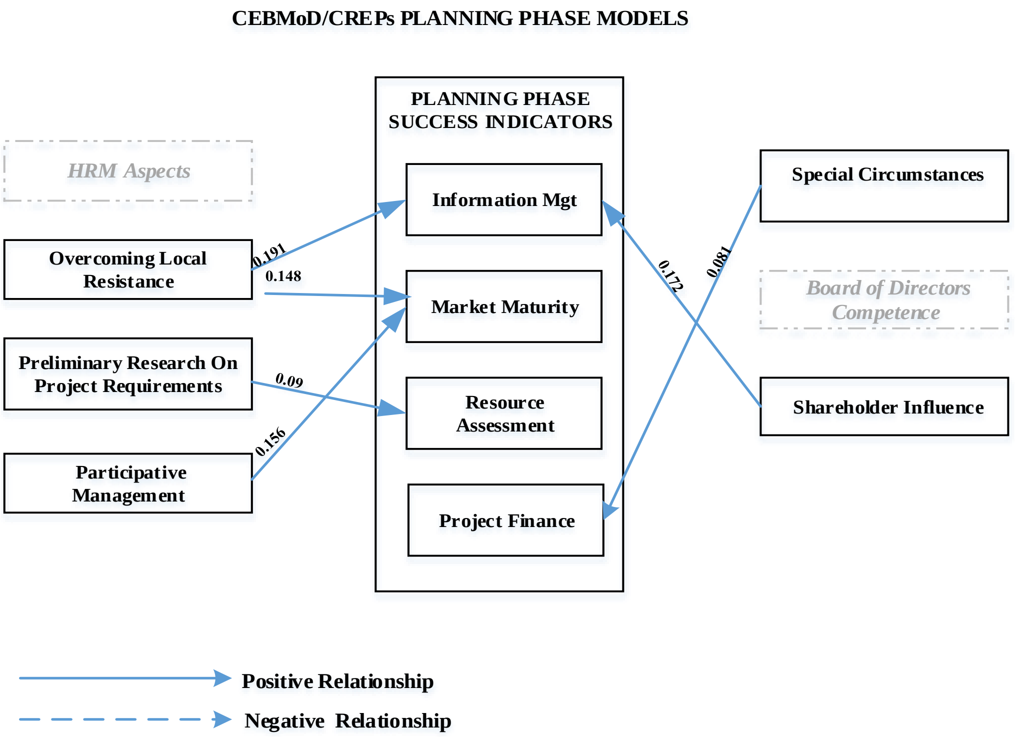

Figure 7.1: Pictorial representation of CREP planning phase regression results

The next section reports on the group of models of the CREP implementation phase.

7.4.3 *CREP Implementation Phase Models*

Three components significantly described the CREP implementation phase based on PCA of its common influencing factors (see Section 6.10).

The components were *conflict resolution*, *cash flow* and *skills availability*. These were the dependent variables used individually against CEBMoD components (as the independent variables) in a follow-up regression analysis, below.

7.4.3.1 Conflict Resolution Model

The first regression model estimates the probability of increasing CREP success rates through effective conflict resolution at the project implementation phase. All seven CEBMoD components were included as predictors while *conflict resolution* was used as the response variable in the multiple regression analysis. The results of the model are reported in Table 7.4 below.

Table 7.4: Regression analysis results for the CREP implementation phase conflict resolution model

Residuals **Min**	**1Q**	**Median**	**3Q**	**Max**
-2.51854	-0.51854	-0.02614	0.80973	2.13799
Coefficients:	**Estimate**	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	2.69787	0.32265	8.362	5.92e-13 ***
Board_of_DirectorsCompetence	0.16413	0.09143	1.795	0.0759 .

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1				
Residual standard error: 1.076 on 93 degrees of freedom Multiple R^2: 0.03349, Adjusted R^2: 0.0231 F-statistic: 3.223 on 1 and 93 DF, p-value: 0.07588				

The results reveal a relationship between the predictor *board of directors' competence* and the response variable *conflict resolution.* The R^2 value of 0.033 implies that *board of directors' competence* accounts for 3.3% of the variation in *conflict resolution*. The model equation can therefore be given as:

CONFLICT RESOLUTION = 2.69787 + 0.16413 (BOARD OF DIRECTORS' COMPETENCE)

Although the R^2 value is low, the P-value of 0.07 still shows a satisfactory overall model fit. Furthermore, the F-statistic of 3.223 with 1 and 93 degrees of freedom, shows that conflict resolution significantly improves the ability to predict CREP implementation phase success.

The following six predictors: *HRM aspects*, *overcoming local resistance*, *participative management*, *preliminary research on project requirements*, *special circumstances*, and *shareholder influence* were eliminated from the final model through stepwise regression (see Appendix D, Table 5) because they were not very useful predictors of *conflict resolution*.

7.4.3.2 Cash flow Model

The second regression model in this category estimates the probability that CREPs could succeed more in their implementation phase if there was proper management of day-to-day cash flow in and out of the project. All seven CEBMoD components were included as predictors, along with *cash flow* as the response variable in the multiple regression analysis. The results are given in Table 7.5, below.

Table 7.5: Regression analysis results for the effect of cash flow on the CREP implementation phase

Residuals **Min**	**1Q**	**Median**	**3Q**	**Max**
-2.04983	-0.9081	0.09192	0.95017	2.23366
Coefficients:				
	Estimate	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	2.48285	0.28246	8.79	7.41e-14 ***
Overcoming_Local_Resistance	0.14174	0.09052	1.566	0.121

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				
Residual standard error: 1.157 on 93 degrees of freedom Multiple R^2: 0.02569, Adjusted R^2: 0.01521 F-statistic: 2.452 on 1 and 93 DF, p-value: 0.1208				

The outcome of the analysis showed there was only one predictor, *overcoming local resistance*. This predictor accounts for 3% of the variation in cash flow based on the R^2 value generated from the analysis. Although the R^2 value is low, and the P-value obtained is > 0.05 stipulated significance value, the F-statistic of 2.452 with 1 and 93 DF reveals that the explanatory variables have some form of effect on the response variable. With a regression intercept of 2.483 and coefficient estimates for *overcoming local resistance* of 0.142, the complete regression equation for the CREP implementation phase cash flow management model is:

CASH FLOW = 2.483 + 0.142 (OVERCOMING LOCAL RESISTANCE).

The following six predictors; *HRM aspects*, *participative management*, *preliminary research on project requirements*, *board of directors' competence*, *special circumstances*, and *shareholder influence* were eliminated from the final model through stepwise regression (see Appendix E, Table 6) because they were not very useful predictors of CREP implementation phase cash flow management.

7.4.3.3 Skills Availability Model

Multiple regression analysis was also used to model the impact of CEBMoD components (see Section 6.11) on CREP implementation phase success (Section 6.10). In particular, the regression was used to estimate the probability that adequate local skills availability can increase the success rate of CREP implementation. The seven CEBMoD components (independent variables) were included in the model, with *skills availability* used as the response variable. The results of the model are reported in Table 7.6.

Table 7.6: Regression analysis results for CREPs implementation phase skills availability

Residuals **Min**	**1Q**	**Median**	**3Q**	**Max**
-2.7896	-1.0257	0.2104	0.7833	1.9743
Coefficients:	**Estimate**	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	2.8347	0.2729	10.386	<2e-16 ***
PreliminaryResearchOnProjectRequirements	0.191	0.0913	2.092	0.0392 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				
Residual standard error: 1.171 on 93 degrees of freedom Multiple R^2: 0.04494, Adjusted R^2: 0.03467 F-statistic: 4.376 on 1 and 93 DF, p-value: 0.03918				

The predictor *preliminary research on project requirements* turned out to be significant for the CREP local skill availability model. A p-value of 0.05 or less was assumed to be adequate for identifying a statistically significant relationship between dependent and independent variables in regression analysis. As can be seen in Table 7.6 above, the predictor variable in the regression generated a significant p-value of 0.03 and R^2 value of 4%. Hence, the predictor was significant despite a low R^2 value indicating that the relationship was weak. Also, the F-statistic of 4.376 with 1 and 93 DF reveals that the explanatory variables have some form of effect on the response variable.

The expected mean value of the response variable when all predictor variables were equal to zero was 2.8347, while the regression coefficient estimate for the only model predictor, *preliminary research on project requirements*, was 0.191. Therefore, the complete regression equation for the CREP skills availability model is:

SKILL AVAILABILITY = 2.8347 + 0.191 (PRELIMINARY RESEARCH ON PROJECT REQUIREMENTS)

The following six predictors, *HRM aspects*, *overcoming local resistance*, *participative management*, *board of directors' competence*, *special circumstances*, and *shareholder influence*, were eliminated from the final model through stepwise regression (see Appendix D, Table 7) because they were not very useful predictors of *skills availability* at the implementation phase of CREPs.

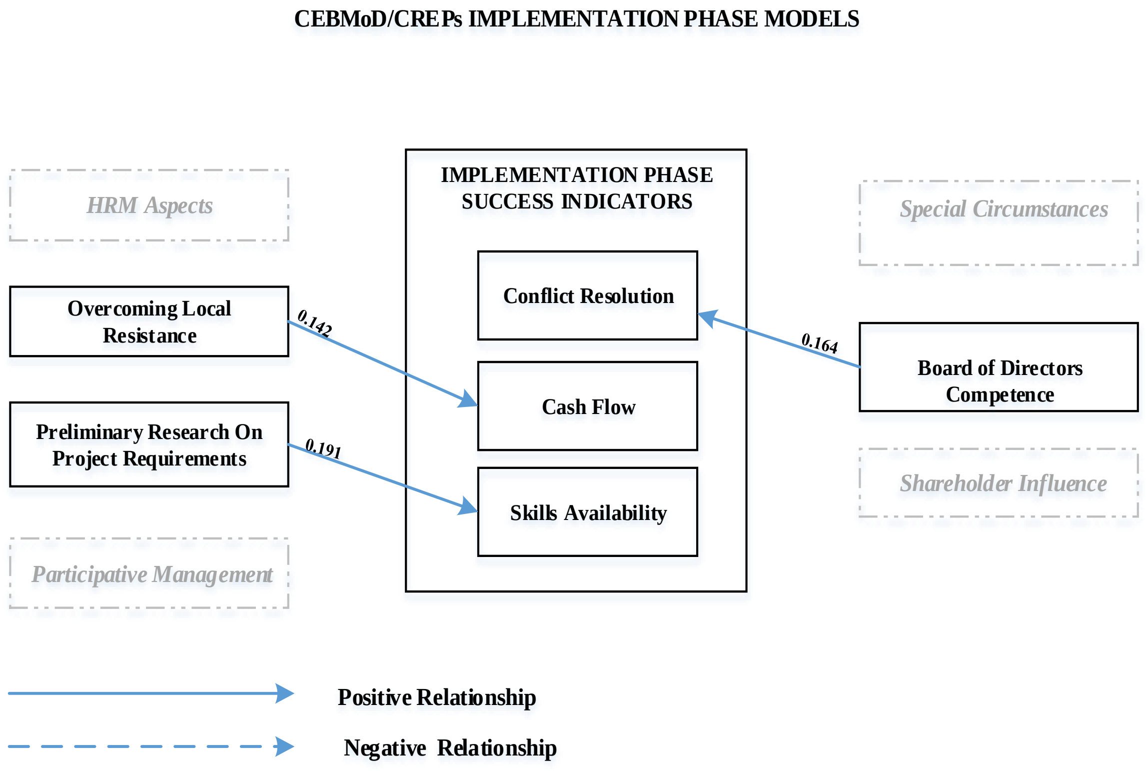

Figure 7.2: Pictorial representation of CREP implementation phase regression results

The next section reports on the group of models developed for the CREP operational phase.

7.4.4 *CREP operational phase models*

The PCA conducted in Section 6.10.2.3 revealed that local benefits, government regulations and technical complexities are significantly associated with the success of CREP operational phases. Consequently, each of these components were used (as dependent variables) against the CEBMoD components (as the independent variables) to conduct multiple regression.

7.4.4.1 Local Benefits Models

The first amongst the three operational phase components to be examined is *local benefits.* Multiple regression was conducted to predict CREP operational phase success rates based on significant benefits accruing to local stakeholders from project operations. All seven CEBMoD components were included as predictors while *local benefits* were the response variable used in the multiple regression analysis. The main features of the model fitness are reported in Table 7.7.

Table 7.7: Regression analysis results for CREP operational phase local benefits

Residuals **Min**	**1Q**	**Median**	**3Q**	**Max**
-1.8302	-0.90873	0.01273	0.85566	2.01273
Coefficients:	**Estimate**	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	2.67313	0.23935	11.168	<2e-16 ***
PreliminaryResearchOnProjectRequirements	0.15707	0.08007	1.962	0.0528 .

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1				
Residual standard error: 1.027 on 93 degrees of freedom Multiple R^2: 0.03974, Adjusted R^2: 0.02941 *F*-statistic: 3.848 on 1 and 93 DF, *p*-value: 0.05278				

The predictor *preliminary research on project requirements* turned out to be significant for the CREP local benefits model (similar to the skills availability model in Section 7.3.3.3). A *p*-value of 0.05 or less was assumed to be adequate for identifying statistically significant relationships between the dependent and independent variables used in the regression analysis.

As can be seen in Table 7.7 above, the predictor variable in the regression generated R^2 value of 4% and p-value of 0.05, which are statistically significant, but with weak relationship between dependent and independent variables in regression analysis

Also, the *F*-statistic of 3.848 with 1 and 93 DF reveals that the explanatory variables have some form of effect on the response variable. The expected mean value of the response variable when all predictor variables equal zero was 2.673, while the regression coefficient estimate for the only model predictor *preliminary research on project requirements* was 0.157. Therefore, the regression equation for the CREP operational phase local benefit model is

LOCAL BENEFIT = 2.673 + 0. 157 (PRELIMINARY RESEARCH ON PROJECT REQUIREMENTS)

The following six predictors: *HRM aspects*, *overcoming local resistance*, *participative management*, *board of directors' competence*, *special circumstances*, and *shareholder influence* were eliminated from the final model through stepwise regression (see Appendix D, Table 8) because they were not very useful predictors of local benefits at the CREP operational phase.

7.4.4.2 Government Regulations Models

The second operational phase regression model estimates the probability that CREP operations could succeed when government policies and regulations are favourable to community energy engagements. Again, all seven CEBMoD components were included as predictors along, with *government regulations* as the response variable in the multiple regression analysis.

Table 7.8: Regression analysis results for CREP operational phase - government regulation

Residuals **Min**	**1Q**	**Median**	**3Q**	**Max**
-2.2768	-0.7992	-0.1144	0.7281	2.2008
Coefficients:	**Estimate**	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	3.28002	0.37063	8.85	6e-14 ***
PreliminaryResearchOnProjectRequirements	0.15594	0.08013	1.946	0.0547 .
Shareholder_Influence	-0.15918	0.10601	-1.502	0.1366

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1				
Residual standard error: 1.016 on 92 degrees of freedom Multiple R^2: 0.0542, Adjusted R^2: 0.03364 F-statistic: 2.636 on 2 and 92 DF, p-value: 0.07705				

As can be seen from the Table 7.8 above, *preliminary research on project requirements* and *shareholders’ influence* were the two significant predictors in the *government regulations* model. The measure of relationship between predictor variables the response variable resulted in an R^2 of 0.054, an indication of a weak relationship between the dependent and independent variables. The F-statistic of 2.636 on 2 and 92 DF, with a p-value of 0.07 imply that the explanatory variables have some form of effect on the response variable.

The expected mean value of the response variable when all predictor variables equal zero was 3.280, while the regression coefficient estimates for the two model predictors *preliminary research on project requirements and shareholders’ influence* were 0.156 and -0.159, respectively. Therefore, the complete regression equation for the CREP operational phase government regulations model is:

GOVERNMENT REGULATIONS = 3.280 + 0. 156 (PRELIMINARY RESEARCH ON PROJECT REQUIREMENTS) - 0.159 (SHAREHOLDERS’ INFLUENCE)

The following five predictors; *HRM aspects*, *overcoming local resistance*, *participative management, board of directors’ competence*, and *special circumstances* were eliminated from the final model through stepwise regression (see Appendix D, Table 9) because they were not very useful predictors of the effect of government regulations on the operations of CREPs.

7.4.4.3 Technical Complexities Models

The third operational phase regression model estimates the probability that CREP operations could be scaled-up if all the technical complexities associated with community energy engagements are identified. Again, all seven CEBMoD components were included as predictors, along with *technical complexities* as the response variable in the multiple regression analysis.

Table 7.9: Regression analysis results for CREPs operational phase technical complexities

Residuals **Min**	**1Q**	**Median**	**3Q**	**Max**
-2.29642	-0.97727	0.02273	0.86316	1.86316
Coefficients:	**Estimate**	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	2.6581	0.3257	8.162	1.56e-12 ***
Shareholder_Influence	0.1596	0.103	1.549	0.125

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				

Residual standard error: 0.9991 on 93 degrees of freedom
Multiple R^2: 0.02514, Adjusted R^2: 0.01466
F-statistic: 2.398 on 1 and 93 DF, *p*-value: 0.1249

Multiple regression analysis result shown in above table reveals that there is a relationship between the predictor *shareholders' influence* and the response variable *technical complexities.* This model produced an R^2 value of 0.03, implying that *shareholders' influence* accounts for 3% of the variation in *conflict resolution*.

Although the R^2 value is low and the *P*-value is greater than 5%, the *F*-statistic of 3.223 with 1 and 93 degrees of freedom implies that the overall model fit is satisfactory. In other words, *shareholders' influence* can predict CREP operational phase success. The model can therefore be given as:

TECHNICAL COMPLEXITIES = 2.658 + 0.1596 (SHAREHOLDERS' INFLUENCE)

The following six predictors; *HRM aspects, overcoming local resistance, participative management, preliminary research on project requirements, special circumstances*, and *board of directors' competence* were eliminated from the final model through stepwise regression (see Appendix D, Table 10) because they were not very useful predictors of *technical complexities*.

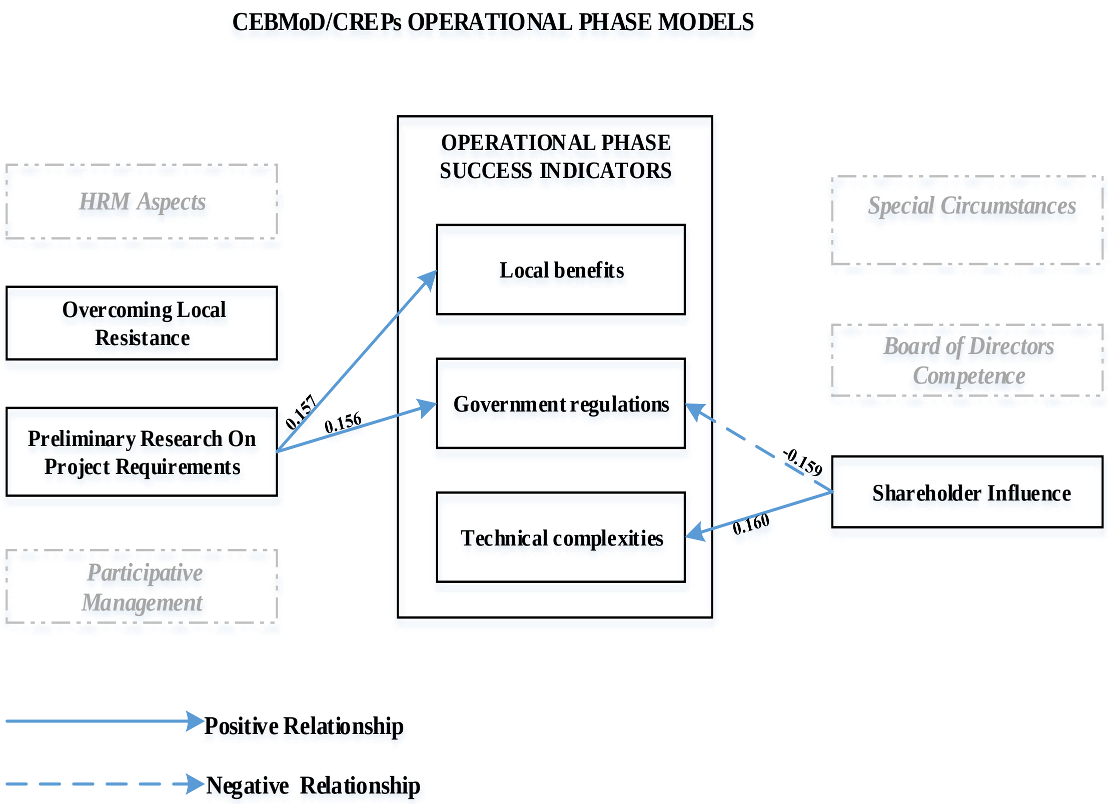

Figure 7.3: A pictorial representation of CREP operational phase regression results

The next section reports on the group of models developed for the CREP disposal phase.

7.4.5 *CREP disposal phase models*

The two components that exhaustively describe the CREP disposal phase were *detailed completion reports* and *lessons learned*. Again, these are the dependent variables to be used individually against CEBMoD components (as the independent variables) in the regression analysis below.

7.4.5.1 Detailed Completion Reports Models

The first amongst the two CREPs disposal phase components to be examined is *detailed completion reports*. Multiple regression was used to predict the probability that producing and keeping detailed CREP completion reports is an indicator of a satisfactorily disposed project.

All seven CEBMoD components were included as predictors while *detailed completion reports* were the response variable used in the multiple regression analysis. The main features of the model fitness are reported in Table 7.10.

Table 7.10: Regression analysis results for CREP detailed completion reports

Residuals				
Min	**1Q**	**Median**	**3Q**	**Max**
-2.29188	-0.6018	0.00672	0.64231	2.1541

Coefficients:	**Estimate**	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	2.56839	0.40239	6.383	7.17e-09 ***
HRM_Aspects	-0.20786	0.10606	-1.96	0.05308 .
Overcoming_Local_Resistance	0.23811	0.08489	2.805	0.00615 **
Special_Circumstances	0.18221	0.08078	2.256	0.02649 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9912 on 91 degrees of freedom
Multiple R^2: 0.1054, Adjusted R^2: 0.07593
F-statistic: 3.575 on 3 and 91 DF, p-value: 0.017

The predictors *HRM aspects*, *overcoming local resistance*, and *special circumstances* turned out to be significant in the CREP disposal phase *detailed completion reports* model. A p-value of 0.05 or less is assumed to be adequate for establishing a relationship between dependent and independent variables in regression analysis. As can be seen in Table 7.10 above, the predictor variables in the regression generated a significant p-value range of 0.02–0.06.

The R^2 value of 10.5% in this model is much higher than those of the other models discussed in previous sections. By implication, there is a stronger relationship between the predictors and the response variable. The F-statistic of 3.575 on 3 and 91 DF further reveals the effect of the explanatory variables on the response variable.

The expected mean value of the response variable when all predictor variables equal zero was 2.56839, while the regression coefficient estimates for the model predictors *HRM aspects, overcoming local resistance*, and *special circumstances* were -0.20786, 0.23811, and 0.18221, respectively. Therefore, the complete regression equation for the *detailed completion reports model* is

DETAILED COMPLETION REPORTS = 2.56839 - 0.20786 (HRM ASPECTS) + 0.23811 (OVERCOMING LOCAL RESISTANCE) + 0.18221 (SPECIAL CIRCUMSTANCES).

The following four predictors; *participative management, preliminary research on project requirements, board of directors' competence*, and *shareholder influence* were eliminated from the final model through stepwise regression (see Appendix D, Table 11) because they were not very useful predictors of *detailed completion reports* at the disposal phase of CREPs.

7.4.5.2 Lessons Learned Models

The second amongst the two CREPs disposal phase components to be examined is that of *lessons learned*. Multiple regression was used to determine the probability that the insights gained from previously executed projects influence future projects, whether those projects were successful or not. Again, backward stepwise regression was the procedure used to determine which CEBMoD factors could be used as predictors in the *lessons learned* model. Seven predictor variables were included in the analysis, with the results provided in Table 7.11.

Table 7.11: Regression analysis results for CREPs disposal phase lessons learned model

Residuals **Min**	**1Q**	**Median**	**3Q**	**Max**
-2.94003	-0.68523	0.07112	0.71029	1.98481
Coefficients:	**Estimate**	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	2.63073	0.48999	5.369	6.02e-07 ***
Overcoming_Local_Resistance	0.1434	0.07869	1.822	0.0717 .
Participative_Management	0.20896	0.1064	1.964	0.0526 .
Shareholder_Influence	-0.15456	0.10408	-1.485	0.141

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				
Residual standard error: 1.005 on 91 degrees of freedom Multiple R^2: 0.09131, Adjusted R^2: 0.06136 F-statistic: 3.048 on 3 and 91 DF, p-value: 0.03264				

As can be seen from the table above, *overcoming local resistance, participative management*, and *shareholders' influence* were the three predictors with significant contributions to the *lessons learned* model.

The measure of the relationship between the predictor and response variables was $R^2 = 0.091$, an indication that the model explains 9.1% of the variability in the *lessons learned* variable. Furthermore, the *F*-statistic of 3.048 with 3 and 91 DF and *p*-value of 0.03264 indicates that the explanatory variables collectively have an effect on the response variable.

The expected mean value of the response variable when all predictor variables equal zero was 2.63073, while the regression coefficient estimates for *overcoming local resistance*, *participative management*, and *shareholders' influence* were 0.143, 0.209 and -0.155, respectively. Therefore, the complete regression equation for the *lessons learned* model is:

LESSONS LEARNED = 2.63073 + 0.1434 (OVERCOMING LOCAL RESISTANCE) + 0.20896 (PARTICIPATIVE MANAGEMENT) - 0.15456 (SHAREHOLDERS' INFLUENCE).

The following four predictors; *HRM aspects*, *preliminary research on project requirements*, *board of directors' competence*, and *special circumstances* were eliminated from the final model through stepwise regression (see Appendix D, Table 12) because they were not very useful predictors of *lessons learned* at the CREPs disposal phase.

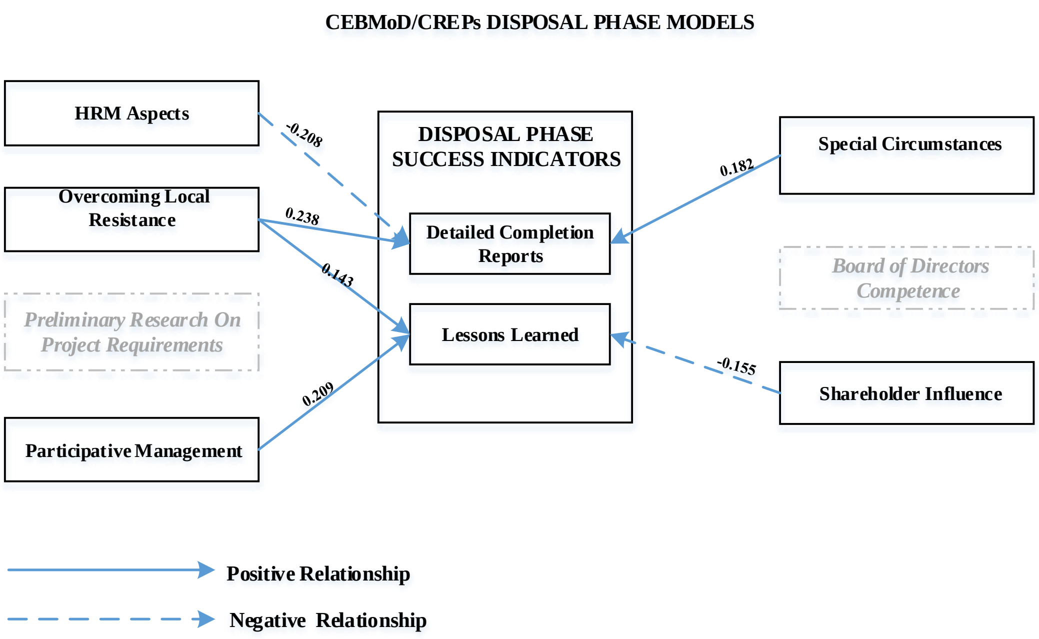

Figure 7.4: Pictorial representation of the CREP disposal phase regression results

7.5 CEBMoD efficiency and CREP impact model

In Chapter 6 (Section 6.9.5) of this thesis, the economic impacts of CREPs expected by stakeholders were rated and were further subjected to factor analysis in Section 6.10.2.5 using PCA and orthogonal varimax rotation techniques. The following sections will discuss the various regression models examined, the model selection techniques and regression assumptions.

7.5.1 *Test of Regression Assumptions – CREPs Impact models*

To detect assumption violations in the CREP social, economic and environmental impact variables, a plot and analysis of the residuals was made (Appendix E, Figures 37-69). There was strong evidence that the assumption of normality was not violated, as can be seen in the bell-shaped distribution of residuals in Appendix E (Figures 37-40, 49-51 and 58-61).

In addition, Appendix E (Figures 41-44, 52-54 and 62-65) shows the points forming roughly straight lines, which appears to be a safe assumption that both sets of quantiles truly come from normal distributions.

The assumption of linearity in this case was also not violated, as the residuals in Appendix E (Figures 45-48, 55-57 and 66-69) were uniformly distributed with no clear pattern. These figures show horizontal lines with randomly spread points, which implies that the residuals are spread equally along the ranges of predictors; hence, the assumption of equal variance (homoscedasticity) is not violated.

For the multicollinearity tests, a maximum VIF value of 1.250 was obtained from the coefficient analysis of all the CREP impact model predictors (Table 7.12). The minimum VIF was equally significant at 1.012, an indication that the data is free of collinearity. However, there were models with one predictor and, by default, VIF cannot be obtained from a single predictor (Mansfield and Helms, 1982).

Table 7.12: Assumption for collinearity and autocorrelation for CREP impact models

Sn	Models	VIF	D-W Statistic
1	Improved local economy model	1.053	2.375
2	Energy affordability model	1.250	1.875
3	Local goods demand model	0.000	2.081
4	Energy type switch model	1.198	1.831
5	Health and safety model	1.012	2.060
6	Air pollution model	0.000	2.091
7	Visual aesthetics model	1.172	1.732
8	Local capacity building model	0.000	2.067
9	Local acceptance model	1.020	2.150
10	Job creation model	0.000	2.003
11	Fuel poverty reduction model	0.000	1.861

Similarly, Durbin-Watson statistical tests were used to detect autocorrelation in residuals (in other words, tests of the independence of residuals). Normal value ranges of 1.54 – 2.16 were obtained for all predictors of CREP impacts (see Table 7.12 above). By implication, the independence of error terms assumption has not been violated. Having met the assumption for multiple regression, the following sections presents the results and discussion of the social, economic and environmental impact sub-models.

7.5.2 *CREP Economic Impact Models*

Four components that exhaustively describe economic impacts on CREPs were extracted from factor analysis. They were *improved local economy*, *energy affordability*, *local goods demand* and *energy type switch*. These were the dependent variables used individually against CEBMoD components (as the independent variables) in a follow-up regression analysis to test whether the CEBMoD components contributed to any of these impacts.

7.5.2.1 Improved Local Economy Model

In the CREP economic impact analysis, the first relationship to be tested using MR was whether CEBMoD management structures and approaches to CREP delivery affect the local economy. Using all seven CEBMoD components as predictors and *improved local economy* as the response variable, the multiple regression analysis found *participative management* and *special circumstances* to be the only significant predictors. The results of the model fitting are reported in Table 7.13 below.

Table 7.13: Regression analysis results for improved local economy impact

Residuals **Min**	**1Q**	**Median**	**3Q**	**Max**
-2.7679	-0.4685	0.0278	0.72	1.9402
Coefficients:	**Estimate**	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	2.17906	0.37534	5.806	9.06e-08 ***
Participative_Management	0.20435	0.10783	1.895	0.06121 .
Special_Circumstances	0.23602	0.07773	3.036	0.00311 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				
Residual standard error: 0.9969 on 92 degrees of freedom Multiple R^2: 0.1498, Adjusted R^2: 0.1313 F-statistic: 8.104 on 2 and 92 DF, p-value: 0.0005733				

As can be seen in Table 7.13 above, the model produced an R^2 value of 0.15, implying that *participative management* and *special circumstances* account for 15% of the variation in the *improved local economy* model.

There was evidence of a satisfactory overall model fit based on the highly significant *P*-value of 0.0005, and *F*-statistic of 8.104 with 2 and 92 degrees of freedom. The expected mean value of the response variable when all predictor variables equal zero was 2.179, while the regression coefficient estimates for the two model predictors *participative management and* special circumstances *were 0.204 and 0.236, respectively. Therefore, the complete regression equation for* improved local economy *model is*

IMPROVED LOCAL ECONOMY = 2.18 + 0.204 (PARTICIPATIVE MANAGEMENT) + 0.236 (SPECIAL CIRCUMSTANCES)

The following five predictors; *hrm aspects*, *overcoming local resistance*, *preliminary research on project requirements*, *board of directors' competence*, and *shareholder influence* were eliminated from the final model through stepwise regression (see Appendix D, Table 13) because they were not very useful predictors for this model.

7.5.2.2 Energy Affordability Model

The next MR model predicts the probability of generating positive CREP impacts through the *economic impact* criterion of delivering affordable energy to consumers.

Amongst the CEBMoD management structures and approaches to CREP delivery components used as predictors, only *participative management*, *preliminary research on project requirements, board of directors' competence* and *special circumstances* were selected for inclusion in this model, as obtained from the stepwise variable selection analysis conducted. Some of the main characteristics of the model fit are reported in Table 7.14 below.

Table 7.14: Regression analysis results for energy affordability

Residuals **Min**	**1Q**	**Median**	**3Q**	**Max**
-1.9124	-0.5881	-0.07361	0.67376	2.14485
Coefficients:	**Estimate**	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	3.64997	0.46836	7.793	1.09e-11 ***
Participative_Management	-0.2746	0.10866	-2.527	0.0133 *
PreliminaryResearchOnProjectRequirements	0.13283	0.07887	1.684	0.0956 .
Board_of_DirectorsCompetence	-0.1612	0.09403	-1.714	0.0899 .
Special_Circumstances	0.21847	0.08391	2.603	0.0108 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				
Residual standard error: 0.99 on 90 degrees of freedom Multiple R^2: 0.148, Adjusted R^2: 0.1101 *F*-statistic: 3.909 on 4 and 90 DF, *p*-value: 0.005673				

It is apparent from this table that the model had a good fit to the data. First and foremost, the predictor variables in the regression generated significant *p*-values ranging from 0.01–0.09, which is a great improvement on the models previously described in this chapter. Again, this model produced an R^2 value of 0.148 and *F*-statistic of 8.104 on 2 and 92 degrees of freedom, implying that, together, the predictor variables account for 15% of the variation in the model.

The expected mean value of the response variable when all predictor variables equal zero was 3.649, while the regression coefficient estimates for the model predictors *participative management, preliminary research on project requirements, board of directors' competence,* and *special circumstances* were -0.2746, 0.13283, -0.1612 and 0.21847, respectively. Therefore, the complete regression equation for the *energy affordability* model is:

ENERGY AFFORDABILITY = 3.64997 - 0.275 (PARTICIPATIVE MANAGEMENT) + 0.133 (PRELIMINARY RESEARCH ON PROJECT REQUIREMENTS) – 0.1612 (BOARD OF DIRECTORS' COMPETENCE) + 0.21847 (SPECIAL CIRCUMSTANCES)

The following three predictors; *HRM aspects*, *overcoming local resistance,* and *shareholder influence* were eliminated from the final model through stepwise regression (see Appendix D, Table 14) because they were not very useful predictors in this model.

7.5.2.3 Local Goods Demand Model

To predict the probability of generating positive CREP impacts through the economic impact criterion of *high demand* for local goods during project delivery, all seven CEBMoD components were used as predictors in backward stepwise regression (see Appendix D, Table 15). The regression did not return any variable local goods demand model. It may be that other factors not covered in this study would be more significant predictors for this model.

7.5.2.4 Energy Type Switch Model

Multiple regression analysis was also used to predict the probability of generating positive CREP impacts through the economic impact criterion of having a greater number of consumers switch from conventional to renewable energy suppliers. The stepwise method of variable selection was used to reduce the CEBMoD components from 7 to 2, namely, *board of directors' competence* and *special circumstances*. The main features of the model fitting are reported in Table 7.15.

Table 7.15: Regression analysis results for energy type switch

Residuals **Min**	**1Q**	**Median**	**3Q**	**Max**
-2.48687	-0.71992	0.03272	0.66593	1.97922
Coefficients:	**Estimate**	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	3.32638	0.33983	9.788	6.36e-16 ***
Board_of_DirectorsCompetence	-0.2063	0.09542	-2.162	0.03322 *
Special_Circumstances	0.2598	0.08534	3.044	0.00304 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				
Residual standard error: 1.026 on 92 degrees of freedom Multiple R^2: 0.1006, Adjusted R^2: 0.08104 *F*-statistic: 5.145 on 2 and 92 DF, *p*-value: 0.00762				

As can be seen in Table 7.15 above, the two predictor variables in the regression generated highly significant *p*-values of 0.03 and 0.003. Also, the R^2 value of 10.1% in this model seems quite significant compared to the *energy affordability* model in section 7.5.2.2. By implication, there is a relationship between the predictors and the response variable. The *F*-statistic of 5.145 on 2 and 92 DF further reveals the effect of the explanatory variables on the response variable. The expected mean value of response variable when all predictor variables equal zero was 3.33, while the regression coefficient estimates for the model predictors *board of directors' competence* and *special circumstances* were -0.21 and 0.26, respectively. Therefore, the complete regression equation for the *energy type switch* model is:

ENERGY TYPE SWITCH = 3.33 - 0.21 (BOARD OF DIRECTORS COMPETENCE) + 0.26 (SPECIAL CIRCUMSTANCES)

The following six predictors; *hrm aspects*, *overcoming local resistance*, *participative management*, *preliminary research on project requirements*, and *shareholder influence* were eliminated from the final model through stepwise regression (see Appendix D, Table 16) because they were not very useful predictors in this model.

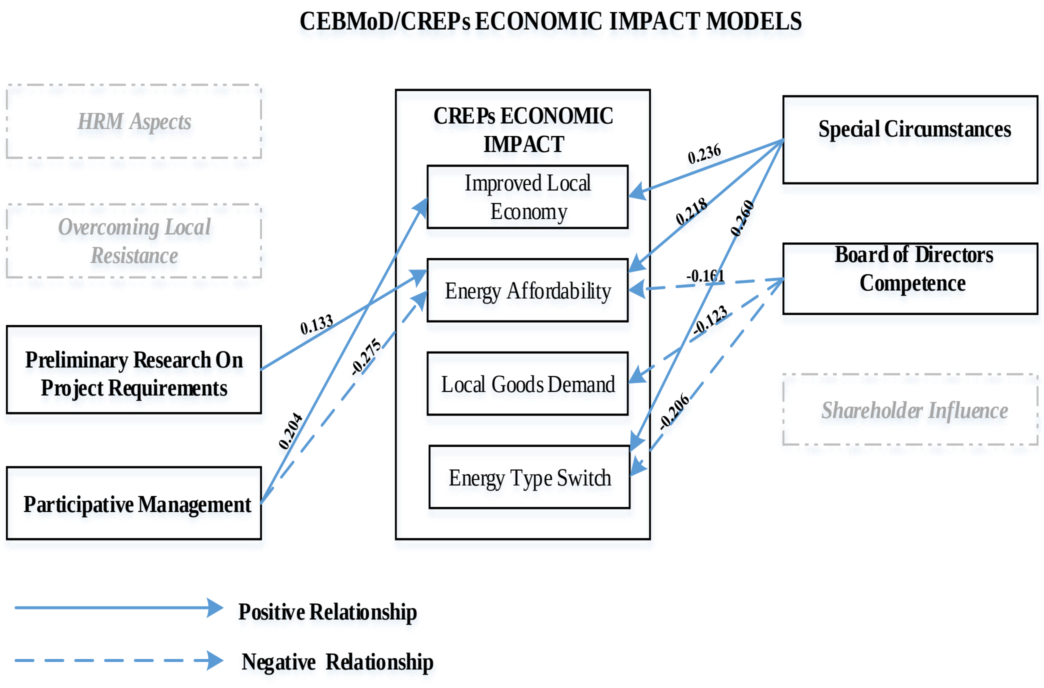

Figure 7.5: Pictorial representation of CREP economic impact regression results

7.5.3 *CREPs Environmental Impact Models*

Three components significantly described the environmental impacts anticipated from CREP development based on the PCA undertaken in Section 6.10.2.6.
The components are *health and safety, air pollution* and *visual aesthetics*. These are the dependent variables to be used individually against the CEBMoD components (as the independent variables) in the regression analysis below.

7.5.3.1 Health and Safety Model

In the CREP environmental impact analysis, the first relationship to be tested using MR is to predict the probability that the CEBMoD management structure and approach to CREP delivery can reduce risks to stakeholder health and safety before, during and after project development.

Again, the stepwise method of variable selection was used to reduce the predictors (CEBMoD components) from 7 to 2, namely, *preliminary research on project requirements* and *board of directors' competence*. The main features of the model fitting are reported in Table 7.16 below.

Table 7.16: Regression analysis results for health and safety

Residuals **Min**	**1Q**	**Median**	**3Q**	**Max**
-2.07419	-0.92728	-0.05267	1.13053	2.78868

Coefficients:	**Estimate**	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	2.71484	0.41675	6.514	3.82e-09 ***
PreliminaryResearchOnProjectRequirements	0.2948	0.09352	3.152	0.00219 **
Board_of_DirectorsCompetence	-0.27328	0.10192	-2.681	0.00869 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.192 on 92 degrees of freedom
Multiple R^2: 0.1439, Adjusted R^2: 0.1253
F-statistic: 7.733 on 2 and 92 DF, *p*-value: 0.0007869

It is apparent from this table that the model is good fit, as the predictor variables in the regression generated significant *p*-value ranging from 0.002 to 0.009. The model produced an R^2 value of 0.144 and *F*-statistic of 7.733 on 2 and 92 degrees of freedom, implying that, together, the predictor variables account for 14.4% of the variation in the model. Table 7.16 also provides the expected mean value of the response variable when all predictor variables equal zero, and the regression coefficient estimates for the model predictors. Based on this information, the complete regression equation for the *health* and *safety* model is:

HEALTH AND SAFETY = 2.71484 + 0.2948 (PRELIMINARY RESEARCH ON PROJECT REQUIREMENTS) – 0.27328 (BOARD OF DIRECTORS' COMPETENCE)

The following five predictors; *hrm aspects*, *overcoming local resistance*, *participative management*, *special circumstances*, and *shareholder influence* were eliminated from the final model through stepwise regression (see Appendix D, Table 17) because they were not very useful predictors in this model.

7.5.3.2 Air Pollution Model

The second environmental impact regression model estimates the probability that a CEBMoD's management structure and approach to CREP delivery can minimise air pollution during and after project development. Again, all seven CEBMoD components were included as predictors, with *air pollution* as the response variable in the multiple regression analysis.

Table 7.17: Regression analysis results for air pollution model

Residuals **Min**	**1Q**	**Median**	**3Q**	**Max**
-2.24552	-0.90433	-0.07492	-0.75448	2.26626
Coefficients:	**Estimate**	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	3.5867	0.32299	11.105	<2e-16 ***
Board_of_DirectorsCompetence	-0.17059	0.09153	-1.864	0.0655 .

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				
Residual standard error: 1.077 on 93 degrees of freedom Multiple R^2: 0.03601, Adjusted R^2: 0.02564 F-statistic: 3.474 on 1 and 93 DF, p-value: 0.0655				

The results, as shown in Table 7.17 above, indicate that *board of directors' competence* was the only significant predictor in the *air pollution* model. This model generated an R^2 value of 0.036, implying that *board of directors' competence* accounts for 3.6% of the variation in the model.

The table also provides the expected mean value of the response variable when all predictor variables equal zero, and the regression coefficient estimates for the model predictors. Based on this information, the complete regression equation for the air pollution model is

AIR POLLUTION = 3.5867– 0. 17059 (BOARD OF DIRECTORS' COMPETENCE)

The following six predictors; *HRM aspects, overcoming local resistance, participative management, preliminary research on project requirements, special circumstances*, and *shareholder influence* were eliminated from the final model through stepwise regression (see Appendix D, Table 18) because they were not very useful predictors in this model.

7.5.3.3 Visual Aesthetics Model

The third CREP environmental impact to be tested using MR was the probability that a CEBMoD's management structure and approach to CREP delivery can influence the design and final product installed, to ensure that it is aesthetically pleasing in appearance on completion. Using the stepwise variable selection method, the predictors (CEBMoD components) were reduced from 7 to 4, namely; *overcoming local resistance*, *preliminary research on project requirements, special circumstances*, and *shareholder influence*. The main features of the model fitting are reported in Table 7.18.

Table 7.18: Regression analysis results for the visual aesthetics model

Residuals **Min**	**1Q**	**Median**	**3Q**	**Max**
-2.2367	-0.6936	-0.1134	0.6955	2.2134
Coefficients:	**Estimate**	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	3.91348	0.42986	9.104	2.09e-14 ***
Overcoming_Local_Resistance	-0.18517	0.07657	-2.418	0.017610 *
PreliminaryResearchOnProjectRequirements	0.30495	0.07675	3.973	0.000143 ***
Special_Circumstances	-0.16302	0.0705	-2.312	0.023045 *
Shareholder_Influence	-0.18306	0.09605	-1.906	0.059849 .

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9093 on 90 degrees of freedom
Multiple R^2: 0.2185, Adjusted R^2: 0.1837
F-statistic: 6.29 on 4 and 90 DF, *p*-value: 0.0001649

Table 7.18 indicates that there was a good fit model, as the predictor variables in the regression generated significant *p*-values between 0.0001 and 0.06.
The model produced an R^2 value of 0.219 and *F*-statistic of 6.29 with 4 and 90 degrees of freedom, implying that, together, the predictor variables account for 22% of the variation in the model.

Table 7.18 also provides the expected mean value of the response variable when all predictor variables equal zero, and the regression coefficient estimates for the model predictors. Based on this information, the complete regression equation for the *visual aesthetics* model is:

VISUAL AESTHETICS = 3.91348 - 0.18517 (OVERCOMING LOCAL RESISTANCE) + 0.30495 (PRELIMINARY RESEARCH ON PROJECT REQUIREMENTS) - 0.16302 (SPECIAL CIRCUMSTANCES) - 0.18306 (SHAREHOLDER INFLUENCE)

The following three predictors; *HRM aspects*, *participative management* and *board of directors' competence* were eliminated from the final model through stepwise regression (see Appendix D, Table 19) because they were not very useful predictors.

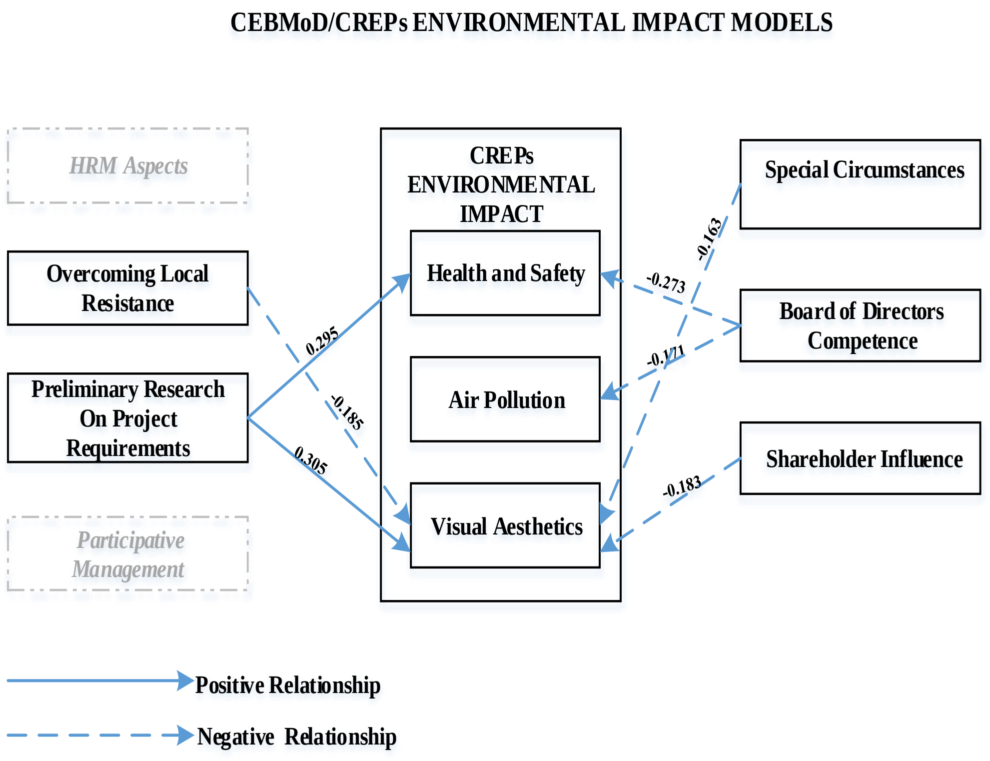

Figure 7.6: Pictorial representation of CREP environmental impact regression results

The sections that follow reports on the group of models developed for CREP social impacts.

7.5.4 *CREP Social Impact Models*

Following the PCA that was conducted to distil and classify CREP social impact factors into significant components, the results identified *local capacity building, local acceptance, job creation* and *fuel poverty reduction* as prominent social impacts generated by most CREPs in the UK (see Section 6.10.2.6).

There were no direct relationships between the independent variables (CEBMoD components) and social impacts (dependent variables) identified above. Therefore, multiple regression models were built to establish these relationships.

7.5.4.1 Local Capacity Building Model

The first regression model developed was for *local capacity building,* the purpose being to predict the probability that a CEBMoD's management structure and approach to CREP delivery enhances local capabilities and abilities. Using all seven CEBMoD components as predictors and *local capacity building* as the response variable, the multiple regression analysis indicated that only *preliminary research on project requirements* was significant. The main features of model fitting are reported in Table 7.19.

Table 7.19: Regression analysis results for local capacity building

Residuals **Min**	**1Q**	**Median**	**3Q**	**Max**
-2.835	-0.5992	0.165	0.7544	1.6365
Coefficients:	**Estimate**	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	4.30653	0.22116	19.473	< 2e-16 ***
PreliminaryResearchOnProjectRequirements	-0.23576	0.07398	-3.187	0.00196 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				
Residual standard error: 0.9489 on 93 degrees of freedom Multiple R^2: 0.09846, Adjusted R^2: 0.08876 F-statistic: 3.474 on 1 and 93 DF, p-value: 0.0655				

The *F*-statistic for this model, as shown in the table above, was significant at 3.474 with 1 and 93 degrees of freedom. The model produced an R^2 value of 0.10, an indicator that the predictor variable accounts for 10% of the variation in the model. The expected mean value of the response variable when all predictor variables equal zero was 4.30653, while the regression coefficient for *preliminary research on project requirements* was -0.23576. Based on this information, the complete regression equation for the *local capacity building model* is:

LOCAL CAPACITY BUILDING = 4.30653 - 0.23576 (PRELIMINARY RESEARCH ON PROJECT REQUIREMENTS)

The following six predictors; *HRM aspects, overcoming local resistance, participative management, board of directors' competence, special circumstances,* and *shareholder influence* were eliminated from the final model through stepwise regression (see Appendix D, Table 20) because they were not very useful predictors.

7.5.4.2 Local Acceptance Model

The second social impact regression model estimated the probability that a CEBMoD's management structure and approach to CREP delivery enhances the local acceptance of community energy projects. All seven CEBMoD components were included as predictors, along with *local acceptance* as the response variable in the multiple regression analysis.

Table 7.20: Regression analysis results for local acceptance

Residuals **Min**	**1Q**	**Median**	**3Q**	**Max**
-2.53073	-0.53909	0.03425	0.53713	1.60498
Coefficients:	**Estimate**	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	3.51957	0.3467	10.151	<2e-16 ***
Overcoming_Local_Resistance	-0.14129	0.07417	-1.905	0.0599 .
Special_Circumstances	0.14687	0.07203	2.039	0.0443 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				
Residual standard error: 0.9383 on 92 degrees of freedom Multiple R^2: 0.08971, Adjusted R^2: 0.06992 *F*-statistic: 4.534 on 2 and 92 DF, *p*-value: 0.01325				

The predictors *overcoming local resistance* and *special circumstances* were significant in the CREP *local acceptance* model. As can be seen in Table 7.20 above, the predictor variables generated a significant *p*-value of 0.013, indicating a relationship between the dependent and independent variables in regression analysis despite the low R^2 value of 9%.

Also, the *F*-statistic of 4.534 with 2 and 92 DF reveals that the explanatory variables affect the response variable. The expected mean value of the response variable when all predictor variables equal zero was 3.51957, while the regression coefficient estimates for the only model predictors, *overcoming local resistance* and *special circumstances*, were 0.141 and 0.147, respectively. Therefore, the complete regression equation for the *local acceptance* model is

LOCAL ACCEPTANCE = 3.520 - 0. 141 (OVERCOMING LOCAL RESISTANCE) + 0.147 (SPECIAL CIRCUMSTANCES)

The following five predictors; *HRM aspects*, *participative management*, *preliminary research on project requirements, board of directors' competence* and *shareholders' influence* were eliminated from the final model through stepwise regression (see Appendix D, Table 21) because they were not very useful predictors of *local acceptance*.

7.5.4.3 Job Creation Model

The third social impact regression model estimates the probability that a CEBMoD's management structure and approach to CREP delivery creates jobs for the host community. The regression did not produce any predictor variables for this model (see Appendix D, Table 22). A plausible explanation for such an occurrence is that other factors not covered in this research could be more useful predictors in the *job creation* model.

7.5.4.4 Fuel Poverty Reduction Model

Multiple regression analysis was used to predict the probability that the social impact criterion *achieving a greater degree of fuel poverty reduction* positively impacts CREPs. All seven CEBMoD components were entered into the model as predictors, while *fuel poverty reduction* was the response variable.

Through the stepwise regression method, *shareholders' influence* was the only significant predictor. The main features of the model fitting are reported in Table 7.21.

Table 7.21: Regression analysis results for fuel poverty reduction

Residuals **Min**	**1Q**	**Median**	**3Q**	**Max**
-2.3053	-0.4968	-0.1138	0.6947	1.6947
Coefficients:	**Estimate**	**Std Error**	**T value**	**Pr(>|t|)**
(Intercept)	3.87973	0.30367	12.776	<2e-16 ***
Shareholder_Influence	-0.19149	0.09608	-1.993	0.0492 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				
Residual standard error: 0.9315 on 93 degrees of freedom Multiple R^2: 0.04096, Adjusted R^2: 0.03065 F-statistic: 3.972 on 1 and 93 DF, p-value: 0.04919				

Table 8.21 indicates a good model fit. The predictor variable in the regression generated a borderline significant p-value of 0.05 and a low R^2 value of 0.041 produced by the model. The F-statistic was equally significant at 3.972 with 1 and 93 degrees of freedom. Table 7.21 also provides the expected mean value of the response variable when all predictor variables equal zero, and the regression coefficient estimates for the model predictors.

Based on this information, the complete regression equation for the fuel poverty reduction model is:

FUEL POVERTY REDUCTION = 3.880 – 0.191 (SHAREHOLDER INFLUENCE)

The following six predictors; *HRM aspects, overcoming local resistance, participative management, preliminary research on project requirements, board of directors' competence*, and *special circumstances* were eliminated from the final model through stepwise regression (see Appendix D, Table 23) because they were not very useful predictors.

CEBMoD/CREPs SOCIAL IMPACT MODELS

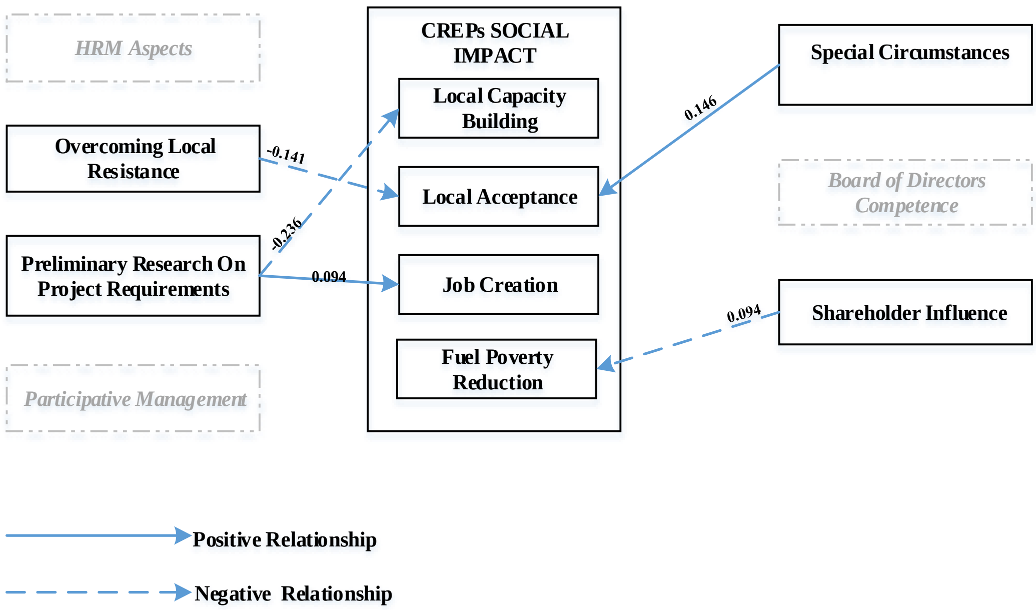

Figure 7.7: Pictorial representation of CREP environmental impact regression results.

The next section discusses the results of each of the above models.

7.6 Discussion of Multiple Regression Results

In Chapter 6 of this thesis, common factors influencing overall CREP success were categorised according to the planning, implementation, operational and disposal phases of project development. The PCA results obtained for each phase recommended extraction of four principal components (success indicators) for the planning phase, three components each for the implementation and operational phases, and two components for the CREPs disposal phase. Furthermore, the gains expected by stakeholders from CREPs were categorised into economic, environmental and social gains.

Application of PCA to each category led to the extraction of four components that exhaustively describe CREP economic impacts, three that describe environmental impacts and four that describe social impacts. The fourth objective of this research is to develop and evaluate a framework for the selection of appropriate CEBMoDs for the development of particular CREPs.

It was, however, important to, first and foremost, examine whether relationships exist between these components and the overall success of CREPs, as well as the anticipated economic, environmental and social impacts.

Therefore, multiple regression analysis was used to predict the probability of achieving CREP success, and how effective CEBMoDs and management structures contribute to it. Consequently, the set of the seven most parsimonious components of an effective CEBMoD and management structure were extracted through PCA (Section 6.11) and used as independent variables in the regression analyses. A number of regression models were developed, and significant predictors of CREP success at various phases were identified. The sections that follow present discussions on these models.

7.6.1 *Discussion on CREPs phases' regression models*

7.6.1.1 CREPs planning phase regression models

The first of the four regression models developed to ascertain CREP planning phase success was the *information management* model (see Section 7.4.2.1). The predictors *overcoming local resistance* and *shareholders' influence* were statistically significant in this model. In other words, for overcoming local resistance, more effort should be put into curbing public resistance to CREP development. More valuable information for addressing similar problems in future projects should be obtained.

This finding is consistent with that of Jami and Walsh (2017), who alleged that the level of public acceptance and participation in community energy activities depends on the extent of information available to stakeholders or distilled from them. One such source of exchanging CREP information is via political debates on renewable energy engagement, which has been a key attribute in curbing local resistance in Denmark (Sperling, 2017b).

There was no clear empirical evidence to support the assumption that community energy project shareholders can positively influence planning phase success through disseminating positive project information to the public. However, according to Joslin and Müller (2016), the overall success of any project can be linked to how well the shareholders interact with the parent organisation.

In other words, CREP shareholders can have a significant influence on the effectiveness of the CEBMoD's management structure and approach to CREP development by engaging regularly in productive dialogue and information sharing. This, in turn, will impact on overall project success.

The *market maturity* model (see Section 7.4.2.2) revealed that *HRM aspects*, *overcoming local resistance* and *participative management* were significant predictors of success at the CREP planning phase. *Market maturity*, in this context, addresses the extent of advancement in renewable energy storage devices. Although there are cost effective and efficient energy storage technologies available at the grid level, Gissey, Dodds and Radcliffe (2018) opined that the markets for wind and solar devices are more mature than those of other technologies, and suggested more regulatory support could enhance market growth. Schmidt et al. (2017) added that the allocation of more funds, quicker decision-making processes, and removal of possible institutional barriers could also improve the market.

Multiple regression analysis also revealed that the detailed assessment of renewable energy resources is vital to the success of CREPs. Studies thus far have linked the success of wind energy projects to detailed preliminary assessments of the wind resource (Murthy and Rahi, 2016; McCarthy and Thatcher, 2017). The assessment involves data collection on wind direction and speed, and the amount of energy that can be generated from the site. Similarly, data is readily available for solar radiation estimates.

These data are obtained from weather reports and radiation stations with instruments installed (Badescu, 2014; Teke, Yıldırım and Çelik, 2015; Wang et al., 2016). It is interesting to note that the global renewable energy generation potential has been captured in maps, particularly in regions where such resources occur in significant quantities (Pleßmann et al., 2014; Blechinger et al., 2016; Zheng et al., 2016)

Again, the regression results indicated that circumstances where the project organisers (CEBMoD board of directors) are knowledgeable about renewable energy technologies and the financial requirements of their development, the process of obtaining funds from lenders or other means would be easy. Since adequate or poor funding is critical to project success, Aquila et al. (2017) posits that for the CREP sector to expand beyond its current size, the rate of installation must cover technologies other than solar and wind, and will require additional financial investment. For instance, in the coming two decades, the UK electricity sector will require substantial financial investment according to studies conducted by several organisations, such as the DECC and National Grid (Ofgem, 2012).

7.6.1.2 CREPs implementation phase regression models

Another three regression models were developed for the CREP implementation phase, namely, the *conflict resolution, cash flow* and *local skill availability* models (see Section 7.4.3). The results for the conflict resolution model show that the competence level of a CEBMoD's board of directors is important for the quick resolution of issues (see Section 7.4.3.1). According to Larsen, Hansen and Nielsen (2018), conflicts may arise within an establishment (project organisation), if there is a deviation from the original project values and objectives.

In addition to conflict, trust has also been identified as a major determining factor in the success or failure of community engagements (Kadefors, 2004; Walker et al., 2010). It has also been empirically proven that CREP organisers are motivated by different incentives (Walker, 2008). While some invest in the project for financial gains, others do so for social cohesion or environmental sustainability, or combination of the above factors.

Conflict is a fundamental part of any social setting and CEBMoDs, being social platforms for CREP delivery, are susceptible to conflict. Kienast et al. (2017), recommend more research to fully understand conflict types, causes and consequences in CEBMoDs. Admittedly, unresolved conflicts can hinder project success; and project managers and sponsors (in this case, CEBMoD BoDs) have the responsibility to identify and resolve perceived or full-blown conflicts.

The cash flow model showed that *overcoming local resistance* was the predictor of CREP implementation phase success. The researcher found no empirical data to link the impacts of local resistance to CREP implementation on project cash flow. However, the absence of a relationship between the response and the predictor variables in this model does not in any way undermine its role in project success. CREPs are mostly funded through grants obtained from public and private financial support schemes, or bonds and shares offered to the public. It is expected that such funds be properly managed to avoid bankruptcy (Jong and Park, 2017).

Cash flow forecasting and management is one of the many ways of monitoring the impacts of payment delays, variations, price fluctuations and loan repayment plans on final project costs (De Marco and Mangano, 2017).

The last regression model developed for the CREP implementation phase was the *local skill availability* model (Section 7.4.3.3). The predictor *preliminary research on project requirements* turned out to be significant for the CREP *local skill availability* model. Every project is unique no matter its size and nature, and has specific requirements that must be met for them to succeed (van Veelen and Haggett, 2017).

Conducting preliminary research to understand these specific requirements is congruent to each project's success. This is what Kerzner (2017) termed best practice for successful project delivery. Some basic preliminary project requirements include, but are not limited to, employee skills (Raidén, Dainty and Neale, 2006), contractor expertise (Chan and Chan, 2004) cost, quality, time and design certainty (Hoxha and Baseel, 2017; Reza-Pour and Khalili-Damghani, 2017).

7.6.1.3 CREPs operational phase regression models

Regarding CREP operational phase success, three regression models: *local benefits, government regulations* and *technical complexities* were developed (see Section 7.4.4). Similar to the *local skills availability* model mentioned above, the predictor *preliminary research on project requirements* turned out to be significant in the CREP *local benefits* model. Most CREPs have been criticised and resisted by host communities for being noisy, destructive to the natural environment and, sometimes, not being aesthetically pleasing (Glasson, 2017).

In order to ameliorate these challenges to CREPs' expansion and acceptance, various compensation schemes have been introduced for the benefit of host communities (Kerr, Johnson and Weir, 2017). These benefits are introduced, discussed and agreed on by project stakeholders at the inception of projects, and formalised in what are widely regarded as community benefit agreements. The developers agree to set aside some proceeds from the project for use in championing whatever is of interest to the host community.

As can be seen from Section 7.4.4.2, *preliminary research on project requirements* and *shareholders' influence* appear to contribute to the *government regulations* model. In other words, government policies and regulations for the sector should be based on an understanding of the larger sector and specific project requirements. This agrees with the provisions of Annex 51 of the International Energy Agency's implementing agreement on *Energy in Buildings and Communities* published in 2013 (IEA-EBC, 2017).

This publication serves as a guidebook for the achievement of GHG emissions reductions through the implementation of a comprehensive renewable energy masterplan. Shareholders' influence has no significant influence on the policy direction of the sector but could be affected by the policies. This is evident in the model fit of $p > 0.05$ for this predictor. Furthermore, major CREP stakeholders have a role to play, particularly, when it comes to speaking up against unpopular policies, as in the case of the subsidy cuts and policy changes that generated great resistance in the UK in early 2016.

The last regression model developed for the CREP operational phase was the *technical complexities* model. What is surprising is that *shareholders' influence* had significant predictive power in this model. To the best of the researcher's knowledge, there is, so far, no empirical evidence to support this result. However, there is evidence to suggest that the solution to lingering global energy problems lies in overcoming certain complexities associated with project development, and in the acceleration of renewable energy investment (Bhattacharya *et al.*, 2016).

A lot of political, regulatory and technical complexities have been identified as hinderances to the expansion of this industry (Hvelplund, Østergaard and Meyer, 2017; Sen and Ganguly, 2017). Comparatively, the total output of electricity generated from renewable energy in a permitted floor area is far less than that generated from conventional technology (Yaqoot, Diwan and Kandpal, 2016). While RE resources are infinite in nature, their availability is somewhat intermittent and varies from place to place (Abujarad, Mustafa and Jamian, 2017).

This has necessitated the storage of energy generated at peak times for distribution and use during off-peak times. The complexities associated with these generation and storage technologies are enormous, and affect their design, performance, reliability, installation and maintenance.

Much of the current literature on renewable energy project complexities pays particular attention to the various ways that generation and consumption can be balanced to avoid wastage or shortages (Parra et al., 2017a, b; Zhang et al., 2017).

7.6.1.4 CREPs disposal phase regression models

The description and phasing of the project lifecycle differs according to the nature of the project, the organisers and the project needs. It is commonplace to find very detailed and sometimes complicated descriptions and sequences of project phases. The last phase of CREP development considered in this study is the disposal phase, which is termed "extended life cycle" in most projects. This phase is mostly omitted from project life cycle-related research such as this but is used in this study to prescribe the requirements of the final stage of projects.

To harness RE resources, manufacturing and installation of special technical devices is a requirement (Mitigation, 2011). Wind turbines, solar panels and hydropower turbines are common technical devices needed for the generation of RE from wind, sun and flowing water, respectively (Jacobsson and Bergek, 2004). On reaching their life expectancies, these installations need to be replaced or decommissioned, depending on the manufacturers' recommendations (Evans, Strezov and Evans, 2009) and/or stakeholders' preferences.

Weisser (2007a) stressed that information on the manufacturing, installation, maintenance, operation and final disposal or recycling of these devices must be detailed and kept up-to-date for future use. For instance, waste from the devices can be toxic to the environment if not properly disposed of (Sica et al., 2017). Improved stakeholder management approaches could be developed for future projects based on the extent of information contained in the end-of-life reports of other projects (Aaltonen and Kujala, 2010).

The predictors *HRM aspects, overcoming local resistance*, and *special circumstances* turned out to be significant in the CREP disposal phase *detailed completion reports* model. By implication, the skillsets and innovative solutions that contributed to, or were lacking in the project, as well as employee motivation and its impact on organisational performance, should be documented.

The final regression model developed to predict CREP success at the disposal phase was the *lessons learned* model. The insights gained from previously-executed projects are invaluable to future projects, whether the previous projects were successful or not (Anbari, 2018). The successful execution of CREPs requires the project team to learn from temporary setbacks and find solutions to problems. According to Mills et al. (2006), when all the challenges that impede previous projects are identified before the commencement of new projects, the fears of failure due to insufficient resources are eliminated.

There are, however, many useful websites where detailed real-life CREPs examples can be found, such as those of Community Energy England and Community Energy Scotland. Some of the lessons learned and useful recommendation for new developers can also be obtained. So much could be distilled from lessons learned regarding CREPs' scope, schedule, budget, collaboration, stakeholder relationships, internal organisational management, quality and risk (Boyd et al., 2009; Lund, 2010).

The predictors *overcoming local resistance, participative management* and *shareholders' influence* made significant contributions to the *lessons learned* model. Participative management is the underlying foundation for any community improvement initiative, be it for fuel poverty reduction, home insulation or energy generation. Similarly, Marroni and Asmus (2013) added that the success of local initiatives is built on the trust and support of local participants.

Owens and Driffill (2008) traced local resistance to the way that local people think about projects and their relevance to them individually and collectively. Breukers and Wolsink (2007) further added that local resistance could be triggered by how local people react to their thoughts which, in turn, appears as actual exhibition of resistive behaviours.

7.6.2 *Discussion on CREPs impacts regression models*

In section 7.5.2, 7.5.3 and 7.5.4, multiple regression analyses were used to estimate the probability of achieving the economic, environmental and social gains expected by stakeholders in CREPs, and how effective CEBMoD and management structures can contribute to these gains. These models are discussed below.

7.6.2.1 CREPs economic impact regression models

The first regression model developed to predict CREP economic impacts was the *improved local economy* model. Interestingly, *participative management* and *special circumstances* were considered to significantly improve host and surrounding communities' economies. This view is supported by Hiteva and Sovacool (2017), who write that although the effects of CREPs on local economies can be negative (e.g. by reducing agricultural activities), the positive impacts outweigh the negatives, particularly in generating local employment and enhancing employee pay rates (Brown et al., 2012).

Warner (2017) further acknowledges that the demand for basic construction materials and services will increase locally during CREP development. For CREPs to substantially improve any local economy, the local people must be willing to participate in their planning, development and operations and, if possible, own the project (Rupasingha, 2017). This is because CREPs have the tendency to create new energy markets locally and reduce the importation of fossil fuels.

The *energy affordability* model, being the next economic impact model, was significantly influenced by *participative management, preliminary research on project requirements, board of directors' competence,* and *special circumstances*. This finding agrees with Crowley and Jayawardena (2017), which showed that the growing energy affordability issues confronting consumers are caused by escalating conventional energy prices, while the repercussions of such price hikes are felt more by the poor, the old and other vulnerable groups.

There is, therefore, the need for these groups of individuals to participate in CREP development. Consequently, there have been government intervention programmes and projects designed to ameliorate these challenges. Renewable energy investment is one such intervention, which still requires huge amounts of money to generate the capacity demanded. The potential of CREPs to deliver affordable energy to public consumers has been acknowledged by practitioners as a major reason for their acceptance and for participation in CREP delivery, but there is very little empirical evidence to substantiate this, as admitted by Berka et al. (2017).

To predict the probability of generating positive CREP impacts through the economic impact criterion of high demand for local goods during project delivery, multiple regression was repeated with the seven CEBMoD components used as predictors. Backward stepwise regression was the variable selection approach used. The regression, however, did not return any significant variables. This may be explained by the possibility that factors not covered in this study would be more significant predictors in this model.

However, Warner (2017) posits that the construction industry spends approximately US$8 trillion globally on material purchases, and this includes goods manufactured or sourced locally or offshore. Irrespective of the low proportion of local construction goods consumed, a percentage of the global construction material expenditure will amount to something substantial locally.

The last regression model developed to predict CREP economic impacts was the *energy type switch* Model. As can be seen from the regression analysis results in Section 7.5.2.4, there is a prospect of generating positive CREP impacts through the economic impact factor of achieving a greater number of consumers who are willing to switch from conventional to renewable energy suppliers. In particular, the result suggests that the more competent the CEBMoD board of directors are, the less willing the people would be to switch from conventional fossil fuel-dominated energy sources.

This is a bit contradictory to practical reality, because in this research, a competent board of directors relates to a practical or theoretical skillset, and the expertise possessed by those overseeing projects. It has been noted that the level of managerial competence within an organisation is directly proportional to the organisation's overall competence (Turner, 2014).

The second predictor of this model, *special circumstances*, on the other hand, showed a positive relationship to *energy type switch*. *Special circumstances*, in this context, relates to adequate knowledge of evolving technology and the RE sector. According to Rezai and Van Der Ploeg (2017), the transition from fossil fuel-dominated energy resources to renewable energy ones is easier when more people are aware of dangers of the former and the benefits of the latter.

7.6.2.2 CREPs environmental impact regression models

Regarding CREP environmental impacts, three regression models, namely, *health and safety*, *air pollution* and *visual aesthetics*, were developed (see Section 7.4.3). The regression analysis revealed that if more preliminary research on project requirements is conducted before embarking on a project, most health and safety issues can be avoided. For instance, accident rates on project sites and in the construction industry in general tops those of other industries (Biswas, Bhattacharya and Bhattacharya, 2017). Consequently, several studies have been conducted to proffer solutions to these problems (Grill et al., 2017; Manu, 2017).

In the CREPs sector, there are few H&S regulations and guidelines because the sector is emerging and deploys various technologies in project delivery. As the sector grows, the project-location and technology-specific hazards also increase, placing great responsibility on major stakeholders to identify H&S gaps and tailor mitigation measures (Behm and Pearce, 2017). Similar to the *energy type switch* model, the level of *board of directors' competence* did not show a significant relationship with H&S. This is also very surprising, because an incompetent management is a great risk to all aspects of project management and success (Ansah and Sorooshian, 2018).

Multiple regression analysis on CREP environmental impacts further revealed that highly competent CEBMoD directorate board tends to have less impact on *air pollution* during CREP development. The construction phases of CREPs are not totally free from dust (air) pollution, as pointed out by Zuo et al. (2017). Most project management plans do not incorporate dust pollution as a major task. Wu, Zhang and Wu (2016) warned that dust exposure levels of 0.1 mg/m^3 and above can affect site employees and neighbours.

The last regression model developed to predict CREP environmental impacts was the *visual aesthetics* model. The regression results confirm the existence of a positive relationship between *preliminary research into project requirements* and *visual aesthetics*. The visual impact of renewable energy technologies (RETs) is a major factor considered by local authorities before planning consent is issued to project organisers (especially for onshore wind projects; Sklenicka and Zouhar, 2018). It is also a major concern to host and neighbouring communities (Harper et al., 2017).

There has been so much public resentment towards CREPs, especially wind technology, as a result of noise from the rotor blades and high mortality rates of birds and bats (Firestone et al., 2017). These concerns have heightened the need for continuous research on how to improve the design and manufacturing of wind turbines for future projects (van Grieken and Dower, 2017). The results also showed a negative relationship between *overcoming local resistance, special circumstances, shareholder influence* and *visual aesthetics.*

7.6.2.3 CREPs social impact regression models

The last group of regression models were for *local capacity building, local acceptance, job creation* and *fuel poverty reduction*. These models were developed to predict the most social impact CREP stakeholders expect from project development (see Section 7.5). The first regression results in this category confirmed the existence of a negative relationship between *preliminary research on project requirements* and *local capacity building*. In other words, inexperienced locals can start up the project and learn on the job to develop and strengthen capacity, though with some external support (Van Der Schoor and Scholtens, 2015).

Local capacity, as used in this research, relates to the development of new and existing technical and organisational skills necessary for the delivery and operation of CREPs amongst local people. Local people invest and participate in CREPs for different reasons, some for environmental sustainability (Hoffman and High-Pippert, 2010), some for fun, while a few engage for the long-term benefits of building a career from it (Walker et al., 2007; Seyfang, Park and Smith, 2013).

According to Seyfang, Park and Smith (2013), the sector is mostly dominated by volunteer retirees and the impact of this over time would be a shortage of human capacity to expand the market. Again, one major objective of CREPs is to curb the rural-to-urban migration of youth by providing socially-engaging benefits and creating jobs (Uzzell, Pol and Badenas, 2002). There is, however, a general disinterest in CREPs among the younger local population. One way to address this is to provide training about emerging trends in the industry, especially in CREP technical requirements, organisation and operations (Forman, 2017).

Furthermore, every barrier to CREP participation needs to be disrupted or replaced with a more flexible and engaging one (Becker, Kunze and Vancea, 2017). The local acceptance model in Section 7.5.4 revealed that *overcoming local resistance* and *special circumstances* contributed to the model's overall fit. This result corroborates the ideas of Süsser and Kannen (2017), who suggested that CREPs have contributed to reductions of GHG emissions globally, and contribute to the rich energy mixes of many countries. They further advised that for this progress to be sustained, the market needs to be expanded and, by implication, the technical, environmental, economic and social barriers to expansion must be tackled.

From the social point of view, citizens' acceptance of the expansion of existing projects or the initiation of new ones is crucial to achieving market expansion (Wüstenhagen, Wolsink and Bürer, 2007). In a recent study conducted by Langer et al. (2018) to gauge the experiences of citizens living near wind energy installations in Germany, it was discovered that people are still concerned about the long-term health implications of the low-frequency sound produced constantly by the wind turbines.

In a similar study in Switzerland, Fytili and Zabaniotou (2017) reported that local acceptance depends on the attitudes of the people towards the projects, as most citizens are interested in the benefits they obtain from the projects rather than the negative consequences. The regression for the third social impact assessment model, which was the *job creation* model, did not produce any predictor variables. Apparently, other factors not covered in this research could be more useful predictors of *job creation*.

That notwithstanding, most arguments in favour of CREP deployment can be traced to their contributions to employment generation (Becker, Kunze and Vancea, 2017). According to Wei, Patadia and Kammen (2010), when the rate of job losses in the coal and natural gas sectors increases, the RE sector creates more jobs. Several studies thus far acknowledge this fact (Singh and Fehrs, 2001; Thornley, Rogers and Huang, 2008; del Carmen, 2017; Hondo and Moriizumi, 2017), although they employed contradicting methodology.

As a result, there has been little agreement on the quantities of jobs created by each technology. However, if governments can be more committed to promoting policies that strengthen local and state engagement in CREPs, more jobs will become available (Lee, 2017).

The fourth and the last regression result in this category confirmed the existence of a negative relationship between *shareholders' influence* and *fuel poverty reduction*. The result can be interpreted to mean that fuel poverty indicators, such as household income and energy consumption costs, should have been included in the model as predictor variables. It has been reported that millions of lives are affected by fuel poverty (Healy, 2017), which is the situation where energy expenditure is greater than 10% of household income (Fuel Poverty UK, 2018).

In England alone, approximately 2.5 million families are living under this condition (Mattioli, Lucas and Marsden, 2017), with the under-educated and retirees dominating this group. Various intervention programmes, such as neighbourhood renewal and energy efficiency measures, have been introduced to reduce fuel poverty, because houses with uninsulated walls require more energy to heat them. CREPs are overwhelmingly recognised as platforms for reducing overarching fuel poverty (DECC, 2013). This includes helping locals reduce energy use, tackling climate change and making buildings more energy efficient.

It is important to reemphasise at this point that the generalisability of these results is subject to certain limitations. For instance, most of the R^2-values in the regression models were low and, by implication, the predictors influenced the models less than expected. Garson (2012), however, posits that R^2 alone does not define the quality of regression model predictions, and further advised that residual plots should be examined. A notable example of related research with low R^2 is the work by Omoregie (2006). The plots produced in Appendix E did not violate any of the regression assumptions.

7.7 Summary

This chapter began by calculating Pearson product-moment correlation coefficients and performing multiple regression analyses on the CEBMoD components and CREP performance factors obtained in Chapter 6. The purpose of these analyses was to figure out which CEBMoD component best predicts CREP success in each of the development phases, as well as the social, economic and environmental impacts desired by project stakeholders.

From the results obtained, there is evidence suggesting that various CEBMoD components contribute to CREP success. A total of twenty-three models were tested, four for planning phase, three for the implementation and operational phases, respectively, and two for the disposal phase. The other eleven models focused on testing CREP impacts. It is also worth noting that the regression results obtained did not produce any predictor variables for the *resource assessment and project finance* (planning phase) model or the *local goods demand* and *job creation* (impact assessment) models. There are several possible explanations for these results. For instance, other factors not covered in this research could be more useful predictors of these models. The principal issues and suggestions which have arisen in this chapter were used in Chapter 9 to develop a framework for the selection of an appropriate CEBMoD for the development of particular CREPs. First, the next chapter will extensively discuss the technique adopted for the analysis of the qualitative data collected. Useful findings relevant to the research problems will also be discussed and related to the secondary data obtained from the literature.

CHAPTER 8: CASE STUDY INTERVIEWS: ANALYSIS AND DISCUSSION

8.1 Introduction

Having analysed and discussed the questionnaire results in Chapter 6, Chapter 7 conducted Pearson product-moment correlation coefficient (PPMCC) and multiple regression analyses to determine which community energy business model (CEBMoD) components best predict the success of community renewable energy projects (CREPs) in each of the development phases, and affect the social, economic and environmental aims set by project stakeholders. This concludes the quantitative data analysis and discussion. This chapter presents the results of the interviews conducted on selected case studies. Some directors sitting on the boards of selected CEBMoDs, and key personnel from CREP support organisations in Scotland, were interviewed to gain broad expert opinions into how CEBMoDs could be effectively structured to deliver CREP goals. The interview outcomes are also used in Chapter 9 to develop a framework for the selection of appropriate CEBMoDs for the development of particular CREPs.

8.2 Qualitative Data Collection and Analysis Procedures

As already emphasised in chapter 5, semi-structured interview was the data collection method deployed for the qualitative strand of this study. The choice of this method was based on its flexibility to draw expected, unexpected and useful insights from the interviewees on particular questions (Creswell, 2007). Moreover, in the history of organisational research, interviews have been thought of as the most effective and widely adopted strategy for qualitative data collection (Barriball and While, 1994).

The questions were designed to draw information on the operational efficiency of incumbent CEBMoDs in the UK (see Appendix B for the interview protocol). Prior to the interviews, letters requesting that the interviewees participate in the interviews were sent to trustee directors and members managing various CREPs. These CREPs used the five CEBMoDs identified for this research: the *cooperative* (Coop), *social enterprise* (SocEnt), *community interest company* (CIC), *community charity* (ComCha) and *development trust* (DevTru) models.

The set of participants contacted were believed to be experienced professionals in renewable energy development in the UK, with proven expertise in the community energy sector and, hence, could provide valid information on a variety of ownership models and projects. After two email reminders at two-week intervals, eleven CREP experts, drawn mostly from community energy cooperatives, development trusts and third-party organisations, indicated interest in the study and were interviewed. Care must be taken by researchers not to overgeneralise interview outcomes to other ownership models. As contained in the interview protocol, some personal questions were asked covering aspects such as participants' professional experience and backgrounds, and how these have led to their involvement in community energy projects.

From the ownership model point of view, the researcher sought to know more about the various CEBMoD structures that participants were experienced in, their individual and collective roles, and how these impact CREP outcomes. As part of ethical research considerations, the interviewees were assured that the publication of their interview results would be anonymised and exclude any identifying information.

To reduce costs and save time, ten participants were interviewed over the phone, while one was happy to attend to the researcher's office. With their consent and approval, each conversation was recorded using a digital voice recorder (Sony ICD-PX333D). In addition to the voice recordings and, as postulated by Cachia and Millward (2011), a complementary strategy of noting down vital emerging and already established themes relating to each question was deployed by the researcher to ensure no aspect of the interview was missed.

8.3 Case selection and presentation

To fully address the overarching question underpinning this research, it was important to choose cases (CEBMoDs) from a pool of possible alternatives (alternative ownership models deployed by community energy groups). Therefore, the research explored various rationales of case selection principles, particularly their suitability to the general research concept of analytical generalisation. Although these principles are contestable, Curtis et al. (2000) argue that some aspects of the many sampling principles available can be distilled for general applicability. The case sampling approach used for this research adopted the sampling criteria proposed by Miles and Huberman (1994).

This was discussed in Chapter 5. Brief profiles of the interviewees and their organisations are described for each case below.

8.3.1 *Case 1*

Case 1 was a consortium of organisations comprising four Scottish charities, which will be referred to as Charities A-D. The consortium relies solely on external technical consultants for technical support. The consortium works with enthusiastic local charities to deliver CREPs and related activities locally, and benefit from those local networks. Their activities occur across Scotland, and the lead charity in the consortium (Charity A) is responsible for programme management, fund management, and the design of work strategies. This structure is made clear to people engaging with them from the outset. The interviewee for Case 1 had worked in energy efficiency, micro generation and support companies for fifteen years (1998-2013), before taking a management role at Charity A.

The interviewee is currently in charge of assessing the credibility of community groups seeking grants and loans from the consortium. He provides advice on how communities can develop projects. Prior to this role, he was involved in renewable energy projects in community buildings on a domestic scale, looking at how micro-generation could be used to tackle fuel poverty. His background has been in energy and project management since about 1998, with a real focus on community energy since 2013.

8.3.2 *Case 2*

Case 2 was an integrated investment organisation made up of several CREP cooperatives (and still growing). The main responsibilities of this organisation are to help local people form community-centred cooperatives, raise funds for CREPs, initiate and supervise construction, and provide long-term production management expertise. In other words, the investment organisation does not own the cooperatives, rather, all the cooperatives supported by this organisation own shares in it. To meet the research aims and objectives, interviewees were drawn only from community-centred cooperatives and not from other structures or the mother organisation. The community-centred cooperatives are structured such that it allows each member to buy a share in the project.

The project then produces income and the cooperative (coop) members gain their respective shares of that income. Six experts from community-centred coops were interviewed for Case 2, and below is a brief description of their respective areas of expertise and what informed their interest in CREPs.

Interviewee 1 for Case 2 worked in the environmental area for over ten years but his first role in the renewable energy sector was in 2011 as an investor in a cooperative-owned wind turbine. Although he is passionate about community energy, it was the contribution to the environment that endeared him to community energy, rather than any prospect of income.

Interviewee 2 was a retiree whose interest in CREPs was triggered by living close to where a wind farm was being built. He decided to take an interest in the cooperative element of the project. Prior to this, however, he had no experience in renewable energy at all, but was quite knowledgeable about what is happening in Scotland in terms of CREPs and related activities. His management skills qualified him to be elected a director of one of the community energy boards.

Interviewee 3 was a chartered civil engineer with over 30 years' interest in sustainable energy activities. His involvement in the local cooperative basically came about because of where he lived and the opportunity to have part-ownership of the local wind farm.

Interviewee 4 was a graduate of Oxford University with a degree in engineering science; he worked with a UK electricity company for nineteen years on power generation projects, mostly gas turbines. He also served in the commercial side of the company selling gas turbines, principally to Middle Eastern and African countries. He volunteered for the board of the co-operative, was eventually elected in 2010, and has been its Chairman since 2013.

Interviewee 5 holds a PhD in social anthropology and specialises in sociology and anthropology finance, with an interest in any form of financing or alternative forms of cooperative organisation. Professionally, he worked for five years (from 1998-2003) in London where he was a housing investment fund manager and invested in UK equity. One of his industry sector responsibilities was in electrical utilities.

He has an in-depth understanding of how the regulatory framework works, the generation market, and how the British electricity industry was privatised in the 1980s and 1990s.

Interviewee 6 was a community mobiliser and project manager who had been working in the CREP sector since 2003. He partnered with various local authorities in Scotland to develop various programmes to help local people execute CREPs. He visits communities that are interested in renewable energy projects to help them develop them.

8.3.3 *Case 3*

Case 3 operated as a trading subsidiary of a charity, which is the standard way most development trusts are set up. The trading company takes all the project risks and rewards and then all the profits and spare cash are gifted to the parent company, which is the charity. The interviewee for Case 3 was not enrolled in the trust board but works daily in the office (9 am – 5 pm). His role is to ensure that the project happens (i.e. the turbines are successfully installed, and all the funding is in place). His background is much more in building and construction management rather than planning windfarms, having worked as an in-house project manager in the public sector for twelve years.

8.3.4 *Case 4*

Case 4 was also a development trust whose aim is to protect the way of life of local people by promoting development that is sustainable in terms of keeping the population steady or allowing slow increases in growth that are sustainable for the locality. The trust comprised a lot of other community groups involved in several areas of community-centred engagements, such as farming, cattle rearing, conserving the local habitat and wildlife, and generation of renewable energy, amongst many others.

The trust was borne out of the need for a robust income stream that was independent of mainland funders or the council. Already, the village is dependent on the council to provide schools, medical facilities and other basic social amenities, which are obviously important. However, the local people realised that over-reliance on money coming from outside is not good and, at times, access to such money can be tight, as it is now.

The trust was, therefore, set up as a means of exploring avenues to generate income locally that could then be used to bridge funding gaps for local projects. Two interviewees were selected from the renewable energy sub-group of the trust.

Interviewee 1 worked as a conservation officer for fifteen years. He used his experience to work out the best locations for wind turbines to ensure minimum impacts on birdlife and local people. He volunteered as the Vice Chairman of the trust, because he was passionate about seeing that the local population is not depleted and that are jobs available so that people can stay and collectively build a more robust local economy. Interviewee 2 qualified as a chartered accountant in 1989 and joined the trust board in 2006 as a volunteer accountant at the request of another board member. She handles all the financial and secretarial responsibilities of the trust.

8.3.5 *Case 5*

Case 5 was a development trust registered as a charity and a company limited by guarantee. It was established in the early 1990s as a community body interested in tackling the declining population of the island where it operates. Somewhere along the line, the trustee members identified that they needed an income stream and, together, they took advantage of some funding that was available, lottery money called Growing Community Assets. They applied for that, were successful, teamed up with a group of other developers on the island, and invited a wind generator company to consider coming up to the island to erect a wind turbine.

The project started operating in 2009 and has since been generating income for the trust's 280 members and the community. The interviewee for Case 5 was a retired naval officer. While in the navy, he undertook a degree programme in community development, which led to him working with communities who were dependent on grants to achieve their goals. On retiring from the navy, he volunteered for four different development trusts.

Table 8.1: Profile of interviewees for the five cases

Participants	Interviewee's role in CREPs	Profession	Years of experience in REPs	Interview duration
1	Project Manager	Project Management	17	40 minutes
2	Investor	Environmentalist	06	35 minutes
3	Board chairman	Retiree	08	20 minutes
4	Board Member	Retiree	08	25 minutes
5	Board Member	Investment Fund Manager	06	35 minutes
6	Project Manager	Project Management	14	50 minutes
7	Construction Manager	Construction Management	07	43 minutes
8	Board vice chairman	Conservation Officer	14	54 minutes
9	Board treasurer	Chartered Accountant	11	30 minutes
10	Board chairman	Electrical Engineer	12	30 minutes
11	Volunteer Staff	Retiree	10	64 minutes

8.4 Data Analysis Procedures

In construction management research, *content analysis, narrative analysis, discourse analysis and grounded theory* are commonly used qualitative data analysis methods (Roberts and Pettigrew, 2007). The goals, advantages and disadvantages of each of the methods are briefly discussed in Table 8.2.

Table 8.2: Overview of qualitative data analysis methods, goals, advantages and disadvantages [Source: Downe-Wamboldt, 1992; Miles and Huberman, 1994; Roberts and Pettigrew, 2007]

SN	Qualitative data analysis methods	Goal	Advantages	Disadvantages
1	Content Analysis	It seeks to unravel what concept exists and the relationship and frequency of such concepts in human communication. It makes use of recorded human communication such as recorded face-to-face interviews, videos, books and so on.	• It can be used for both qualitative and quantitative research. • It can be used to simplify the complexities in human communication.	• It can be time consuming. • Prone to coding error.
2	Narrative Analysis	In narrative analysis, the researcher interprets and use stories told by other people in a different context. This is usually done in collaboration with the owner of the stories because the outcome of the analysis always reflects the different experience of the story tellers.	• The researcher and the story teller collaborate to drive the research. • It focuses on specific, real-life situations, rather than theoretical abstractions.	• There might be problems with ownership of the interpreted story after the research. • It is difficult to substantiate the trueness of the original story.
3	Discourse Analysis	Discourse Analysis focuses on analysing the structure and functions of spoken language within a social context.	• It is practical, relevant and very specific to the context analysed per time.	• The approach to addressing research problems

			• It enables the researcher to capture a detailed overview of the research problem.	is not based on scientific research. • Due to its several approaches to solving research problems, it is difficult to link it to a particular research philosophy.
4	Grounded Theory	It focuses on generating theories from systematically collected and rigorously analysed data.	• It is a flexible analysis method that can respond and change as conditions that affect phenomena change. • It is better at determining what happens.	• Sometimes, the data generated for analysis becomes too large for the researcher to manage. • It has no laid down rules to be followed in data categorization.

The common purpose of each method of analysis highlighted above is, to present the outcome of analysis in such a way that the reader is able to understand the basis of interpretations (Bowen, 2009). Since the researcher was investigating the impacts of CEBMoD effectiveness on the nature and performance of CREPs.

There was a need to derive this understanding through concepts/themes that relate to the investigations from the views, attitudes and opinions of the directors of various CEBMoD board, and other CREPs stakeholders. *Content analysis* being a systematically coding and categorizing method of concepts and relationships in textual data (Joffe and Yardley, 2004), was adopted for the analysis of the interviews conducted.

This is because, *content analysis* is widely accepted and used by qualitative research social constructionist (Life, 1994; Marshall and Rossman, 2014; Taylor, Bogdan and DeVault, 2015). In addition, data generated through spoken or written acts are best analysed through this method (Wodak and Meyer, 2009).

Neuendorf (2016), posits that when critical and relevant steps are taken to distil, analyse, (not undermining homogeneity of) data, then *content analysis* can yield valid research outcomes.

8.5 Steps of content analysis

The strength of *content analysis* lies in its stringent procedural step by step analysis of information (Downe-Wamboldt, 1992). In this research, the analysis of the interview contents followed the steps thus:

8.5.1 *Step 1: Preparation of data*

Before meaningful inference can be drawn from the recorded interviews, the first thing to do was to transcribe the interview. In line with Marshall and Rossman (2014)'s suggestion, every observation and verbalizations in the data were transcribed verbatim. This practice allowed the researcher to have a good grasp on all the interview contents, before defining themes and classifying contents according to the themes.

8.5.2 *Step 2: Coding and categorization of themes and concepts*

Having completed the interview transcription, the next step was to deduce common or contrary themes/concepts, and code them into categories and sub-categories based on the research objectives. According to Joffe and Yardley (2004), the categories and codes can be developed based on either deductive, inductive or combination of both research approaches. Neuendorf (2016) added that deductive codes are developed from existing theories in the research area, while the inductive codes can be developed from the primary data. The latter applies to the coding pattern used in the transcribed interview data analysis. NVivo 12 qualitative data analysis (QDA) computer software package was employed to facilitate the analysis.

8.5.3 *Step 3: Presentation of result*

This involves reporting on the inferences drawn on the basis of coding, organising, linking, and exploring of the interview transcripts and notes. According to Saunders, et al. (2012), results should be presented in such a way that the reader is able to understand the basis of interpretations, for instance, through concept, mind or project maps (see

Figure 8.1). Please refer to appendix F for a full schedule that guided the interview process and next section for discussion on the interview findings.

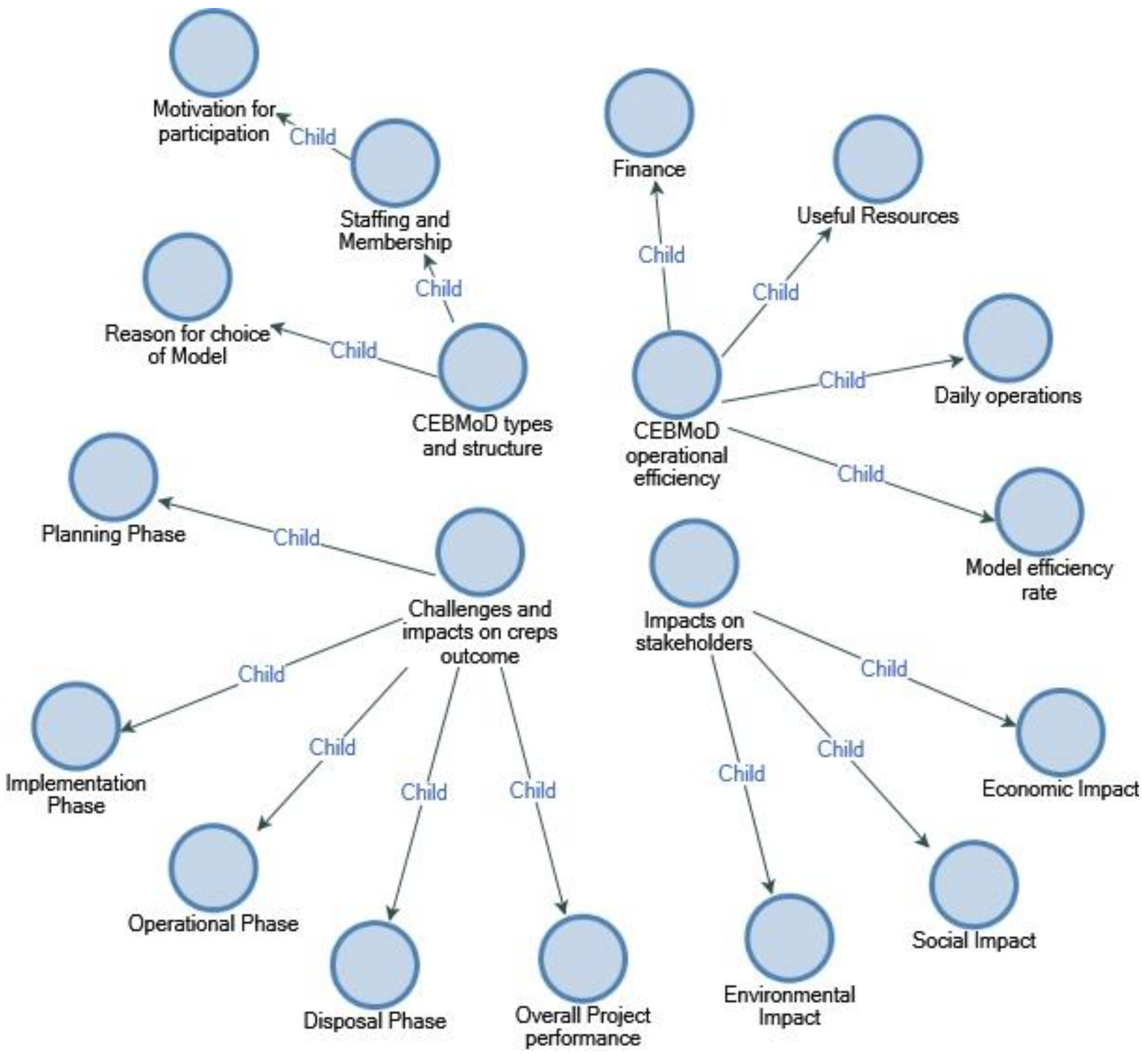

Figure 8.1: Themes and sub-themes relevant to the research objectives as identified by interviewees (NVivo QDA output).

8.6 Discussion of interview findings

Having completed the coding of responses from interviewees and organising them into appropriate themes and sub-themes. The sections below present key findings from these themes

8.6.1 *Understanding incumbent CEBMoD types and structures in the UK*

In the researcher's quest to understand the types and structures of incumbent CEBMoDs from a practitioner's point of view, interviewees were asked to describe their organisation, its structure and engagements. A range of views were expressed in response to this question, including the following quotations from interviewees.

"…we are a support organisation working alongside the government to deliver Community and Renewable Energy Schemes (CARES)".

"…we are a development trust with focus on generating benefits for its members and the local community. Any member of the community can apply to the trust for funding assistance on a range of projects to a range of budget streams that we have developed".

"… we are a charity structured as a development trust with voluntary group of directors and a non-executive chairman who only leads the meeting and all decisions are very much joint decisions and, unlike some boards where the chairman decides, and the others are sort of guided by him, it's a very democratic process with us".

"…we are a subsidiary of a charity, we are the trading subsidiary of a charity, and there is a trading company that takes all the project risks on behalf of the parent company, which is the charity".

The expert opinions expressed above further support the assertions by the UK Department for Energy and Climate Change (DECC) contained in the *UK Community Energy Strategy* published in 2013, that most of these community-owned endeavours were created in response to perceived or anticipated local economic benefits and, therefore, were structured to fit the problems they were intended to solve. In terms of the CEBMoD activities and engagements, it is essentially their respective boards of volunteer directors that spearhead these.

Their main role is to ensure that shareholders are looked after, and they achieve this by ensuring that the generation plants are operating at their best possible level of performance. However, some of these boards rely on externally contracted experts who, more or less, manage the projects. One of the directors interviewed had the following to say:

"…In terms of my team, there is a mix of full-time and part-time staff and we communicate through fortnightly calls and quarterly; so, every three months, we get together as a team. And we obviously work closely to support projects".

A few interviewees worked for CREP support organisations either independently or through the government. One interviewee in this category stated:

"…we have got a team across Scotland and they go out and support communities. We have development officers, but locally-based, who will support communities and work alongside them and attend community meetings and support communities to develop and manage their projects".

Another commented: "*we are slightly different than a community group, we are a support service and funded through the Scottish Government to provide specialist service to the community".*

The above statements suggest the existence of a variety of CEBMoD structures, project arrangements and participant engagement. For the community-centred CEBMoDs with volunteer directors, their activities revolve around the scrutiny of the monthly reports submitted by the contracted project managers and plant operators.

These reports highlight what the performance level was, what the problems were, and so on. Clarification is sought where doubt about any aspect of the report exists. As aptly acknowledged by one of the directors interviewed:

"...we have, not every time though, observed a few problems from the reports we receive, which we asked them to explain and try and understand and, because of that, we ended up with some compensation payments from the plant operators. I cannot go into too many details, because it is confidential".

In summary, every CEBMoD is structured to deliver the goals set out by the CREP it seeks to develop, and there is a unifying responsibility to maximise the opportunities for shareholders by giving them good returns their investments, as well as ensuring that all stakeholders are satisfied. It is, therefore, likely that CEBMoD board structures affect CREPs.

8.6.2 *The strengths and other aspects of the operational efficiency of case study CEBMoDs*

In response to the question about what constitutes the strengths of a particular CEBMoD over others, and whether each case has aspects of its management structure and approach to CREP development that could be adopted for future use, a range of responses was elicited. A common view amongst the responses received was that the strength of any model lies in its people and skillsets, and that a lot of communities' struggle to drive a delicate CREP which, most times, may take up to five or six years to actualise. This is where more dedicated local volunteers are needed to avoid volunteer fatigue, as one interviewee put it:

"…when it is just five of you, there is high possibility of early fatigue and feelings of frustration because of the difficulty to spread the load. Whereas, if there are ten of you, you can swap and one day it's somebody sorting out the legal paperwork and another day it is somebody working out what the gravel path's going to look like, you need to have a big committed team".

In one of the case CEBMoDs studied, there were two investment bankers, some accountants, a logistics expert, a conservation officer, two builders and a computer specialist sitting as ordinary members or directors of the board. This was a near-perfect team for driving a CREP, and is consistent with existing research on the importance of having robust skillsets in project endeavours (Kerzner, 2018).

A further instance on what constitutes the strength of a particular CEBMoD is the transparency of the contractor selection process, because funding for CREPs is sourced from lottery funds, share offers and so on. The board must be very careful about ensuring that invitation to tender are put out for competitive bidding.

This supports Waara and Bröchner's (2006) opinion that estimates must be obtained from at least three different contractors. So that the process is completely transparent, the bids received are assessed based on contractors' proximity to the project, the cost tendered and the quality of the work that they are going be executing.

In their accounts of the events surrounding aspects of CEBMoD management structures and approaches to CREP development that can be adopted for future use, the majority of interviewees agreed that it is important to ensure that the three longest-serving directors stand down each year.

This decision must be taken at the annual general meetings (AGMs) of the board. This offers opportunities to new volunteers—preferably younger people—to be voted onto the board. Furthermore, it is important, right from the outset when the CEBMoD is set up, to seek as much legal input from a solicitor as possible. This will keep the board consistent on memorandums and articles of association, and all other rules of engagement.

However, in cases where the CEBMoD is the trading subsidiary of a parent charity, a high possibility of conflict of interest may exist amongst directors, and this must be checked. For instance, it is possible to have one person sitting as director on both, as one of the interviewees claimed:

"... I am one of the directors on the parent charity and director of the trust. So, when I am at the parent charity I must be its director and when I am at the trust I must be a trust director. And you sometimes may forget to put the right hat on"

Such conflict can occur, for example, when there is a need to service the generation plant, as parent charity directors have a funding approval role. At the same time, trust directors must ensure there are funds in reserve to look after community projects.

8.6.3 *CEBMoD challenges and impacts on CREP outcomes*

This theme came up, for example, in the discussions of Bauwens, Gotchev and Holstenkamp (2016), Klein and Coffey (2016) and Fast et al. (2016). Whilst a minority of interviewees asserted the non-existence of challenges to their respective CEBMoDs, others referred to several challenges they faced.

At inception, delays in obtaining planning approvals seemed to be common issues faced by most private operators. In some projects, this issue took about 2.5–3 years to be resolved. However, for local community groups developing projects for sustainable community growth, stakeholders were always prepared to give a positive voice and reverse any unfavourable planning decisions.

These challenges change as a project progresses. In some of the projects, setting up an ownership model and acquiring the generation plant in the first place was a huge challenge. There were legal, financial and even physical issues in building energy infrastructure. For example, one interviewee said:

"*The rock was incredibly hard … a whole range of things in order to get it up. And since then, of course, there is different challenges in terms of breakages to the turbine, in terms of either the property cable breaks or there is an issue with the turbine head*".

It took quite some time for some community groups to procure plant and equipment for their projects. Particularly when there are requests from commercial developers for 20–50 pieces of equipment per time while communities are only requesting one or two at a time. No doubt suppliers are more committed to supplying and sending installers out to bulk buyers because it is much more efficient to install, test or service up to fifty plants at the same time than one or two.

The operational phases of these projects had to deal with grid connection restrictions, because the nature of the grid in Scotland does not permit connection of too many projects (turbines or panels) at the same time. This agrees with Okkonen and Lehtonen's (2016) findings on wind power in Scotland, as one of the interviewees lamented:

"…Some communities are happy to embark on more projects but there is no grid connection capacity to accommodate them yet".

On the financial side of the projects, looking at the gross turnover on the balance sheet of some of these projects, it was obvious that a substantial proportion of income from the projects goes into loan repayments. In other words, large loans from commercial lenders and awards from national lotteries are to be paid annually or as agreed with the lender. Talking about this issue, an interviewee had this to say:

"…we have a huge bank loan, there is not a lot left now, and we repay about 120, 130 of that every year".

Apart from loan repayments, there are also insurance payments and maintenance contracts with the generating plants (e.g. turbines), although the amount paid depends on output (it could be low or high). There are also office and day-to-day running costs. It is when all these financial obligations are settled that staff wages are paid. The remaining funds can be used to support core local benefit projects, with some saved in windfall fund accounts.

The implication of this for community groups is that the projects must produce a certain number of kilowatt hours per year to meet these obligations. This indirectly exerts pressure on technical installations, which sometimes results in breakdown of plants, necessitating unplanned maintenance. Interviewees identified the remoteness of CREPs as a major cause of delay in carrying out maintenance of equipment by saying:

"… sometimes the maintenance contractors are happy to send somebody, but the plane cannot get in for three days, because it is so windy, or the weather is so bad.

Another critical technical issue that must be addressed for off- and on-shore community wind projects is the medium of grid connectivity. Presently, a subsea cable is used, and there is a history of interference by fishing nets and underwater rocks. This often result in temporary disconnection from the grid and monumental losses. According to one of the interviewees:

"…there is always issues with turbines, faults could be minor or major. We have problems with the sub-sea cable that takes the energy back to the mainland, that sometimes snaps in the winter and needs to be replaced. That really has a big impact on our income stream"

Although there are insurance companies that absorb some of these risks, from the practical point of view, it is getting to the point where insurance is quite difficult to get for remote projects.

8.6.4 *Implications of points above on communities and groups intending to invest in renewable energy projects*

The last theme to be addressed in this chapter is the implications of the first three themes on communities and groups intending to invest in renewable energy projects.
As expected, some positive discourses consistent with positive CREP impacts already identified in the literature emerged from the interviewees. At the inception phase of CREPs, most local members and investors were concerned about the possible outcomes of the projects, which are highly competitive and capital-intensive investments.

Moreover, some technical installations were perceived as very controversial, unpleasant and aesthetically unpleasing. For example, there was a strong neighbourhood opposition campaign named *Not In My Back Yard* (NIMBY). Today, these perceptions have changed because the overall design of technical equipment used in the sector has evolved greatly.

For instance, wind turbines are now noiseless, and the flickers are disappearing as well. Over and above overcoming local resistance, there are a wide range of mandatory community benefit initiatives in place. As an integral requirement for community projects of this nature, there must be a pot of money put aside for local value addition, such as building, maintaining or upgrading buildings as people desire. Furthermore, there is another pot of money for smaller funding bids for individual groups who may have specific needs.

Individuals or groups can apply to the management board for these funds and, within a month, the CEBMoD board is expected to review the applications based on some strict scoring system. This is one of the strongest selling points for communities and groups intending to invest in renewable energy projects, as it guarantees wider local support. There are accessible facts on how these gestures have helped local people achieve targets and things they ordinarily could not undertake.

There are no restrictions on what people want to engage in; however, each CEBMoD is expected to have a growth plan for their locality covering a whole range of activities that the people may want to undertake, which means everyone is a possible beneficiary. As one interviewee put it:

"... It's hard to find anybody in the village who has not benefitted one way or another, with money from this project".

The interview further revealed the importance and implications of having a sound team of professionals as directors. One of the cases studied is unique in this aspect; as a result, the board could get their turbine running much quicker than others did.
The financial modelling, business case development and legal documentation were all executed in-house.
… Yes, if you have the expertise in-house and you are not paying for it, that's a very costly thing to have experts in these areas.

It is difficult to conclude that a particular model is superior to, or more efficient than, others in effective CREP delivery on the basis of above findings, because there are so many mismatched project goals, renewable resources and stakeholder expectations. Furthermore, running an engineering business is different from running a commercial business, and this is a huge milestone for local community energy groups engaging in various engineering projects. There are many risks that only a well-structured CEBMoD can accommodate, particularly where the project existed before the setting up of a legal ownership structure.

Based on the findings reported in this chapter, there are many lessons to learn from incumbent CEBMoDs and their project activities, which new entrant communities and investors can deploy to develop CREPs more quickly and cheaply because they are not doing it for the first time. When people have tried something that did not work in the sector, it is quite practical for others to explore alternative ways of doing it better.

There is already so much information on the types of renewable energy technologies available in the market. People are also aware of possible planning consent and grid restrictions and how to raise money for the projects. So, there are not many other challenges apart from what is currently prevailing in the industry. Therefore, intending CREP investors and developers should be able to deliver more successful projects with some guidance.

8.7 Summary

With the use of multiple case studies, this chapter established that CREP delivery teams comprise people who are mostly enthusiastic about the environmental friendliness of renewable energy technology. The trustee directors managing most of these projects have quite good cross-sections of relevant experience, which they voluntarily bring to the projects. The findings further suggest that the strength of any model lies in its people and skillsets, and that everyone is involved in the management, from the trustee board directors to ordinary community members. Finally, the chapter identified a variety of CEBMoD structures, project arrangements and participant engagement, as well as challenges faced by CREP developers. These findings will be used in Chapter 9 to complement the findings of the quantitative data analysis and develop a framework for the selection of appropriate CEBMoDs for the development of particular CREPs. The next chapter examines the predictive power of CEBMoD principal components on CREP successes and impacts, as detailed in Chapter 6.

CHAPTER 9: FRAMEWORK DEVELOPMENT AND VALIDATION OF THE RESEARCH

9.1 Introduction

In Chapter 7, 23 regression models were tested: four for the planning phase of community renewable energy projects (CREPs), three for each of the implementation and operational phases, and two for disposal phase. The other eleven models focused on testing CREP impacts. This is over and above the many other findings obtained from the qualitative analysis in Chapter 8 and the extant literature, collectively providing some support for the conceptual premise that underpins this research (see the introductory chapter). The principal issues and suggestions which arose in Chapters 7 and 8 are used in this chapter to develop a framework for the selection of appropriate community energy business models (CEBMoDs) for the development of particular CREPs. Useful recommendations for the setting-up of CEBMoDs for future CREP implementations are prescribed, thereby addressing Objectives 4 and 5 of this research. Finally, the various processes and procedures deployed in confirming or refuting the findings reported in this thesis are addressed, since the generalisability of research results depends on the outcome of their validation.

9.2 CEBMoD/CREP Framework Development

Larsen, Osorio and van Ackere (2017) defined *framework* as a holistic overview of related ideas used in interpreting various aspects of a complex concept in a simple and comprehensible way. A considerable amount of literature has been published on household energy, community engagement and public perception frameworks (Howard, 2015; Rathnayaka et al., 2015; Devine-Wright et al., 2017).

However, much uncertainty still exists about CEBMoD management structures and approaches to CREP development in these frameworks. Moreover, none of these frameworks consider CEBMoD management structures and approaches to CREP development at each phase of the project lifecycle. Consequently, the framework proposed in this study seeks to:

i. Complement existing innovation tools employed by community energy groups (CEGs) to achieve continuous renewable energy (RE) technology evolution and diffusion
ii. Suggest approaches for effective CREP management that delivers positive socioeconomic and environmental project goals
iii. Generate sets of guiding recommendations for selecting a CEBMoD for the implementation of CREPs

Although there are many intervention programmes and guidelines launched by government departments such as the Department of Energy and Climate Change (DECC) and third-party organisations such as Community Energy England and Community Energy Scotland, the challenges of insufficient local knowledge of the technical and financial risks associated with projects are still prevalent (Herbes et al., 2017; Sen and Ganguly, 2017; Karunathilake et al., 2018). The proposed framework is expected to contribute to solutions for these and many other challenges.

As already emphasised in the introductory section above, a combination of qualitative and quantitative data from primary and secondary sources were used in the development of this framework. For instance, Chapters 2, 3 and 4 referred to empirical studies on which this study is built. Chapters 6 and 8 detailed the various quantitative analyses undertaken for this study and their results.

Chapter 7, on the other hand, addressed the qualitative aspects of the research, and together, these findings form the basis for the development of the framework. However, it is important to state that the generalisability of the framework presented in Figure 9.1 is subject to certain limitations that will be acknowledged in the next chapter.

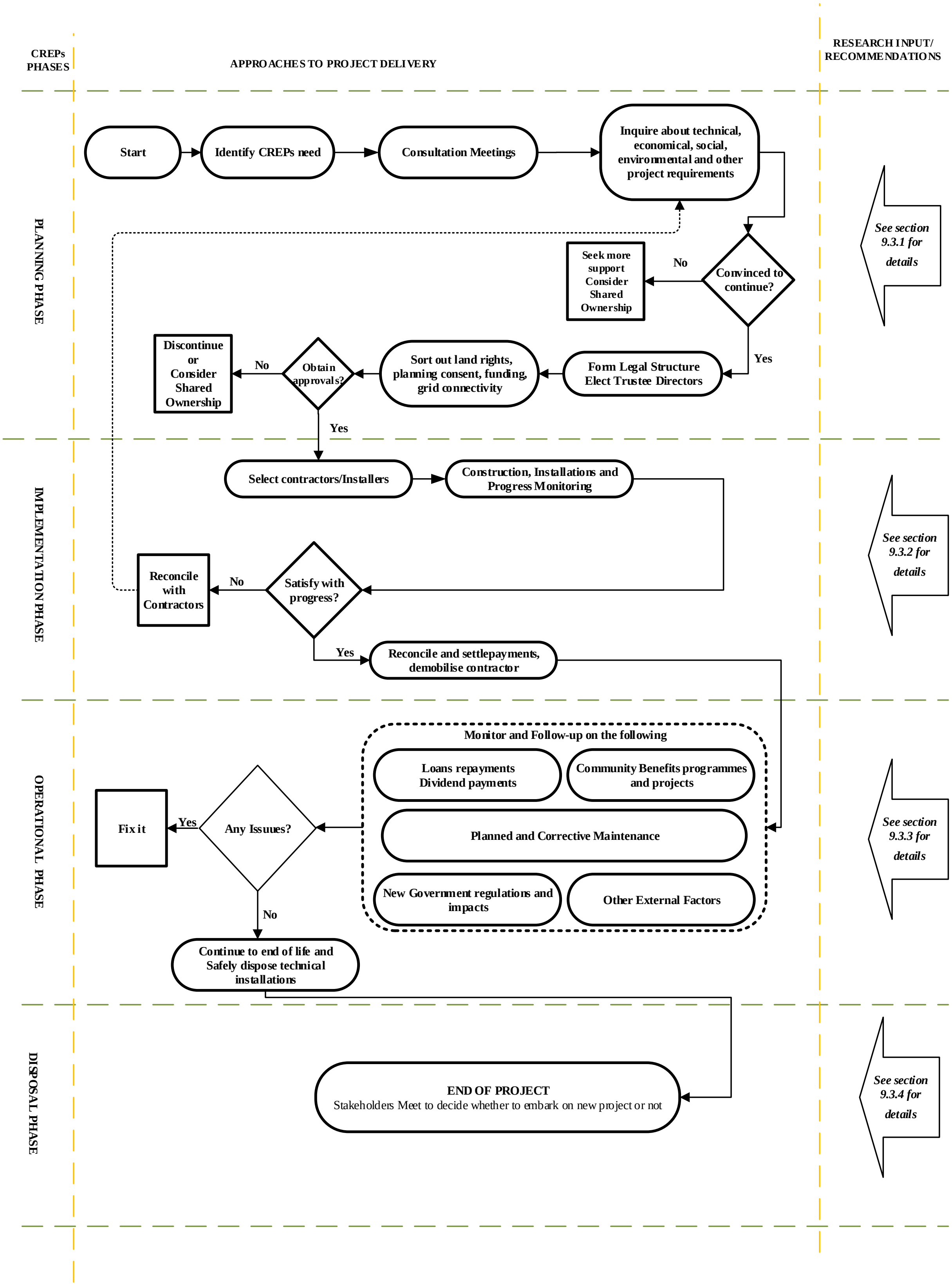

Figure9.1: Framework for community renewable energy projects (CREPs) development

As shown in the figure above, the framework depicts the step-by-step approach to CREP development and the various roles CEBMoD boards of directors and other stakeholders play in the planning, implementation, operational and disposal phases of such projects. Apart from the disposal phase, other phases and approaches to project delivery are illustrative of a fairly standard "tried and tested" process. However, the research input and recommendation for improving these phases, approaches and CREP outcomes are discussed in Section 9.3. Before that, each of the steps illustrated by the framework are briefly explained.

9.2.1 *Planning Phase*

Prior to the commencement of any project, it is expected that the goal of the project is defined, without which the resources for its completion cannot be fully ascertained. The scope of community energy engagement is changing. Traditionally, one would think of community energy as putting up and owning a wind turbine or solar panels and generating revenue to fund community activities. Whereas now, a community energy project could be an energy efficiency or energy storage project, or a heating project, depending on the prevailing local needs.

9.2.1.1 The need for CREPs

Fundamentally, the choice of project depends on what the energy needs are in that community and what the opportunities are. There is a greater chance of success if the local energy needs and project goals are fully identified. In the UK, the common need for community engagement in RE activities is either to reduce, purchase, generate or manage energy use. Depending on the immediate local needs, an individual can conceive of an idea to embark on any project, but not without consultation with the wider community

9.2.1.2 Community Consultation/Preliminary research on project requirements

CREPs depend on the input of the wider community to succeed, as wide local acceptance means more volunteers will help drive the project. However, the initial consultation should be with like-minded people who share similar views about the importance of the project.

Collectively, preliminary research can be conducted to fully understand the technical (equipment), environmental (site), economic (funding) and social (local benefits) requirements of the project. Based on the outcome of the research and consultations, the scope of the project becomes clearer. At this stage, it is important for the project organisers to decide on whether to continue or not.

9.2.1.3 Strategic decision making

Without a strong conviction to continue, most projects are suspended after clear scope identification. For instance, a recent report published by Community Energy England revealed that 31% of projects in England were suspended between 2015 and 2017 due to planning phase concerns such as unresolved feed-in tariffs, lack of funds and planning consent refusals, to mention but a few (CEE, 2017). More support or reviews of scope are needed for struggling groups to progress past this stage. Projects that have progressed beyond this point are investment-ready and will require a legal structure.

9.2.1.4 CEBMoD Structure

Although having a legal form, community-scale RE project ownership is a matter of choice, as self-sufficient local investors and interest groups can decide to do otherwise (Seyfang, Park and Smith, 2013). However, there are great benefits attached to legally-formed ownership structures for CREP implementation, particularly at the inception stage, where investors and lenders are doubtful about their returns on a project (Hakkila, 2003).

While a variety of CEBMoDs exist in the UK, this research adopts the models suggested by DECC for CREP delivery. They are the cooperative (Coop), social enterprise (SocEnt), community interest company (CIC), community charity (ComCha) and development trust (DevTru) models.

9.2.1.5 Legal, financial and other due diligence matters

Fully-regulated models have proven to be effective vehicles for securing planning consent, raising funds, negotiating grid connectivity, constituting trustee boards and electing members. Setting-up the legal structures early is good practice and can facilitate the implementation process.

9.2.2 *Implementation Phase*

In most cases reviewed, this was the phase with the most commitments. It starts shortly after all legal, technical and financial due diligence processes have been undertaken. Renewable projects, by nature, have aspects of civil, mechanical and electrical works, and rely on highly-skilled professional input to succeed. Therefore, most activities in this phase are outsourced but monitored by an in-house team. As acknowledged by Gaziulusoy and Ryan (2017), technical design skills and knowledge from external experts can be brought in to ensure project uncertainties and complexities are addressed.

For instance, in a typical wind project, the manufacturers of the turbine usually have specifications for the turbine foundation, and all these are done by experts. Furthermore, the access roads to the sites need to be widened for the installation of power poles that connect to the electricity grids. These and many more are factors to consider before selecting a contractor for a project.

9.2.2.1 Contractor selection and project monitoring

To select the right contractor, the local trustee management board has the responsibility to check the technical and financial capabilities of each prospective bidding company. The capabilities check ranges from assessment of company size, track record on similar jobs and reputation in the industry, to financial history. Having completed the checks, a contractor is selected for various aspects of the job. The monitoring of progress and consultative meetings with the immediate community and other stakeholders continue side-by-side through to practical completion.

This is important, because emerging environmental, financial and social issues can be readily resolved. The concluding activities in this phase include a post mortem meeting where the initial design is compared against the final build, value is compared against cost, and a snag list of unaccomplished tasks, defects and other local concerns that may affect the operational phase is created.

9.2.2.2 Practical Completion and Final account

Final payments are made to contractors and all contract documentation is updated and stored for future reference.

Furthermore, construction and installation contracts are terminated while maintenance contracts are executed. Implementation (construction and installation) phase disputes that may arise between parties must be resolved and all installations tested before handing over.

9.2.3 *Operational Phase*

From a practical point of view, the management structures of most CEBMoDs in the UK operate as a trading subsidiary of a charity. They take all the risks, rewards and profits and then transfer them to the parent company, which is the charity. There is a board of directors that oversees the work of the community group, who meet at least once a month or more as needed. The parent company maintains an office with a few staff to manage payments of bills such as wages, utilities, insurance premiums and maintenance of energy production installations.

9.2.3.1 *Loan and dividend payments*

Before any fund is transferred to the parent company (usually quarterly), a comprehensive budget of all outgoings is matched with income. If for any reason there was a breakdown of the generation plant or disruptions in RE resource (off peaks) supplies, then the losses resulting from these must be accommodated by the management before remitting profits to the parent company. However, loan repayments and dividend payments to shareholders must not be disrupted.

9.2.3.2 Community Benefits

Another key success indicator of CREPs is the ability to deliver local benefits. Usually, a legally-binding agreement is executed between the developers and the immediate communities affected by the project. The process of negotiation must start at the planning phase. Local benefit agreement is now a key requirement to be met by the developer before approval is given by the local authority.

Depending on the project and identified local needs, a pot of money is usually put aside for community benefit gestures. Individuals or groups who may need specific things can apply for these funds and, based on merit of application, funds are awarded.

In some projects, the management team go some steps further to engage a youth worker to mobilise and plan events for the younger population, and another worker to oversee other important aspects of community needs such as upgrades to buildings, maintenance of cultural heritage, improved inter-communal transportation or reductions of energy costs (details in chapter 8). This has proven to be one way to overcome local or public resistance to energy installations.

9.2.3.3 Maintenance of Energy Generation Installations

There are no serious technical and operational issues associated with CREPs generally, apart from occasional minor communication breakdowns between the generation monitoring equipment and the technical installations. The maintenance contract entered into between the management board and the equipment supplier is meant to address these concerns.

9.2.4 *Disposal Phase*

Typically, projects of this nature span 20–30 years, as recommended by the technical equipment manufacturers. Having delivered on the social, economic and environmental benefits for which they were conceived, the technical installations are repowered or decommissioned at this stage. Obsolete installations could be replaced with more recent and sophisticated equipment. The various stakeholders in the project are responsible for making these decisions.

This phase is not really very common in most CREPs, as the sector is still growing. As earlier emphasised, the processes discussed above illustrate a fairly standard process; however, this research suggests several courses of action for improving the processes and expected outcomes, as follows.

9.3 Guiding recommendations for improving incumbent/setting up of new CEBMoDs for implementation of future CREPs

The fifth objective of this research was to generate sets of guiding recommendations for improving incumbent CEBMoDs and setting up new ones for the implementation of future CREPs. This is in response to the challenges facing incumbent CEBMoDs acknowledged in Chapter 3.

Based on the research findings, the framework makes a number of assumptions that may not correspond to every community energy group's experience. This is because the findings are based on typical legal structures mentioned in Section 9.2.1.4. This, however, does not undermine the fact that there are several important areas of incumbent CEBMoDs, and CREP success and impacts, where this study makes an original contribution, as discussed below.

9.3.1 *Planning Phase inputs/recommendations*

As already mentioned in Chapter 4, the various CEBMoDs in use are central to understanding communities' many approaches to capturing local energy and other needs, how these needs can be met to their satisfaction, and how revenue can be generated in the process. This research recommends that in addition to reducing, purchasing, generating and managing energy, community energy groups should consider other needs such as ensuring the flow of more money to local charitable funds.

This is because cuts to subsidies have reduced the potential income from projects, and this in turn has reduced the incentives for partners. One practical approach of getting more income into the projects, as identified by this study, is for new community groups to set up a model that prioritises the cost-effective delivery of projects.

In addition, the model should consider direct sales of electricity to business owners and other consumers within the community through power purchase agreements. Having this constant funding stream means the community can plan a long way into the future. This is why most incumbent community groups affected by deployment cuts are struggling from year to year in coping with financial commitments associated with the project.

This research also proffers solutions to community groups who are unsuccessful in obtaining planning consent for new projects but are enthusiastic about meeting local needs through CREP ownership. Through partnership arrangements between a struggling but enthusiastic community and a commercial developer, the community can buy and own a share in a larger project.

There are many benefits associated with this option. First, the community will benefit from the experience of the developer and its economies of scale.

Second, the developer bears most of the external risk because of its ability to understand and operate in the energy market.
Also, the community will not have to go through the learning process and, thirdly, the community will probably be involved in a much larger project. For instance, buying a 10% share of a 30 MW project means the community owns 3 MW, which is a large ownership stake.

The stake could be more, depending on how the developer values the project and at what point the community buys into the project. Similarly, existing projects affected by the feed-in tariffs cut could invest proceeds in the shared ownership of a new project. In other words, the community can buy and own a share in a commercially-developed project from income generated from fully-owned on-going CREPs. Although there are a lot of factors around the process, it is still achievable because commercial developers are becoming more receptive to partnerships with communities.

Another research input to increase CEBMoD efficiency and further improve the CREP planning phase is that, in nominating and voting directors into the trustee board, it is important to consider members with specific skills, such as accounting, legal, technical and project management. Although this is not a prerequisite to becoming a director, projects with such skillsets are usually delivered at much lesser costs, and on time.

Although public resistance is becoming a thing of the past, the research findings revealed that the level of public acceptance and participation in community energy activities depends on the extent of information available to them or distilled from them. Therefore, information management has become a major contributor to CREP success. It is recognised from the research that CREP shareholders have a significant influence on the effectiveness of the CEBMoD management structure and approach to CREP development when engaged regularly in productive dialogue and information sharing.

As a result of grid connectivity constraints, attention is now on energy storage technologies. CEGs are worried about the maturity level of these technologies and opine that allocation of more funds, quicker decision-making processes and removal of possible institutional barriers could also improve the market. Detailed assessments of renewable energy resources are vital to the success of CREPs, as revealed from the research findings.

For instance, the assessment of wind resource involves site data collection on the direction, speed and amount of energy that can be generated from wind available on the sites. This information is necessary for energy generation and storage planning.

9.3.2 *Implementation Phase inputs/ recommendations*

A few important changes could be introduced to complement incumbent CEBMoDs in the implementation of new projects. Firstly, where possible, the construction materials, and the skilled and unskilled workforce should be sourced locally to create local jobs and boost the local economy. Furthermore, due to the remoteness of most CREP sites, routine maintenance has become a basic requirement. The research findings support the need for training of local people on how to undertake minor repairs on technical installations.

Secondly, this will increase local competence in CREPs delivery. Again, the research findings revealed that conflict is a fundamental part of any social setting and CEBMoDs, being social platforms for CREP delivery, are susceptible to conflict. There is a need for more research to fully understand conflict types, and the causes and consequences of CEBMoD and CREP success.

9.3.3 *Operational Phase inputs/recommendations*

The strength of any model lies in its people and their skillsets, and a lot of communities currently struggle to drive delicate CREPs. Projects often take five or six years to actualise. Therefore, this phase requires long-term commitment from the community groups, and since most of the trustees and other members are volunteers and retirees, it is important to encourage and attract new and younger people with new ideas to projects to sustain their operations. As a matter of necessity, the changeover of directors should be more regular than what it is now.

At the moment, it is only during annual general meetings of the trustee board that votes for a changeover of the longest-serving directors occurs. To avoid fatigue and volunteer burnout, the capacity and efficiency of each director should be reviewed quarterly. However, there are instances where there are not enough people coming forward to be directors. That can sometimes be an issue; in such situations, board membership could be extended to people living outside the locality.

In cases where the CEBMoD is the trading subsidiary of a parent charity, a high possibility of conflicting interests may exist amongst directors, and this must be checked. For instance, this study showed that one person was sitting as a director of a trading company and a charity. This must be reviewed when setting up a new business model.

Research findings also indicate that most government policies and regulations of the sector are not based on an understanding of the larger sector and specific project requirements. Therefore, major CREP stakeholders have a role to play, particularly when it comes to speaking up against unpopular policies, as in the case of the subsidy cuts and policy changes that generated great resistance in the UK in early 2016. Policy changes have a great impact on CREP operations; they could be positive or negative depending on how favourable the policy is.

9.3.4 *Disposal Phase inputs/ recommendations*

The description and phasing of a project lifecycle differs according to the nature of the project, the organisers and the project needs. It is commonplace to find very detailed and sometimes complicated descriptions and sequences of project phases.

The last phase of CREP development included in this study is the disposal phase, which often is termed *extended lifecycle* in most projects. This phase is mostly omitted from project lifecycle-related research such as this but was used in this study to prescribe the requirements of the final stage of a project.

9.3.4.1 Evaluation of overall project Impacts

As stated in the planning phase, it is important for the wider community to meet, discuss and agree on the need for the project, the benefits or impacts it will generate and, then, collectively design an approach by which these can be achieved. There are many useful websites where detailed real-life CREP cases can be found, such as those of Community Energy England and Community Energy Scotland.

Some of the lessons learned and useful recommendations for new developers can also be obtained. Much can be distilled from the scope, schedule, budget, collaborations, stakeholder relationships, internal organisational management, quality and risk lessons.

The basic CREP impacts are economic, environmental and social. Research suggests that for CREPs to substantially boost a local economy, the local people must be willing to participate in its planning, development and operations and, if possible, own the project. Also, the potential for CREPs to deliver affordable energy to public consumers has been acknowledged by practitioners as a major reason for their acceptance and for public participation in their delivery.

In as much as there are no known H&S issues in the sector at the moment, it is acknowledged that as the sector grows, project location- and technology-specific hazards will also increase. By implication, there will be a great obligation for major stakeholders in the sector to identify H&S gaps and tailor mitigation measures to manage them.

9.3.4.2 Final Reports, Stakeholder meeting and Future plans

The research findings suggest that it is important to document CREPs impacts, challenges, achievements and lessons learned at each phase of the project delivery. This will become a source of reference for decision-making by stakeholders, particularly in terms of whether there is a need to start up a new project of higher capacity or pay off local investors. The trustworthiness of the entire research process and findings is, however, subject to various validations, as addressed in the sections that follow.

9.4 Research Validation and Framework Evaluation

Social science research entails the methodological processes of data collection and analysis, and the invention of measures for the assessment and amelioration of societal problems (Cooper, 2017; Dingwall *et al.*, 2017). A key aspect of these processes is *research validity*, which determines the extent to which a study measured what it set out to measure. There have been attempts to empirically define the various types of validity used in social science research (Drost, 2011; Bhattacherjee, 2012). Commonly used ones are content, internal, external, face, criterion, concurrent, discriminant and construct validity.

Face and content validations were considered while piloting the initial questionnaire developed for this study. Similarly, factor analysis is an acceptable form of construct validation (DiStefano and Hess, 2005); hence, this was also addressed as part of the statistical analysis (refer to Chapter 6).

The two most important types of validation yet to be fully addressed for this research are *internal* and *external validation*, which are addressed below

9.4.1 *Internal validation*

The term 'internal validation' is used by Drost (2011) to refer to the degree of flawlessness of a research. Bailey (2008), added that validation ensures the research processes were correctly executed, while Bhattacherjee (2012) describes internal validity as the degree of trustworthiness of theory drawn from a causal relationship in a study.

It is clear that every research strategy has flaws which, in turn, affect the overall research outcome. These are often acknowledged as *limitations* in the concluding chapter of a study. By adoption and application of multiple strategies, strategic research flaws associated with a one strategy are complemented by the other, thereby strengthening the credibility of findings.

Both quantitative and qualitative research strategies were combined to achieve the findings reported in Chapters 6 to 9. The lesser the flaws in a study, the higher its internal validity, and this is where the question of the effectiveness of the research design deployed for the study becomes important. This question has been extensively addressed in Chapter 5.

9.4.2 *External validation*

The trustworthiness, explanation and generalisability of research findings are achieved through *external validation* (Bleeker *et al.*, 2003). External validation confirms whether a study is robust enough to describe similar phenomena in different settings and can be achieved through the following processes: a) boundary search, b) replication of research findings and c) convergence analysis of research findings.

9.4.2.1 Boundary search

There are boundaries associated with every study in terms of time, location, type, amount of data required and so forth. As the name implies, *boundary search* is the consideration of all the constraints associated with a study. Within the context of this research, there were key limitations which will be fully detailed in next chapter.

9.4.2.2 Replication of Research findings

The essence of replication is to test the possibility of producing similar results from a study assuming its aim, objectives, data collection tools and analysis procedures are repeated. In other words, replication challenges the reliability of a piece of academic work, the competence of the researcher and the integrity of the instruments deployed.

It is important to reinforce Fabrigar and Wegener's (2017) views that perfect replication has never been achieved for any research, no matter the control procedures put in place by the researcher. This is because circumstances beyond the control of the researcher may arise. To replicate this research would be practically unrealistic due to so many predictable limitations such as time, funds, and the willingness of the same group of survey and interview participants to participate in studies.

This, however, does not undermine the fact that the data collection tools were adequately designed to extract reliable data (see Section 5.15 in Chapter 5).

9.4.2.3 Convergence analysis of Research findings

While replication seeks to determine the validity of research findings under similar conditions, *convergence analysis*, on the other hand, assesses various conditions under which a research topic can yield similar outcomes. For instance, various data collection tools and analysis procedures could be manipulated to arrive at the same research outcome on a topic.

Bryman (2017) posits that convergence is achieved not only when findings are the same, but when research is robust in scope and has common themes that agree with the findings of other independent studies in the same field.

While there was acceptable degree of convergence of findings from both the quantitative and qualitative strands, there is a common belief that bias may exist, since the findings were based on strategies borne out of the researcher's ontological and epistemological assumptions (Yvonne Feilzer, 2010).

Consequently, and as suggested by Sargent (2015), the framework developed based on qualitative and quantitative findings, was presented to CREP experts with proven records of practical engagement in the sector for evaluation.

9.4.2.3.1 Framework Evaluation

To assess whether the framework developed for this research (see figure 9.1) can be useful to the wider UK community energy groups, an evaluation questionnaire was designed and distributed to UK wide CREPs practitioners. Before this, potential participants with proven track record in the sector were identified (see profile of participants in table 9.1 below) and contacted by email.

Table 9.1: Background Information on the respondent

PROFILE OF RESPONDENTS		NUMBER OF PARTICIPANT	PERCENTAGE
TYPE OF ORGANIZATION			
Community Energy Funders		1	16.67
Community Energy Local Groups		3	50.00
Research (Academia)		1	16.67
Consulting		1	16.67
	Total	**6**	**100**
ACADEMIC QUALIFICATION			
PhD		2	33.33
Msc		1	16.67
Bsc/B.Ed		2	33.33
Others		1	16.67
	Total	**6**	**100**
DESIGNATION OF RESPONDENT			
Development Officer		1	16.67
Trustee Director		1	16.67
Chair of Board of Directors		1	16.67
Trustee member/Treasurer		1	16.67
Project Development officer		1	16.67
Lecturer		1	16.67
	Total	**6**	**100**
YEARS OF EXPERIENCE (COMMUNITY ENERGY SECTOR)			
0-5 years		1	16.67
6-10 years		4	66.67
11-15 years		1	16.67
16-20 years		0	0.00
	Total	**6**	**100**

Respondents were asked to evaluate the framework (based on scale 1-5, in other words, from extremely poor to excellent) for its clarity, conciseness, and logical sequencing of phased activities. They were also asked to evaluate the comprehensiveness and practical relevance and suitability of the framework to the UK community energy sector.

Another set of questions sought expert comments of the framework's limitations, weaknesses, strength and usefulness to new community energy groups. Finally, they were asked to comment on similar framework for community energy project development in the UK or anywhere else (if any).

These questions were structured in this manner to fulfil Matthew *et al.* (2016) recommendation, which states that a framework is only valid for generalisability when the causal relationships discovered are clear, logical and holistic

It is apparent from table 9.1 above that respondents were from a wide range of community energy organization, 50% were from target users of the framework (the community energy groups). While approximately 17% of other participants were from the community energy funding, research and consulting organizations respectively. Table 9.1 further revealed the respondent's academic qualifications, designation in their respective organizations, as well as the number of years they have individually engaged with community energy related responsibilities.

The expert (participants) identification criteria above is consistent with approach reported by Bautista *et al.* (2016) and therefore the evaluation results from these categories of people can be trusted.

9.4.2.3.2 Result on assessment of the framework

Apart from the *comprehensiveness of the framework* with a mean rating of 4.03 there appears to be high positive rating for all other assessment attributes (see Figure 9.2).

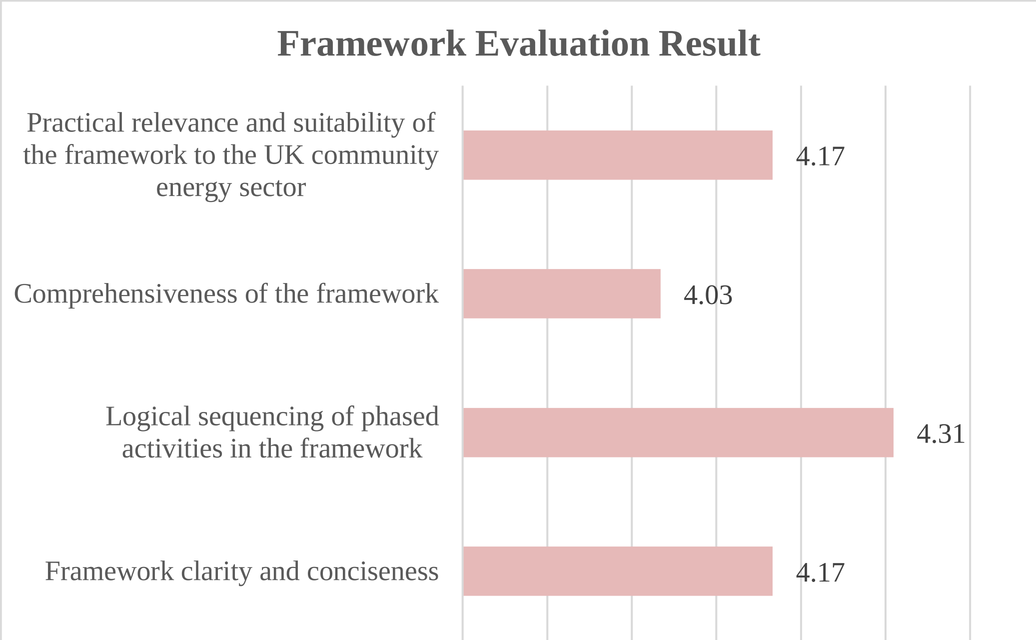

Figure 9.2: Framework evaluation results

For instance, *practical relevance and suitability of the framework to the UK community energy sector* had 4.17 mean rating, an indication that a substantial aspect of the framework will be beneficial to new entrant community energy group.
Furthermore, there is an obvious standout in the mean rating of sequencing of phased activities, and the *overall clarity and conciseness of the framework structure* as evident in the 4.31 and 4.17 mean ratings respectively.

By implication, prospective users do not necessarily have to be experts in community energy business to understand the framework. Although activities sequencing varies according to project type and ownership structure (Demirkesen and Ozorhon, 2017), the framework can be adjusted to accommodate these variabilities.

A few open-ended questions were introduced as part of the framework evaluation exercise. Respondents were asked to comment on the strength (if any) of the proposed framework and a range of responses was elicited, thus:

"it gives a clear summary of the key stages involved and an introduction to the basics for someone not involved in the sector"

"*It's a nice idea, but there are many different types of project and many funding permutations that were not clearly captured, and on top of that, the government keeps moving the goalposts, which in turn disrupts the process".*

"It is very commendable, it offers a starting place and would help a project at the very start"

In response to the question "What are the limitations/weakness (if any) of the framework?", one participant expressed the belief that:

"more emphasis is required on the need for a sound business plan at the outset (the planning phase). Another participant stated:

"The framework should have given some indication of the difficulties involved in obtaining a Power Purchase Agreement (PPA) and also refer to the regulatory issues associated with delivery of power to local residents".

Contrary to expectations, all the respondents claimed to be unaware of any framework for community energy project development in the UK that is structured in this manner, but admitted that there are bits of guidance available from other sources such as Leapfrog, Community Energy Scotland and Community Energy England. For example, one respondent said:

"In 2008 Community Energy Scotland development workers provided something similar but in a verbal way. Once they lost the contract to the Energy Savings Trust, that stopped. I'm not sure if they still offer the service.

Drawing on the comments and ratings reported above, it can be surmised that the framework will be relevant as a complementary improvement tool to incumbent CEBMoDs deployed in the delivery of on-going and new CREPs in the UK. That notwithstanding, the framework should be further assessed by more experts, tested on real life projects and other community energy legal structures not covered by this research to further substantiate the strength of its practicability in successful CREPs delivery.

9.5 Summary

The framework proposed in this chapter depicts a step-by-step approach to CREP development and the various roles CEBMoD boards of directors and other stakeholders play in the planning, implementation, operational and disposal phases of projects. Research findings show that incumbent CEBMoDs are faced with various technical, financial and policy threats. Therefore, some guiding recommendations for coping with these challenges have been introduced in the framework. However, the generalisability of the research results and the proposed framework depend on the outcome of its validation. In addition to various methods used in validating this research, experts were contacted to assess the framework for its clarity, conciseness, logical sequencing of phased activities, comprehensiveness, practical relevance and suitability to the UK community energy sector. The comments and ratings from these experts indicate that the framework could be a complementary tool to improve incumbent CEBMoDs. The next chapter will summarise the thesis.

CHAPTER 10: CONCLUSIONS AND RECOMMENDATIONS

10.1 Introduction

This chapter concludes the research by first presenting an overview of the research aim and objectives, and how preceding chapters contributed to addressing them. It then goes on to present several important areas where this study makes an original contribution and, at the same time, highlights a number of caveats that need to be noted regarding the present study. Finally, this research has raised many questions in need of further investigation.

10.2 Summary of the Overall Research

This research was undertaken to explore various community energy business models (CEBMoDs) and their approaches to community renewable energy project (CREP) development in the UK, with a view to developing and validating a framework for the selection of appropriate CEBMoDs for future project development. This aim was accomplished through five specific research objectives:

10.2.1 *To review the state of the art in research and practice in relation to the UK Community Energy sector, with a view to understanding the nature and performance of CREPs*

In order to gain a wider perspective of the energy sector, literature on the global energy market and its various reforms and transformations were reviewed in Chapter 2. The energy sector witnessed its first major reform through the privatisation and commercialisation of the government-owned electricity scheme in Chile in the early 1980s (Bacon, 1995; Jamasb and Pollitt, 2005; Sioshansi, 2006). It was discovered that the Chilean reform eventually paved the way for global electricity sector reforms that occurred a decade later. Notably, in the 1990s, various investment banks and industry professionals partnered with the governments of developing countries to overhaul the electricity market (Williams and Ghanadan, 2006). Given the high success rate of these reforms, electricity market reforms became common in Argentina, Brazil, Canada, the

US, the UK and other parts of Europe. At the continental level, the EU electricity market reform symbolises what many scholars (Sioshansi, 2006; Sioshansi and Pfaffenberger, 2006; Moreno, López and García-Álvarez, 2012) refer to as the most coordinated single cross-border electricity market structure. Its main objectives were to bridge the trans-border gaps in the electricity markets of member states and to establish a uniform market structure. The review further revealed some startling facts about EU energy systems. Of central concern is the volume of oil and energy imported by member states. The report indicates that more than 90% of transport systems still use fossil fuels, requiring the region to import more than half of its energy in 2014 (Climate Policy Observer, 2016).

Fossil fuels are limited in terms of geographical distribution, and are costly, hazardous to human health (through GHGs emitted to the atmosphere) and produce low quality energy. Consequently, commitments were made by various countries to consistently cut their carbon dioxide emissions by 2050 using 1990 levels as the baseline (Keyman and Önis, 2004; Carter, Clegg and Wåhlin, 2011).

At the national level, the UK has a long-term target to reduce its total GHG emissions by 80% between 2008 and 2050. In the interim, the UK is expected to depend on renewable energy for at least 15% of its total energy needs by 2020 (Renewable Energy Directives, 2009). The primary functions of the UK energy sector, however, comprise generation, transmission and distribution of energy to end-users (von der Fehr and Harbord, 1993). Apart from the above traditional activities, there are specialist secondary functions such as those that promote efficient generation and consumption (Boardman, 2004; Herring, 2006), as well as the manufacture of clean energy technologies (De Coninck, Haake and Van Der Linden, 2007).

Unfortunately, smaller energy suppliers in the UK still rely on larger companies for purchase of wholesale energy at an uncomfortable price, which they in turn retail to consumers (von der Fehr and Harbord, 1993; Bradley, Leach and Torriti, 2013; Bunn and Yusupov, 2015). In other words, the point of generation is not necessarily the point of distribution or consumption, and the efficiency of this type of energy system has been strongly challenged by a number of writers (Carley, 2009; Sanz *et al.*, 2011; Abbas and Merzouk, 2012; Momoh, Meliopoulos and Saint, 2012).

In particular, Pepermans et al. (2005) lists three common pitfalls of centralised energy systems, including high costs of transmission and distribution, challenges of powering remote locations and lack of energy security and price stability.

Nevertheless, current practice has expanded communities' capacities to be involved in various energy activities and, surprisingly, local communities and groups are gradually making a mark in sustainable energy generation in the developed world, such as in Australia, Denmark, Sweden, Germany, the UK and the US (Gross, 2007; Loring, 2007; St Denis and Parker, 2009; Pitt, 2010). This does not dismiss the importance of large-scale energy projects; however, linking small-scale community-led projects to larger ones can scale up capacity (DECC, 2014). Against this background, it was discovered that one of the most effective emerging energy management systems, to complement or even replace the centralised system, is community-led renewable energy activity.

In the context of this study, while a variety of definitions of the term *community energy* (CE) have been suggested (Hain *et al.*, 2005; Walker and Devine-Wright, 2008; Warren and McFadyen, 2010; Hargreaves *et al.*, 2013; Seyfang, Park and Smith, 2013; DECC, 2014), this research adopted the definition suggested by the UK Department of Energy and Climate (DECC). The DECC (2014) sum up CE as referring to diverse groups and the various responsibilities they undertake to ensure that local people accept and participate in small-scale RE projects and benefit from the positive environmental, social and economic outcomes of such projects. This can be either temporary or permanent groups of enthusiastic individuals generating, purchasing and managing energy and/or promoting the efficient use of energy.

Emerging empirical evidence indicates that community groups are common RE activist organisations, which both developed and emerging economies rely on in order to meet their various GHG reduction targets. It was also discovered that local participation and leadership in energy matters is an important aspect of deploying renewables for the fulfilment of the UK's global carbon emission reduction pledges. One unanswered question from the review is whether full global community leadership of energy projects can be achieved, considering the continuously growing energy demand, changing market conditions and regulatory reforms, which automatically place huge investment burdens on the energy sector. This is an indication that there is a knowledge gap that needs to be filled.

10.2.2 *To appraise the various Community Energy Business Models used in the UK, including their effectiveness, management structures and approaches to CREP development*

In Chapter 3, it was discovered that when two similar CEBMoDs are deployed for the development of two different projects under the same market and regulatory conditions, the project outcomes may be different. Drawing on the resource-based view (RBV) theory, the chapter appraised community energy groups' many approaches to capturing local energy needs, how these needs can be met to the satisfaction of stakeholders, and how revenue generated in the process can be put to other uses. RBV theorists believe that one way that organisations achieve and sustain competitive advantage is by mobilising and using scarce and useful resources for continuous business expansion. This provided a clearer understanding of the whole concept of community ownership as a reformation of asset and infrastructure management practices.

While a variety of CEBMoDs exist in the UK, this research adopted the models suggested by DECC, which are the cooperative (Coop), social enterprise (SocEnt), community interest company (CIC), community charity (ComCha) and development trust (DevTru) models, and appraised their effectiveness, management structures and approaches to CREP development. Consequently, a total of 25 factors were distilled from extant literature. Out of these factors, 20 described an effective CEBMoD, while 5 other factors described an efficient CEBMoD, as reported in Chapter 4. These factors were part of the conceptual framework suggested in Chapter 4 and the factor analysis reported in Chapter 6

10.2.3 *To identify the impacts CREPs is expected to generate and the common influencing factors to overall project success*

Following on from Chapter 3, extant literature was reviewed to understand the factors that impede CREP success/performance. A total of 68 factors were identified from the review. Of the 68 factors, 39 factors explained what could go wrong in the planning, implementation, operational and disposal phases of CREPs, while the remaining 29 factors captured the economic, environmental and social impacts expected by CREP stakeholders. To understand the interrelations among CEBMoD and CREP factors, a theoretical framework was conceptualised in an attempt to address the research aim. The framework hypothesised a relationship between effective internal organisation, efficient management structure, proactive approach to CREP development, and overall project success and positive impacts. With the conceptual theoretical framework in place, the research design, strategies and methods deemed appropriate in investigating CEBMoD impacts on CREPs were suggested in Chapter 5. Thereafter, exploratory factor analysis (EFA) was employed to produce a linear combination of CEBMoD and CREP factors to produce a parsimonious set of components for each of the CEBMoD and CREP groups of factors.

10.2.4 *To develop and evaluate a framework for the selection of appropriate Community Energy Business Models for the development of particular Community Renewable Projects*

The factor analysis conducted in Chapter 6 led to the extraction of four principal factors influencing the CREP planning phase, three each for the implementation and operational phases, and two for disposal phase. Another eleven principal factors focused on testing CREP impacts were also obtained; together, these factors formed the dependent variables used in the research. The seven most parsimonious sets of components for CEBMoD management structure and approaches to CREP development were also obtained in the same chapter and used as the independent variables. There was no evidence of relationships between the independent and dependent variable analysed in Chapter 6. Therefore, in Chapter 7, Pearson product-moment correlation coefficient and multiple regression analyses were used to examine the CEBMoD principal components that best predict CREP success in each of the development phases, as well as the social, economic, and environmental impacts desired by project stakeholders.

Furthermore, with the use of multiple case study interviews in Chapter 8, it was discovered that CREP delivery teams comprise people who are mostly enthusiastic about the environmental friendliness of renewable energy technology, and that the trustee directors managing most of these projects have quite a good cross-section of relevant experience, which they voluntarily bring into the project. It was also discovered that the strength of any model lies in its people and skillsets, and that everyone is important in its management, from the trustee board directors to ordinary community members.

The variety of CEBMoD structures, project arrangements and participant engagement, as well as the challenges faced by CREPs, were identified from the analysis. This is over and above the many other findings obtained from the qualitative analysis in Chapter 8 and the literature, which, collectively, provide some support for the conceptual premise that underpins this research in the introductory chapter. The principal issues and suggestions which have arisen in Chapters 7 and 8 were used in Chapter 9 to develop a framework for the selection of appropriate CEBMoDs for the development of particular CREPs.

The framework depicts a step-by-step approach to CREP development and the various roles CEBMoD boards of directors and other stakeholders play in their planning, implementation, operational and disposal phases. CREP experts were contacted to assess the framework for its clarity, conciseness, logical sequencing of phased activities, comprehensiveness, practical relevance and suitability to the UK community energy sector. The comments and ratings from these experts indicate the necessity and relevance of the framework as a complementary tool for the improvement of incumbent CEBMoDs.

10.2.5 *Generate sets of guiding recommendations for setting up CEBMoDs for the implementation of future CREPs*

This objective was introduced purposely to add to the growing body of knowledge concerning the setting up of CEBMoDs for the implementation of future CREPs in the UK. Based on the research findings, the research made a number of assumptions that may not correspond to every community energy group's experience. This is because the findings are based on the typical legal structures mentioned in Section 10.2.2. However, there are several important areas related to incumbent CEBMoDs and CREP success and impacts that this study makes original contributions to. These contributions to knowledge are specific to each phase of project development and are as follows.

In the planning phase of CREPs, the following are the main contributions:

- In addition to reducing, purchasing, generating and managing energy, community energy needs should consider other needs such as ensuring the flow of more money to local charitable funds.

- New community groups are encouraged to set up a model that prioritises cost effectiveness in project delivery.

- New models should consider the direct sale of electricity to business owners and other consumers within the community as mandatory.

- Incumbent fully-community-owned business models can be adjusted to accommodate shared ownership, particularly for community groups affected by the deployment cuts.

- In nominating and voting directors to trustee boards, it is important to consider members with specific skills such as accounting and law, and technical and project management. Although this is not a prerequisite to becoming a director, projects with such skillsets are usually delivered at a much lesser cost, and on time.

- Although public resistance is becoming a thing of the past, the research findings revealed that the level of public acceptance and participation in community energy activities depends on the extent of information available to them. Therefore, information management is a major contributor to CREP success.

- As a result of grid connectivity constraints, attention is now on energy storage technologies. CEGs are worried about the market maturity level of these technologies and opine that allocation of more funds, quicker decision-making processes and removal of possible institutional barriers could also improve the market.

In the implementation phase of CREPs, a few important changes could be introduced to complement incumbent CEBMoDs in the implementation of new projects. These are:

- Where possible, the construction materials, and the skilled and unskilled workforces should be sourced locally to create local jobs and boost local economies.

- Due to the remoteness of most CREP sites, routine maintenance has become a basic requirement. The research findings support the need for training local people on how to undertake minor repairs on technical installations. This will further increase local competence in CREP delivery.

In the operational phase of CREPs, the following are recommended.

- Since most of the trustees and other members are volunteers and retirees, it is important to attract the younger generation with new ideas to projects to sustain their operations. As a matter of necessity, the changeover of directors should be more regular than what it is now.

- In cases where the CEBMoD is the trading subsidiary of a parent charity, a high possibility of conflicting interests may exist among the directors, and this must be checked. For instance, the research findings showed that one person was sitting as a director in both a trading company and a charity. In most cases studied, this must be reviewed when setting up a new business model.

- Government policies and regulations of the sector are not based on an understanding of the larger sector and specific project requirements. Therefore, major CREP stakeholders have a role to play, particularly when it comes to speaking up against unpopular policies, as in the case of the subsidy cuts and policy changes that generated great resistance in the UK in early 2016.

This is the first time that the disposal phase of CREPs has been addressed in research. It is mostly omitted from project lifecycle-related research such as this, but was used in this study to prescribe the requirements of the final stage of projects. The following are recommended.

- It is important to commence the evaluation of overall project impacts, although there are many useful websites where detailed real-life CREP examples can be found, such as Community Energy England and Community Energy Scotland. Some of the lessons learned and useful recommendations for new developers can also be obtained. Much can be distilled from scope, schedule, budget, collaboration, stakeholder relationship, internal organisational management, quality and risk lessons.

- The basic impacts of CREPs are economic, environmental and social, and the research findings suggest that, for CREPs to substantially boost any local economy, the local people must be willing to participate in their planning, development and operations and, if possible, own the project.

- Also, the potential for CREPs to deliver affordable energy to public consumers has been acknowledged by practitioners as a major reason why they accept them and participate in their delivery.

- In as much as there are no known H&S issues in the sector at the moment, it is acknowledged that as the sector grows, the project location- and technology-specific hazards will also increase. By implication, there will be a great amount of responsibility placed on major stakeholders in the sector to identify H&S gaps and tailor mitigation measures to manage them.

- Finally, the impacts, challenges, achievements and lessons learned at each phase of CREP delivery must be documented. This can become a reference for decision making by stakeholders, particularly regarding whether there is a need to start up a new project of higher capacity or pay off local investors.

10.3 Contributions to Knowledge

The sets of guiding recommendations generated in section 10.2.5 above adds to the growing body of knowledge concerned with setting up CEBMoD for implementation of future CREPs in the UK. They are summarized below:

In the planning phase of CREPs, the following are the main contributions

- Existing CEBMoDs should ensure the flow of more money to the local charitable fund.
- New entrant CEGs to set up a model that prioritises cost effectiveness in project delivery.
- Existing CEBMoDs should consider direct sale of electricity to business owners and other consumers within the community as mandatory.
- Existing CEBMoDs should adjust structure to accommodate shared ownership, particularly those affected by the deployment cuts.
- Local members with specific skills should be considered when electing trustee directors.
- Information management should be considered as a major contributor to CREPs success.

During CREPs implementation (construction/installations),

- Where possible, the construction materials, skilled and unskilled workforce should be sourced locally to further create jobs and boost local economy.
- More local people should be trained on how to undertake minor repairs on technical installations.

At the operational phase of CREPs

- The changeover of CEBMoD directors should be more regular than what it is now to avoid volunteers' burnout.
- CEGs must ensure there are no conflict of interest in cases where a director have dual function (for the trading subsidiary and parent charity).
- CREPs stakeholders must speak up more against unpopular policies as in the case of subsidy cuts and policy changes that generated great resistance in the UK early 2016.

At the disposal phase of CREPs

- Although there are many useful websites where real-life case CREPs examples can be found such as CEE, CES etc, detailed information on CREPs scope, schedule, budget, collaborating working, stakeholder's relationship, and internal organizational management, quality and risk lessons are still lacking.

In terms of environmental and socio-economic impact of CREPs to stakeholder,

- Local people must be willing to participate in its planning, development, operations and if possible own the project.
- In as much as there are no known health and safety (H&S) issues in the sector at the moment, it is acknowledged that as the sector grows, the project location and technology specific hazard will also increase, and by implication, there will be a great amount of responsibility on major stakeholders in the sector to identify H&S gaps and tailor mitigation measures to manage them.
- The potential of CREPs to deliver affordable energy to public consumers have been acknowledged by practitioners as one major reason for their acceptance and participation in CREPs delivery.

Finally, the project impacts, challenges, achievements lessons learned at each phase of the project delivery must be documented. This becomes a source of reference for decision making by stakeholders, particularly when there is a need to start-up a new project of higher capacity or pay off local investors.

10.4 **Limitations of the Research**

The generalisability of these results is subject to the following limitations.

1. Due to the timeframe available to carry out this research, as well as funding and ease of access, it was practically impossible to collect data from the entire study population, as there are over 5000 community energy groups in the UK.

2. The selected models reviewed in this research are as contained in the UK *Community Energy Strategy Report* published by Department of Energy and Climate (DECC, 2013), and are the unit of analysis. However, the data collected, analysed and used in the development of the framework were mainly from cooperative and development trusts models. Further data is required on other models to determine exactly how each model's approach to CREP delivery affects their outcome.

3. CREP endeavours in the UK cover both community generated electricity and community renewable heat initiatives. This research was limited to community-based generation of electricity from wind and solar technology.

10.5 Areas for Further Research

It is recommended that further research be undertaken in the following areas:

1. The regression result obtained did not produce any predictor variable for *resource assessment and project finance* (planning phase) model; *local goods demand and job creation* (impact assessments) models. There are several possible explanations for this result, for instance other factors not covered in this research could be more useful predictor of these models. No doubt *resource assessment, project finance, local goods demand* and *job creation* are very important for successful CREPs delivery. For instance, some communities are endowed naturally with more than one renewable energy resource, but inaccurate assessment of these resources has led to misguided decisions on investment choice, project team, and implementation strategy selection.

In terms of local goods demand, the community energy sector is a huge consumer of materials and resources but much of the material the industry uses, are not produced or sold in the community. Buying these goods locally, instead of ordering from afar, has many advantages for the local community and the environment. For CREPs financing, there are many funding permutations in the UK, but the government keeps moving the goalposts in the areas of local incentives and policies.

Unlike the UK, the German government have sound policies that support community energy generation. Some of these policies prioritizes grid connections for renewable energy, support schemes for renewables, and makes it mandatory for grid operators to purchase power from renewable energy generators. This has put Germany at the forefront of CREPs delivery.

Hence, further research could explore the effectiveness of existing renewable energy resource assessment tools, CREPs finance options and how to enforce the use of local good for CREPs delivery which in turn will lead to local jobs creation. Grounded theory can be a useful research strategy for achieving these. On the other hand, Action research will enable the identification of new and existing UK CREPs where Germany policies can be tested on.

2. The framework developed for this research follows a particular order of CREPs delivery, precisely wind and solar project. This is because the UK wind energy market is gradually becoming one of the biggest contributors to the Country's energy mix. Being distinguished as having the best wind speed and most wind resource in Europe, the UK can comfortably depend on wind energy for its lifelong energy demands, if fully harnessed. In particular, onshore wind energy which is classified as low-cost route to energy security has surge in recent times thereby contributing to both national and local economic growth.

   In addition, following the sudden thriving of solar energy globally, the installation of solar photovoltaic (PV) systems in the UK has witness exponential growth in recent times. However, there are some other community energy schemes such as hydrogen projects, demand-side management, source heat pumps, and district heating that run in a different order. Further research could be carried out to develop similar framework for these projects.

3. Expectedly, most community owned endeavours are created in response to perceived or anticipated local benefits. So, it becomes very natural for the local people to mobilize support for local resilient endeavours. Community Resilience is usually considered as one of the key CREPs social benefits, but ideally it deserves to be considered as independent CREPs impacts because, strong resilience building has been suggested as one remedy to certain practical realities facing poor households globally.

   For instance, there seem to be an exponential increase in the rate of global youth unemployment resulting in rural urban migration of the youth in search of greener pastures. This has led to partial extinction of some communities, even in the UK. Therefore, another aspect of CREPs where more research is needed is on, how community funds generated from CREPs can be used to curb youth unemployment and reduce rural urban migration. Ethnography could be a better research strategy to adopt for this type of investigation. This strategy is particularly useful in explaining a phenomenon from the viewpoint of those involved or affected by the phenomenon. However, the strategy requires the researcher to, if possible live within the society and among the studied population for the period of the research.

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APPENDIX A - GENERAL QUESTIONNAIRE SURVEY

To Whom It May Concern

Dear Sir/Madam,

FRAMEWORK FOR THE SELECTION OF COMMUNITY ENERGY BUSINESS MODEL (CEBMoD) FOR COMMUNITY RENEWABLE PROJECTS (CREPs) DEVELOPMENT IN THE UK

We would like to invite your participation in above research study which seeks to deepen understanding on operational efficiency of Community Energy Project Business Models (CEBMoD) in managing Energy Projects in the UK and how these Models incorporate Social, Environmental and Economic considerations of a project in its organisational set up and operational activities.
The questionnaire will require that you recall your experiences on one of your most recently completed or ongoing Community Renewable Energy project and use that as a basis for responding to the questions.

Your contribution will be most invaluable. **There are no known or anticipated risks from participating in this study. All information that you provide will remain confidential and will be de-identified for all analyses.**
Also, if there are colleagues in your establishment or another who has more experience, direct responsibilities and or knowledge of Community Energy Projects, please forward the survey link to them if you feel it would be more appropriate.

If you require any further information or clarification, we will be pleased to answer your questions.Contact details are provided below. Alternatively, you may wish to make assumptions on any matters that are unclear to you.

We do appreciate that the questionnaire will take some of your valuable time - say **15 minutes**. However, without your kind and expert input the ambitions of this research project will not be realized.

It is our hope therefore that you will be able to assist us in this research. We would like to receive completed questionnaires by the 23rd of October 2016. The survey can be completed at any time up until this date.

If you would like a summary copy of this study please complete the attached Request for Information Form and return it to me by email

Thanks, in anticipation.

Yours Sincerely,

SECTION A- GENERAL INFORMATION

Name of Respondent……………………………………………………………………………..

Address…………………………………………………………………………………………

Name of Organisation or Company………………………………………………………..

Please provide the name of your latest employer……………………………………………

…………………………………………………………………………………………………….

Please indicate your years of experience in the Renewable / Energy sector
Please choose **only one** of the following:

- From 1 to 5
- From 6 to 10
- From 11 to 15
- From 16 to 20
- From 21 and above

Please indicate your highe
Please choose **only one** of the following:

- ND/NC
- HND/HNC/B.Sc.
- M.Eng/M.Tech/P.Dip
- PhD/D.Eng.
- Other

Please indicate your professional body (ies) membership
Please choose **only one** of the following:

- IMechE
- IExpE
- Other
- CIEH
- CIEEM
- IOSH

Please indicate the category your job falls under
Please choose **only one** of the following:

SECTION B – COMMUNITY ENERGY PROJECT PERFORMANCE, IMPACTS AND OUTCOME

Are you aware of OR been involved in any Community Renewable Project?

- Yes
- No

Based on your experience on the most recent projects you were part of, please rate the factors listed below on how they can hinder progress in each phase of Community Renewable Energy Projects (CREPs) development. Please indicate how strongly you agree or disagree with each statement

PLANNING PHASE		Strongly disagree				Strongly Agree
In this phase do you agree that progress/performance can be hindered by:						
a.	High project start-up cost for poor communities and groups	1	2	3	4	5
b.	Inconsistent project feasibility studies and business case	1	2	3	4	5
c.	Misleading investment information	1	2	3	4	5
d.	Insufficient Renewable resource assessment data and tools	1	2	3	4	5
e.	Inconsistent front-end engineering and technical systems design	1	2	3	4	5
f.	Inconsistent and compromised bidding process	1	2	3	4	5
g.	Inadequate quantification of project investment risks	1	2	3	4	5
h.	Premature local energy market	1	2	3	4	5
i.	Lack of access to project financing	1	2	3	4	5
j.	Lack of guaranteed loan programs for poor communities	1	2	3	4	5
k.	Setting over ambitious project goals	1	2	3	4	5
l.	No prioritization and alignment of project goals to local needs	1	2	3	4	5

IMPLEMENTATION PHASE		Strongly disagree				Strongly Agree
In this phase do you agree that progress/performance can be hindered by:						
a.	Lack of local skills and expertise	1	2	3	4	5
b.	Having the wrong team for the job	1	2	3	4	5
c.	Poor project information management	1	2	3	4	5
d.	Failure to screen site for project development	1	2	3	4	5
e.	Not using experts for evaluation of project cost estimates	1	2	3	4	5
f.	High rate of accidents, injuries, fatalities and near misses on site	1	2	3	4	5
g.	Time and cost overrun	1	2	3	4	5
h.	Looming/unresolved conflicts among participants	1	2	3	4	5
i.	Inability to effectively service project loans	1	2	3	4	5
j.	Bankruptcy and insolvency	1	2	3	4	5
k.	Unforeseen eventualities and externalities	1	2	3	4	5
l.	Poor relationship and communication management	1	2	3	4	5

OPERATIONAL PHASE		Strongly disagree				Strongly Agree
In this phase do you agree that progress/performance can be hindered by:						
a.	Poor knowledge of Technology performance and reliability indicators	1	2	3	4	5
b.	Insufficient/no benefits accrued from the project to the locals	1	2	3	4	5
c.	Unequal subsidies payment and taxes for community groups	1	2	3	4	5
d.	Prolonged Grid integration barriers	1	2	3	4	5
e.	Poorly executed project	1	2	3	4	5
f.	Lack of Installations and Maintenance supports	1	2	3	4	5
g.	Continuous market monopoly by bigger energy companies	1	2	3	4	5
h.	Ineffective/no Government regulations and legislation	1	2	3	4	5
i.	No Research and Development programs to support project	1	2	3	4	5

DISPOSAL AND REINVESTMENT PHASE In this phase do you agree that progress/performance can be hindered by:	Strongly disagree				Strongly Agree
a. No project reinvestment capacity for the community	1	2	3	4	5
b. No expert solutions across the whole life of the project	1	2	3	4	5
c. No long-term preparatory plans to support future sector changes	1	2	3	4	5
d. Poor projections of future sector demands	1	2	3	4	5
e. Ineffective feedback system	1	2	3	4	5
f. Insufficient information on final project evaluation report	1	2	3	4	5

Please indicate your level of agreement or disagreement to the following potential impacts of CREPs on its stakeholders

ECONOMIC impacts of CREPs	Strongly disagree				Strongly Agree
a. Increased local job creation	1	2	3	4	5
b. Reinvested revenue boosted local economic activities	1	2	3	4	5
c. Reinvested revenue diversified the local economy	1	2	3	4	5
d. High prospects for local manufacturing	1	2	3	4	5
e. Local energy market growth	1	2	3	4	5
f. High savings on energy bills	1	2	3	4	5
g. Less reliance on conventionally produced energy	1	2	3	4	5
h. Affordable and stable energy price	1	2	3	4	5
ENVIRONMENTAL impacts	Strongly disagree				Strongly Agree
a. Health risk from toxic chemical storage near site	1	2	3	4	5
b. Severe noise pollution	1	2	3	4	5
c. Alterations to the natural environment	1	2	3	4	5
d. High rate of wildlife fatalities	1	2	3	4	5
e. Conflicts in heritage protected landscapes	1	2	3	4	5
f. Reduction in tourism activities	1	2	3	4	5
g. High carbon embedded material used during construction	1	2	3	4	5
h. Displacement of residential and farmlands	1	2	3	4	5
i. Upsetting effects of construction/maintenance traffic	1	2	3	4	5
SOCIAL impacts of CREPs	Strongly disagree				Strongly Agree
a. Increased local support	1	2	3	4	5
b. Increased local acceptance	1	2	3	4	5
c. Increased knowledge of renewable	1	2	3	4	5
d. High pro-environmental behavioural change	1	2	3	4	5
e. Improved quality of indoor air	1	2	3	4	5
f. Greater local resource reliance	1	2	3	4	5
g. Scaled up local job creation	1	2	3	4	5
h. Reduction in rate of fuel poverty	1	2	3	4	5
i. Offers energy choices to the locals	1	2	3	4	5
j. Increased in local social activities	1	2	3	4	5
k. Local capacity building	1	2	3	4	5
l. Enhanced local skills	1	2	3	4	5

SECTION C – THIS SECTION SEEKS TO ASSESS FACTORS THAT MAKES A PARTICULAR OWNERSHIP MODEL MORE POPULAR AND FREQUENT ADOPTED FOR CREPs DEVELOPMENT THAN OTHERS

BUSINESS MODEL POPULARITY From your experience and knowledge of Community Energy Projects in the UK, please indicate the frequency of employing the following business models in project delivery and ownership.	Not Frequent				Highly Frequent
a. Energy Cooperatives	1	2	3	4	5
b. Social Enterprise	1	2	3	4	5
c. Community Charities	1	2	3	4	5
d. Development Trusts	1	2	3	4	5
e. Community Interest Companies	1	2	3	4	5
f. Community/Local Authority Partners	1	2	3	4	5
g. Community/Housing Association Partner	1	2	3	4	5
h. Community/Commercial Developers Partner	1	2	3	4	5
i. Community/Energy Companies Partner	1	2	3	4	5
BUSINESS MODEL ATTRACTIVENESS Drawing on your experience on the level of effectiveness of incumbent business models please rank what was considered important to the project stakeholders	Not important				Extremely Important
a. Internal knowledge of evolving technology	1	2	3	4	5
b. Zero principal/Agent interest	1	2	3	4	5
c. Robust internal management	1	2	3	4	5
d. Good incentives/rewards to stakeholders	1	2	3	4	5
e. Good staff development programs	1	2	3	4	5
f. Transparency in financial dealings	1	2	3	4	5
g. Effective internal feedback system	1	2	3	4	5
h. Low administrative and overhead costs	1	2	3	4	5
i. Financial stability	1	2	3	4	5
j. Alignment of organisation goal to projects’	1	2	3	4	5
k. High risk appetite against externalities	1	2	3	4	5
l. Flexible membership route	1	2	3	4	5
m. Internal administrative efficiency	1	2	3	4	5
n. Less complicated incorporation process	1	2	3	4	5
o. Attainable economic, social and environmental goals	1	2	3	4	5
p. Substantial shares in the energy market	1	2	3	4	5
q. Evidence of long-term relevance in the market	1	2	3	4	5
r. Effective board/management system with professionals	1	2	3	4	5
s. Engaging locals as managers	1	2	3	4	5
t. Capacity to deal with bureaucratic obstacles	1	2	3	4	5
BUSINESS MODEL EFFICIENCY DETERMINANTS Based on your experience, please indicate your level of agreement to the assertions that a Business Model can be efficient by improving or increasing:	Strongly disagree				Strongly Agree
a. Management structure	1	2	3	4	5
b. Board structure	1	2	3	4	5
c. Shareholding size	1	2	3	4	5
d. Management style	1	2	3	4	5
e. Membership size	1	2	3	4	5

From your knowledge of/experience on how Community Energy Project is organised, would you agree that the type and nature of the Renewable Energy Project have influence on what ownership model to adopt?

Please choose **only one** of the following:

- ◯ Yes
- ◯ No

Based on your response, please make any further comment (if any) on your choice

From your knowledge of/experience on how community energy project is organised, would you agree that OWNERSHIP MODEL type have influence on the choice of RENEWABLE ENERGY PROJECT to invest in?

Please choose **only one** of the following:

- ◯ Yes
- ◯ No

Based on your response, please make any further comment (if any) on your choice in the box provided

Please leave any additional comments (or your opinion) on how Community Ownership of Renewable Energy Projects can influence the outcome of the project

THIS IS THE END OF THE SURVEY

Thank you for completing this survey

APPENDIX B – MULTIVARIATE ANALYSIS TABLES

TABLE 1: ITEM-CORRELATION TEST-ORDINAL VARIABLES

Sn	Variable Code	Variable Names	Alpha.Without	N
1	PPH1a	High project start-up cost for poor communities and groups	0.859	95
2	PPH1b	Inaccurate project feasibility studies and business case	0.862	95
3	PPH1c	Insufficient investment information	0.860	95
4	PPH1d	Insufficient Renewable resource assessment data and tools	0.862	95
5	PPH1e	Inconsistent front-end engineering and technical systems design	0.860	95
6	PPH1f	Compromised bidding process	0.859	95
7	PPH1g	Inadequate quantification of project investment risks	0.861	95
8	PPH1h	Premature local energy market	0.861	95
9	PPH1i	Lack of access to project financing	0.861	95
10	PPH1j	Insufficient loan programs for poor communities	0.860	95
11	PPH1k	Setting over ambitious project goals	0.860	95
12	PPH1l	Non-prioritization and alignment of project goals to local needs	0.859	95
13	PPH2a	Shortage of local skills and expertise	0.860	95
14	PPH2b	Inefficient project team	0.859	95
15	PPH2c	Poor project information management	0.860	95
16	PPH2d	Failure to screen site for project development	0.861	95
17	PPH2e	Not using experts for evaluation of project cost estimates	0.860	95
18	PPH2f	High rate of accidents, injuries, fatalities and near misses on site	0.860	95
19	PPH2g	Time and cost overrun	0.860	95
20	PPH2h	Looming/unresolved conflicts among participants	0.860	95
21	PPH2i	Inability to effectively service project loans	0.859	95
22	PPH2j	Bankruptcy and insolvency	0.860	95
23	PPH2k	Unforeseen eventualities and externalities	0.859	95
24	PPH2l	Poor relationship and communication management	0.859	95
25	PPH3a	Insufficient knowledge of Technical performance and reliability indicators	0.860	95
26	PPH3b	Insufficient/no benefits accrued from the project to the locals	0.860	95
27	PPH3c	Unequal subsidies payment and taxes for community groups	0.859	95
28	PPH3d	Prolonged Grid integration barriers	0.860	95
29	PPH3e	Poorly executed project	0.860	95
30	PPH3f	Lack of Installations and Maintenance supports	0.861	95
31	PPH3g	Continuous market monopoly by bigger energy companies	0.859	95
32	PPH3h	Ineffective/no Government regulations and legislation	0.860	95
33	PPH3i	No Research and Development programs to support project	0.859	95
34	PPH4a	Lack of project reinvestment capacity for the community	0.859	95
35	PPH4b	Lack of expert solutions across the whole life of the project	0.859	95
36	PPH4c	Lack of long-term preparatory plans to support future sector changes	0.859	95
37	PPH4d	Poor projections of future sector demand	0.860	95
38	PPH4e	Ineffective feedback system	0.860	95
39	PPH4f	Insufficient information on final project evaluation report	0.859	95
40	POI1a	Increased local job creation	0.861	95
41	POI1b	Reinvested revenue boosted local economic activities	0.862	95
42	POI1c	Reinvested revenue diversified the local economy	0.863	95
43	POI1d	High prospects for local manufacturing	0.862	95
44	POI1e	Local energy market growth	0.861	95
45	POI1f	High savings on energy bills	0.861	95
46	POI1g	Less reliance on conventionally produced energy	0.861	95
47	POI1h	Affordable and stable energy price	0.861	95
48	POI2a	Health risk from toxic chemical storage near site	0.862	95
49	POI2b	Severe noise pollution	0.861	95
50	POI2c	Alterations to the natural environment	0.861	95
51	POI2d	High rate of wildlife fatalities	0.861	95

52	POI2e	Conflicts in heritage protected landscapes	0.861	95
53	POI2f	Reduction in tourism activities	0.860	95
54	POI2g	High carbon embedded material used during construction	0.859	95
55	POI2h	Displacement of residential and farmlands	0.861	95
56	POI2i	Upsetting effects of construction/maintenance traffic	0.860	95
57	POI3a	Increased local support	0.863	95
58	POI3b	Increased local acceptance	0.864	95
59	POI3c	Increased knowledge of renewable	0.864	95
60	POI3d	High pro-environmental behavioural change	0.863	95
61	POI3e	Improved quality of indoor air	0.862	95
62	POI3f	Greater local resource reliance	0.863	95
63	POI3g	Scaled up local job creation	0.862	95
64	POI3h	Reduction in rate of fuel poverty	0.863	95
65	POI3i	Offers energy choices to the locals	0.862	95
66	POI3j	Increased in local social activities	0.862	95
67	POI3k	Local capacity building	0.863	95
68	POI3l	Enhanced local skills	0.863	95
69	BMP1	Cooperatives (Coops) Model	0.863	95
70	BMP2	Social Enterprise (SocEnt) Model	0.863	95
71	BMP3	Community Charites (ComCha) Model	0.863	95
72	BMP4	Development Trust (DevTru) Model	0.862	95
73	BMP5	Community Interest Companies (CIC) Model	0.862	95
74	BMP6	Community/Local Authority Partial Ownership Model	0.862	95
75	BMP7	Community/Housing Associations Partial Ownership Model	0.861	95
76	BMP8	Community/Development Trusts Partial Ownership Model	0.861	95
77	BMP9	Community/Energy Companies Partial Ownership Model	0.862	95
78	BMAa	Internal knowledge of evolving technology	0.861	95
79	BMAb	Zero principal/Agent interest	0.860	95
80	BMAc	Robust internal management	0.861	95
81	BMAd	Good incentives/rewards to stakeholders	0.863	95
82	BMAe	Good staff development programs	0.859	95
83	BMAf	Transparency in financial dealings	0.862	95
84	BMAg	Effective internal feedback system	0.861	95
85	BMAh	Low administrative and overhead costs	0.861	95
86	BMAi	Financial stability	0.862	95
87	BMAj	Alignment of organisation goal to projects'	0.862	95
88	BMAk	High risk appetite against externalities	0.861	95
89	BMAl	Flexible membership route	0.859	95
90	BMAm	Internal administrative efficiency	0.860	95
91	BMAn	Less complicated incorporation process	0.859	95
92	BMAo	Attainable economic, social and environmental goals	0.860	95
93	BMAp	Substantial shares in the energy market	0.859	95
94	BMAq	Evidence of long-term relevance in the market	0.857	95
95	BMAr	Effective board/management system with professionals	0.858	95
96	BMAs	Engaging locals as managers	0.859	95
97	BMAt	Capacity to deal with bureaucratic obstacles	0.859	95
98	BMIa	Management structure determines risk sharing	0.861	95
99	BMIb	Board structure influences project monitoring	0.859	95
100	BMIc	Shareholders determine board composition	0.862	95
101	BMId	Management style affects model efficiency	0.859	95
102	BMIe	Membership size influences project outcome	0.859	95

TABLE 2: PLANNING PHASE PCA

	PRINCIPAL COMPONENTS				
	1	2	3	4	Communalities
PPH1b. - Inaccurate project feasibility studies and business case	0.30	-0.59	0.25	0.22	0.55
PPH1c. - Insufficient investment information	0.68	-0.45	-0.03	-0.12	0.67
PPH1d. - Insufficient Renewable resource assessment data and tools	0.18	0.45	0.66	-0.13	0.69
PPH1e. - Inconsistent front-end engineering and technical systems design	0.66	0.08	-0.27	-0.45	0.72
PPH1f. - Compromised bidding process	0.60	0.32	-0.25	0.19	0.57
PPH1g.- Inadequate quantification of project investment risks	0.45	-0.02	0.65	-0.38	0.76
PPH1h. - Premature local energy market	0.34	0.51	-0.39	0.11	0.54
PPH1i. - Lack of access to project financing	0.34	-0.11	0.25	0.79	0.81
PPH1j. - Insufficient loan programs for poor communities	0.38	0.55	0.19	0.23	0.54
PPH1k. - Setting over ambitious project goals	0.64	-0.28	-0.25	-0.01	0.55

TABLE 3: IMPLEMENTATION PHASE PCA

	PRINCIPAL COMPONENTS			
	1	2	3	Communalities
PPH2a. - Shortage of local skills and expertise	0.550	-0.530	0.260	0.650
PPH2b. - Inefficient project team	0.600	-0.300	0.410	0.620
PPH2h. - Looming/unresolved conflicts among participants	0.670	-0.270	-0.330	0.620
PPH2i. - Inability to effectively service project loans	0.640	0.510	0.110	0.690
PPH2j. - Bankruptcy and insolvency	0.580	0.510	0.440	0.780
PPH2k. - Unforeseen eventualities and externalities	0.640	-0.320	-0.300	0.600
PPH2l. - Poor relationship and communication management	0.590	0.390	-0.520	0.770

TABLE 4: OPERATIONAL PHASE PCA

	PRINCIPAL COMPONENTS			
	1	2	3	Communalities
PPH3a.- Insufficient knowledge of Technical performance and reliability indicators	0.48	-0.41	0.55	0.71
PPH3b.- Insufficient/no benefits accrued from the project to the locals	0.64	-0.36	-0.4	0.7
PPH3c.- Unequal subsidies payment and taxes for community groups	0.6	0.26	0.43	0.61
PPH3f.- Lack of Installations and Maintenance supports	0.55	-0.49	-0.22	0.59
PPH3g.- Continuous market monopoly by bigger energy companies	0.48	0.55	-0.48	0.76
PPH3h.- Ineffective/no Government regulations and legislation	0.44	0.64	0.2	0.64

TABLE 5: DISPOSAL PHASE PCA

	PRINCIPAL COMPONENTS		
	1	2	Communalities
PPH4a. - Lack of project reinvestment capacity for the community	0.72	0.09	0.53
PPH4b. - Lack of expert solutions across the whole life of the project	0.74	0.21	0.60
PPH4c. - Lack of long-term preparatory plans to support future sector changes	0.78	-0.25	0.68
PPH4e. - Ineffective feedback system	0.47	0.77	0.81
PPH4f. - Insufficient information on final project evaluation report	0.69	-0.57	0.8

TABLE 6: ECONOMIC IMPACT PCA

	PRINCIPAL COMPONENTS				
	1	2	3	4	Communalities
POI1b.- Reinvested revenue boosted local economic activities	0.610	0.070	-0.650	0.050	0.800
POI1c.- Reinvested revenue diversified the local economy	0.670	0.040	-0.150	0.360	0.600
POI1d.- High prospects for local manufacturing	0.320	-0.670	0.520	0.220	0.870
POI1e.- Local energy market growth	0.650	-0.410	-0.080	0.000	0.590
POI1f.- High savings on energy bills	0.500	0.420	0.300	-0.340	0.630
POI1g.- Less reliance on conventionally produced energy	0.560	0.130	0.270	-0.540	0.690
POI1h.- Affordable and stable energy price	0.220	0.570	0.360	0.600	0.860

TABLE 7: ENVIRONMENTAL IMPACT PCA

	PRINCIPAL COMPONENTS			
	1	2	3	Communalities
POI2a.- Health risk from toxic chemical storage near site	0.750	-0.180	-0.390	0.740
POI2b.- Severe noise pollution	0.700	-0.070	0.270	0.580
POI2c.- Alterations to the natural environment	0.460	0.550	0.400	0.680
POI2d.- High rate of wildlife fatalities	0.730	-0.050	-0.180	0.570
POI2e.- Conflicts in heritage protected landscapes	0.560	0.620	-0.250	0.760
POI2f.- Reduction in tourism activities	0.810	-0.120	0.110	0.680
POI2g.- High carbon embedded material used during construction	0.510	-0.570	0.230	0.640
POI2h.- Displacement of residential and farmlands	0.690	-0.010	-0.440	0.670
POI2i.- Upsetting effects of construction/maintenance traffic	0.600	0.020	0.470	0.580

TABLE 8: SOCIAL IMPACT PCA

	PRINCIPAL COMPONENTS				
	1	2	3	4	Communalities
POI3a.- Increased local support	0.560	-0.390	0.260	0.340	0.650
POI3b.- Increased local acceptance	0.480	-0.510	0.150	0.240	0.570
POI3c.- Increased knowledge of renewable	0.550	-0.360	0.310	-0.500	0.780
POI3d.- High pro-environmental behavioural change	0.690	0.050	0.200	0.170	0.550
POI3e.- Improved quality of indoor air	0.230	0.780	0.150	-0.180	0.720
POI3g.- Scaled up local job creation	0.500	0.340	0.560	-0.250	0.750
POI3h.- Reduction in rate of fuel poverty	0.500	0.430	0.030	0.500	0.690
POI3j.- Increased in local social activities	0.560	0.300	-0.390	0.150	0.570
POI3k.- Local capacity building	0.670	-0.090	-0.560	-0.260	0.840
POI3l.- Enhanced local skills	0.770	-0.050	-0.350	-0.190	0.750

APPENDIX C – PEARSON'S PRODUCT-MOMENT CORRELATION MATRICES

Table 1: Pearson's product-moment correlation matrix of CREPs planning phase and CEBMoD components

	Information_Management	Market_Maturity	Resource_Assessment	Project_Finance	HRM_Aspects	Overcoming_Local_Resistance	Participative_Management	PreliminaryResearchOnProjectRequirements	Board_of_DirectorsCompetence	Special_Circumstances	Shareholder_Influence
Information_Management	1	0.284	-0.031	0.184	-0.012	0.236	0.000	0.110	-0.038	-0.028	0.160
Market_Maturity	0.284	1	0.360	0.057	-0.126	0.129	0.130	0.132	-0.092	-0.141	-0.032
Resource_Assessment	-0.031	0.360	1	0.072	-0.065	0.075	0.057	0.107	-0.001	0.027	0.047
Project_Finance	0.184	0.057	0.072	1	-0.017	0.042	0.102	0.047	0.072	0.103	0.000
HRM_Aspects	-0.012	-0.126	-0.065	-0.017	1	0.329	0.130	-0.008	0.235	0.268	0.010
Overcoming_Local_Resistance	0.236	0.129	0.075	0.042	0.329	1	0.025	0.347	-0.106	-0.142	-0.008
Participative_Management	0.000	0.130	0.057	0.102	0.130	0.025	1	-0.115	0.197	0.224	0.087
PreliminaryResearchOnProjectRequiremen	0.110	0.132	0.107	0.047	-0.008	0.347	-0.115	1	0.109	-0.071	0.153
Board_of_DirectorsCompetence	-0.038	-0.092	-0.001	0.072	0.235	-0.106	0.197	0.109	1	0.407	0.140
Special_Circumstances	-0.028	-0.141	0.027	0.103	0.268	-0.142	0.224	-0.071	0.407	1	0.133
Shareholder_Influence	0.160	-0.032	0.047	0.000	0.010	-0.008	0.087	0.153	0.140	0.133	1

Table 2: Pearson's product-moment correlation matrix of CREPs implementation phase and CEBMoD components

	Conflict_Resolution	Cash_Flow	Skill_Availability	HRM_Aspects	Overcoming_Local_Resistance	Participative_Management	PreliminaryResearchOnProjectRequirements	Board_of_DirectorsCompetence	Special_Circumstances	Shareholder_Influence
Conflict_Resolution	1	0.131	0.336	-0.037	-0.031	0.010	0.150	0.183	0.082	0.039
Cash_Flow	0.131	1	0.152	-0.043	0.160	0.093	0.086	-0.117	-0.153	0.046
Skill_Availability	0.336	0.152	1	0.052	-0.057	-0.046	0.212	0.041	0.088	0.000
HRM_Aspects	-0.037	-0.043	0.052	1	0.329	0.130	-0.008	0.235	0.268	0.01
Overcoming_Local_Resistance	-0.031	0.160	-0.057	0.329	1	0.025	0.347	-0.106	-0.142	-0.008
Participative_Management	0.010	0.093	-0.046	0.130	0.025	1	-0.115	0.197	0.224	0.087
PreliminaryResearchOnProjectRequiren	0.150	0.086	0.212	-0.008	0.347	-0.115	1	0.109	-0.071	0.153
Board_of_DirectorsCompetence	0.183	-0.117	0.041	0.235	-0.106	0.197	0.109	1	0.407	0.140
Special_Circumstances	0.082	-0.153	0.088	0.268	-0.142	0.224	-0.071	0.407	1	0.133

Table 3: Pearson's product-moment correlation matrix of CREPs operational phase and CEBMoD components

	Local_Benefits	Government_Regulat ons	Technical_Complexit es	HRM_Aspects	Overcoming_Local_R esistance	Participative_Manag ement	PreliminaryResearch OnProjectRequiremen ts	Board_of_DirectorsC ompetence	Special_Circumstanc es	Shareholder_Influenc e
Local_Benefits	1	0.049	0.251	-0.098	0.074	0.073	0.199	0.035	-0.119	0.000
Government_Regulations	0.049	1	0.052	-0.138	-0.058	-0.032	0.176	0.020	-0.055	-0.124
Technical_Complexities	0.251	0.052	1	0.054	0.082	-0.022	0.041	-0.079	-0.090	0.158548
HRM_Aspects	-0.098	-0.138	0.054	1	0.329	0.130	-0.008	0.235	0.268	0.010
Overcoming_Local_Resistance	0.074	-0.058	0.082	0.329	1	0.025	0.347	-0.106	-0.142	-0.008
Participative_Management	0.073	-0.032	-0.022	0.130	0.025	1	-0.115	0.197	0.224	0.0869771
PreliminaryResearchOnProjectRequirements	0.199	0.176	0.041	-0.008	0.347	-0.115	1	0.109	-0.071	0.1527819
Board_of_DirectorsCompetence	0.035	0.020	-0.079	0.235	-0.106	0.197	0.109	1	0.407	0.140
Special_Circumstances	-0.119	-0.055	-0.090	0.268	-0.142	0.224	-0.071	0.407	1	0.1332328

Table 4: Pearson's product-moment correlation matrix of CREPs disposal phase and CEBMoD components

	Detailed_Completion_Reports	Lessons_Learned	HRM_Aspects	Overcoming_Local_Resistance	Participative_Management	PreliminaryResearchOnProjectRequirements	Board_of_DirectorsCompetence	Special_Circumstances	Shareholder_Influence
Detailed_Completion_Reports	1	0.032	-0.054	0.198	0.011	0.073	0.047	0.138	0.062
Lessons_Learned	0.032	1	0.047	0.188	0.189	-0.008	-0.034	-0.097	-0.133
HRM_Aspects	-0.054	0.047	1	0.329	0.130	-0.008	0.235	0.268	0.010
Overcoming_Local_Resistance	0.198	0.188	0.329	1	0.025	0.347	-0.106	-0.142	-0.008
Participative_Management	0.011	0.189	0.130	0.025	1	-0.115	0.197	0.224	0.087
PreliminaryResearchOnProjectR	0.073	-0.008	-0.008	0.347	-0.115	1	0.109	-0.071	0.153
Board_of_DirectorsCompetence	0.047	-0.034	0.235	-0.106	0.197	0.109	1	0.407	0.140
Special_Circumstances	0.138	-0.097	0.268	-0.142	0.224	-0.071	0.407	1	0.133
Shareholder_Influence	0.062	-0.133	0.010	-0.008	0.087	0.153	0.140	0.133	1

Table 5: Pearson's product-moment correlation matrix of CREPs economic impact and CEBMoD components

	Improved_Local_Economy	Energy_Affordability	Local_Goods_Demand	Energy_Type_Switch	HRM_Aspects	Overcoming_Local_Resistance	Participative_Management	PreliminaryResearchOnProjectRequirements	Board_of_DirectorsCompetence	Special_Circumstances	Shareholder_Influence
Improved_Local_Economy	1	0.018	-0.053	0.143	0.122	-0.138	0.254	-0.147	0.070	0.341	0.010
Energy_Affordability	0.018	1	-0.027	0.070	-0.128	-0.050	-0.249	0.156	-0.104	0.137	0.000
Local_Goods_Demand	-0.053	-0.027	1	0.072	0.033	0.075	-0.060	-0.029	-0.139	-0.020	-0.039
Energy_Type_Switch	0.143	0.070	0.072	1	0.075	0.004	0.142	-0.149	-0.100	0.234	0.119
HRM_Aspects	0.122	-0.128	0.033	0.075	1	0.329	0.130	-0.008	0.235	0.268	0.010
Overcoming_Local_Resistance	-0.138	-0.050	0.075	0.004	0.329	1	0.025	0.347	-0.106	-0.142	-0.008
Participative_Management	0.254	-0.249	-0.060	0.142	0.130	0.025	1	-0.115	0.197	0.224	0.087
PreliminaryResearchOnProjectRequirem	-0.147	0.156	-0.029	-0.149	-0.008	0.347	-0.115	1	0.109	-0.071	0.153
Board_of_DirectorsCompetence	0.070	-0.104	-0.139	-0.100	0.235	-0.106	0.197	0.109	1	0.407	0.140
Special_Circumstances	0.341	0.137	-0.020	0.234	0.268	-0.142	0.224	-0.071	0.407	1	0.133
Shareholder_Influence	0.010	0	-0.039	0.119	0.010	-0.008	0.087	0.153	0.140	0.133	1.000

Table 6: Pearson's product-moment correlation matrix of CREPs environmental impact and CEBMoD components

	Health_and_Safety	Air_Pollution	Visual_Aesthetics	HRM_Aspects	Overcoming_Local_Resistance	Participative_Management	PreliminaryResearchOnProjectRequirements	Board_of_DirectorsCompetence	Special_Circumstances	Shareholder_Influence
Health_and_Safety	1	0.327	0.159	-0.077	0.232	-0.153	0.278	-0.227	-0.230	-0.092
Air_Pollution	0.327	1	0.172	-0.023	0.091	0.080	0.071	-0.190	-0.053	-0.019
Visual_Aesthetics	0.159	0.172	1	-0.209	-0.071	-0.184	0.304	-0.105	-0.238	-0.148
HRM_Aspects	-0.077	-0.023	-0.209	1	0.329	0.130	-0.008	0.235	0.268	0.010
Overcoming_Local_Resistance	0.232	0.091	-0.071	0.329	1	0.025	0.347	-0.106	-0.142	-0.008
Participative_Management	-0.153	0.080	-0.184	0.130	0.025	1	-0.115	0.197	0.224	0.087
PreliminaryResearchOnProjectRequirements	0.278	0.071	0.304	-0.008	0.347	-0.115	1	0.109	-0.071	0.153
Board_of_DirectorsCompetence	-0.227	-0.190	-0.105	0.235	-0.106	0.197	0.109	1	0.407	0.140
Special_Circumstances	-0.230	-0.053	-0.238	0.268	-0.142	0.224	-0.071	0.407	1	0.133
Shareholder_Influence	-0.092	-0.019	-0.148	0.010	-0.008	0.087	0.153	0.140	0.133	1

Table 7: Pearson's product-moment correlation matrix of CREPs social impact and CEBMoD components

	Local_Capacity_Building	Local_Acceptance	Job_Creation	Fuel_Poverty_Reduction	HRM_Aspects	Overcoming_Local_Resistance	Participative_Management	PreliminaryResearchOnProjectRequirements	Board_of_DirectorsCompetence	Special_Circumstances	Shareholder_Influence
Local_Capacity_Building	1	0.201	0.076	0.152	0.061	-0.189	0.120	-0.314	-0.011	0.096	0.086
Local_Acceptance	0.201	1	0.228	0.149	-0.058	-0.220	-0.011	-0.102	0.030	0.232	-0.066
Job_Creation	0.076	0.228	1	0.219	-0.123	0.030	-0.023	0.130	-0.087	0.005	-0.033
Fuel_Poverty_Reduction	0.152	0.149	0.219	1	0.118	-0.061	-0.057	0.001	-0.094	0.010	-0.202
HRM_Aspects	0.061	-0.058	-0.123	0.118	1	0.329	0.130	-0.008	0.235	0.268	0.010
Overcoming_Local_Resistance	-0.189	-0.220	0.030	-0.061	0.329	1	0.025	0.347	-0.106	-0.142	-0.008
Participative_Management	0.120	-0.011	-0.023	-0.057	0.130	0.025	1	-0.115	0.197	0.224	0.087
PreliminaryResearchOnProjectRequirements	-0.314	-0.102	0.130	0.001	-0.008	0.347	-0.115	1	0.109	-0.071	0.153
Board_of_DirectorsCompetence	-0.011	0.030	-0.087	-0.094	0.235	-0.106	0.197	0.109	1	0.407	0.140
Special_Circumstances	0.096	0.232	0.005	0.010	0.268	-0.142	0.224	-0.071	0.407	1	0.133

APPENDIX D – STEPWISE REGRESSION ANALYSIS FOR VARIABLE SELECTION

Table 1: Stepwise variable selection for Information Management Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Information_Management ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Information_Management ~ Overcoming_Local_Resistance + Shareholder_Influence						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	96.170	17.163
2	PreliminaryResearchOnProjectRequirements	1	0.010	88	96.180	15.172
3	Participative_Management	1	0.010	89	96.189	13.182
4	Board_of_DirectorsCompetence	1	0.022	90	96.212	11.204
5	Special_Circumstances	1	0.032	91	96.244	9.236
6	HRM_Aspects	1	1.003	92	97.247	8.221

Table 2: Stepwise variable selection for Market Maturity Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Market_Maturity ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Market_Maturity ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	85.626	6.131
2	Shareholder_Influence	1	0.182	88	85.808	4.332
3	Board_of_DirectorsCompetence	1	0.213	89	86.021	2.568
4	PreliminaryResearchOnProjectRequirements	1	0.802	90	86.823	1.449
5	Special_Circumstances	1	0.941	91	87.764	0.473

Table 3: Stepwise variable selection for Resource Assessment Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Resource_Assessment ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Resource_Assessment ~ PreliminaryResearchOnProjectRequirements						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	119.226	37.579
2	Board_of_DirectorsCompetence	1	0.025	88	119.252	35.599
3	Shareholder_Influence	1	0.058	89	119.309	33.645
4	Special_Circumstances	1	0.423	90	119.733	31.982
5	Overcoming_Local_Resistance	1	0.540	91	120.273	30.409
6	HRM_Aspects	1	0.680	92	120.952	28.944
7	Participative_Management	1	0.598	93	121.551	27.413

Table 4: Stepwise variable selection for Project Finance Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Project_Finance ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Project_Finance ~ Special_Circumstances						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	104.523	25.076
2	Shareholder_Influence	1	0.103	88	104.627	23.170
3	PreliminaryResearchOnProjectRequirements	1	0.088	89	104.715	21.249
4	Board_of_DirectorsCompetence	1	0.182	90	104.897	19.414
5	HRM_Aspects	1	0.659	91	105.555	18.009
6	Overcoming_Local_Resistance	1	0.297	92	105.852	16.276
7	Participative_Management	1	0.700	93	106.553	14.902

Table 5: Stepwise variable selection for Conflict Resolution Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Conflict_Resolution ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Conflict_Resolution ~ Board_of_DirectorsCompetence						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	104.847	25.369
2	Participative_Management	1	0.001	88	104.849	23.371
3	Shareholder_Influence	1	0.015	89	104.863	21.384
4	Overcoming_Local_Resistance	1	0.089	90	104.952	19.464
5	Special_Circumstances	1	0.184	91	105.136	17.631
6	HRM_Aspects	1	0.667	92	105.803	16.232
7	PreliminaryResearchOnProjectRequirements	1	1.897	93	107.700	15.920

Table 6: Stepwise variable selection for Cash Flow Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Cash_Flow ~ HRM_Aspects + Overcoming_Local_Resistance + Participative_Management +						
PreliminaryResearchOnProjectRequirements + Board_of_DirectorsCompetence +						
Special_Circumstances + Shareholder_Influence						
Final Model:						
Cash_Flow ~ Overcoming_Local_Resistance						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	118.581	37.063
2	PreliminaryResearchOnProjectRequirements	1	0.231	88	118.811	35.248
3	HRM_Aspects	1	0.365	89	119.177	33.539
4	Shareholder_Influence	1	0.528	90	119.705	31.960
5	Board_of_DirectorsCompetence	1	0.585	91	120.290	30.422
6	Participative_Management	1	1.932	92	122.222	29.936
7	Special_Circumstances	1	2.223	93	124.445	29.649

*Table 7: Stepwise variable selection for Skill Availability**Model*

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Skill_Availability ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Skill_Availability ~ PreliminaryResearchOnProjectRequirements						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	122.028	39.786
2	Participative_Management	1	0.074	88	122.103	37.844
3	Shareholder_Influence	1	0.328	89	122.430	36.098
4	Board_of_DirectorsCompetence	1	0.512	90	122.942	34.494
5	Special_Circumstances	1	0.371	91	123.312	32.780
6	HRM_Aspects	1	1.625	92	124.937	32.024
7	Overcoming_Local_Resistance	1	2.599	93	127.536	31.980

Table 8: Stepwise variable selection for Local Benefits Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Local_Benefits ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Local_Benefits ~ PreliminaryResearchOnProjectRequirements						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	94.275	15.272
2	Overcoming_Local_Resistance	1	0.056	88	94.331	13.329
3	Shareholder_Influence	1	0.105	89	94.436	11.434
4	Board_of_DirectorsCompetence	1	0.343	90	94.779	9.779
5	HRM_Aspects	1	0.655	91	95.434	8.433
6	Participative_Management	1	1.530	92	96.965	7.945
7	Special_Circumstances	1	1.124	93	98.088	7.039

Table 9: Stepwise variable selection for Government Regulations Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Government_Regulations ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Government_Regulations ~ PreliminaryResearchOnProjectRequirements +						
Shareholder_Influence						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	91.993	12.945
2	Special_Circumstances	1	0.040	88	92.033	10.986
3	Participative_Management	1	0.042	89	92.075	9.029
4	Board_of_DirectorsCompetence	1	0.092	90	92.167	7.124
5	HRM_Aspects	1	0.847	91	93.014	5.993
6	Overcoming_Local_Resistance	1	1.905	92	94.919	5.919

Table 10: Stepwise variable selection for Technical Complexities *Model*

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Technical_Complexities ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Technical_Complexities ~ Shareholder_Influence						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	90.265	11.143
2	PreliminaryResearchOnProjectRequirements	1	0.001	88	90.266	9.144
3	Participative_Management	1	0.013	89	90.279	7.157
4	Overcoming_Local_Resistance	1	0.076	90	90.355	5.237
5	Board_of_DirectorsCompetence	1	0.560	91	90.915	3.825
6	HRM_Aspects	1	0.708	92	91.623	2.562
7	Special_Circumstances	1	1.204	93	92.827	1.802

Table 11: Stepwise variable selection for Detailed Completion Reports Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Detailed_Completion_Reports ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Detailed_Completion_Reports ~ HRM_Aspects + Overcoming_Local_Resistance +						
Special_Circumstances						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	88.944	9.742
2	Participative_Management	1	0.119	88	89.063	7.869
3	PreliminaryResearchOnProjectRequirements	1	0.101	89	89.165	5.978
4	Shareholder_Influence	1	0.097	90	89.262	4.081
5	Board_of_DirectorsCompetence	1	0.140	91	89.401	2.229

Table 12: Stepwise variable selection for Lessons Learned Reports Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Lessons_Learned ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Lessons_Learned ~ Overcoming_Local_Resistance + Participative_Management +						
Shareholder_Influence						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	90.842	11.749
2	Board_of_DirectorsCompetence	1	0.012	88	90.854	9.761
3	HRM_Aspects	1	0.014	89	90.868	7.776
4	PreliminaryResearchOnProjectRequirements	1	0.088	90	90.956	5.868
5	Special_Circumstances	1	1.003	91	91.959	4.909

Table 13: Stepwise variable selection for Improved Local Economy Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Improved_Local_Economy ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Improved_Local_Economy ~ Participative_Management + Special_Circumstances						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	88.210	8.955
2	Shareholder_Influence	1	0.074	88	88.284	7.034
3	PreliminaryResearchOnProjectRequirements	1	0.185	89	88.469	5.233
4	HRM_Aspects	1	0.704	90	89.172	3.986
5	Board_of_DirectorsCompetence	1	1.159	91	90.331	3.212
6	Overcoming_Local_Resistance	1	1.099	92	91.430	2.361

Table 14: Stepwise variable selection for Energy Affordability Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Energy_Affordability ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Energy_Affordability ~ Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	86.243	6.813
2	Shareholder_Influence	1	0.051	88	86.295	4.870
3	Overcoming_Local_Resistance	1	0.134	89	86.429	3.017
4	HRM_Aspects	1	1.784	90	88.213	2.958

Table 15: Stepwise variable selection for Local Goods Demand Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Local_Goods_Demand ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Local_Goods_Demand ~ 1						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	106.320	26.695
2	Shareholder_Influence	1	0.024	88	106.344	24.717
3	HRM_Aspects	1	0.118	89	106.462	22.822
4	PreliminaryResearchOnProjectRequirements	1	0.191	90	106.653	20.992
5	Participative_Management	1	0.222	91	106.875	19.189
6	Special_Circumstances	1	0.236	92	107.111	17.399
7	Overcoming_Local_Resistance	1	0.398	93	107.509	15.751
8	Board_of_DirectorsCompetence	1	2.112	94	109.621	15.599

Table 16: Stepwise variable selection for Energy Type Switch Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Energy_Type_Switch ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Energy_Type_Switch ~ Board_of_DirectorsCompetence + Special_Circumstances						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	92.558	13.526
2	HRM_Aspects	1	0.034	88	92.592	11.561
3	Overcoming_Local_Resistance	1	0.394	89	92.986	9.965
4	Participative_Management	1	1.040	90	94.027	9.021
5	PreliminaryResearchOnProjectRequirements	1	1.530	91	95.557	8.555
6	Shareholder_Influence	1	1.295	92	96.852	7.834

Table 17: Stepwise variable selection for Health and Safety Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Health_and_Safety ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Health_and_Safety ~ PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	125.416	42.387
2	HRM_Aspects	1	0.237	88	125.653	40.566
3	Participative_Management	1	0.527	89	126.180	38.964
4	Shareholder_Influence	1	1.208	90	127.388	37.869
5	Overcoming_Local_Resistance	1	1.474	91	128.862	36.962
6	Special_Circumstances	1	1.948	92	130.811	36.388

Table 18: Stepwise variable selection for Air Pollution Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Air_Pollution ~ HRM_Aspects + Overcoming_Local_Resistance + Participative_Management +						
PreliminaryResearchOnProjectRequirements + Board_of_DirectorsCompetence +						
Special_Circumstances + Shareholder_Influence						
Final Model:						
Air_Pollution ~ Board_of_DirectorsCompetence						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	104.809	25.335
2	HRM_Aspects	1	0.000	88	104.809	23.335
3	Shareholder_Influence	1	0.033	89	104.842	21.365
4	Special_Circumstances	1	0.051	90	104.894	19.412
5	Overcoming_Local_Resistance	1	0.080	91	104.974	17.484
6	PreliminaryResearchOnProjectRequirements	1	1.356	92	106.330	16.703
7	Participative_Management	1	1.597	93	107.927	16.120

Table 19: Stepwise variable selection for Visual Aesthetics Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Visual_Aesthetics ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Visual_Aesthetics ~ Overcoming_Local_Resistance + PreliminaryResearchOnProjectRequirements +						
Special_Circumstances + Shareholder_Influence						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	73.298	-8.638
2	Board_of_DirectorsCompetence	1	0.182	88	73.480	-10.401
3	Participative_Management	1	0.416	89	73.897	-11.865
4	HRM_Aspects	1	0.521	90	74.418	-13.197

Table 20: Stepwise variable selection for Local Capacity Building Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Local_Capacity_Building ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Local_Capacity_Building ~ PreliminaryResearchOnProjectRequirements						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	80.083	-0.227
2	Special_Circumstances	1	0.037	88	80.120	-2.184
3	Board_of_DirectorsCompetence	1	0.217	89	80.337	-3.927
4	Participative_Management	1	0.422	90	80.759	-5.429
5	HRM_Aspects	1	0.746	91	81.505	-6.555
6	Overcoming_Local_Resistance	1	0.537	92	82.043	-7.931
7	Shareholder_Influence	1	1.696	93	83.739	-7.986

Table 21: Stepwise variable selection for Local Acceptance Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Local_Acceptance ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Local_Acceptance ~ Overcoming_Local_Resistance + Special_Circumstances						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	79.404	-1.036
2	PreliminaryResearchOnProjectRequirements	1	0.006	88	79.410	-3.029
3	Participative_Management	1	0.131	89	79.541	-4.872
4	HRM_Aspects	1	0.195	90	79.736	-6.640
5	Board_of_DirectorsCompetence	1	0.462	91	80.198	-8.091
6	Shareholder_Influence	1	0.808	92	81.006	-9.139

Table 22: Stepwise variable selection for Job Creation Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Job_Creation ~ HRM_Aspects + Overcoming_Local_Resistance + Participative_Management +						
PreliminaryResearchOnProjectRequirements + Board_of_DirectorsCompetence +						
Special_Circumstances + Shareholder_Influence						
Final Model:						
Job_Creation ~ 1						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	83.173	3.370
2	Participative_Management	1	0.016	88	83.189	1.387
3	Overcoming_Local_Resistance	1	0.042	89	83.231	-0.564
4	Shareholder_Influence	1	0.241	90	83.472	-2.290
5	Special_Circumstances	1	0.601	91	84.073	-3.608
6	Board_of_DirectorsCompetence	1	0.484	92	84.557	-5.063
7	HRM_Aspects	1	1.304	93	85.861	-5.609
8	PreliminaryResearchOnProjectRequirements	1	1.465	94	87.326	-6.001

Table 23: Stepwise variable selection for Fuel Poverty Reduction Model

Stepwise Model Path						
Analysis of Deviance Table						
Initial Model:						
Fuel_Poverty_Reduction ~ HRM_Aspects + Overcoming_Local_Resistance +						
Participative_Management + PreliminaryResearchOnProjectRequirements +						
Board_of_DirectorsCompetence + Special_Circumstances + Shareholder_Influence						
Final Model:						
Fuel_Poverty_Reduction ~ Shareholder_Influence						
	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				87	76.239	-4.900
2	Participative_Management	1	0.053	88	76.292	-6.834
3	Special_Circumstances	1	0.047	89	76.339	-8.775
4	PreliminaryResearchOnProjectRequirements	1	0.929	90	77.269	-9.626
5	Board_of_DirectorsCompetence	1	1.243	91	78.511	-10.110
6	Overcoming_Local_Resistance	1	0.979	92	79.490	-10.933
7	HRM_Aspects	1	1.210	93	80.701	-11.497

APPENDIX E -TEST OF REGRESSION ASSUMPTION

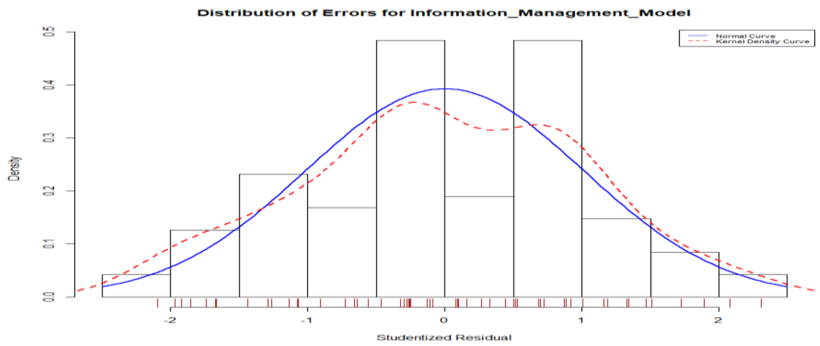

Figure 1: Histogram of Standardized Residuals for Information Management

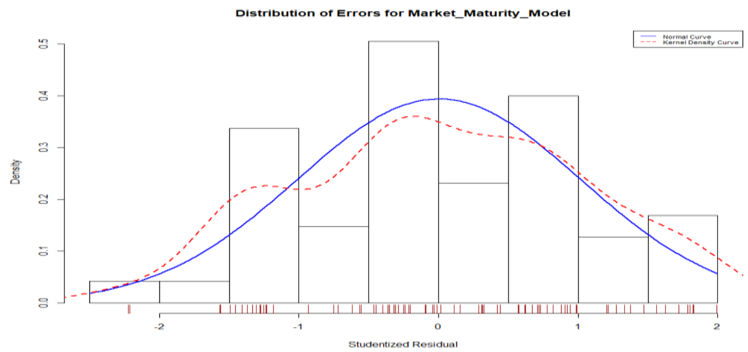

Figure 2: Histogram of Standardized Residuals for Market Maturity

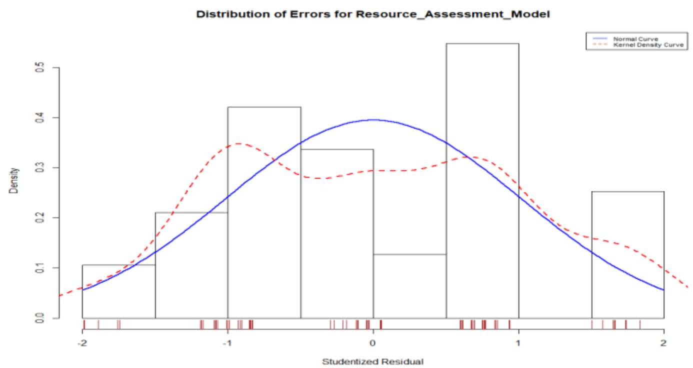

Figure 3: Histogram of standardized Residuals for Resource Assessment

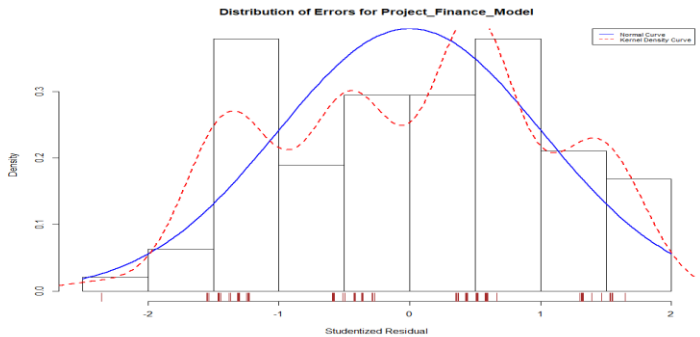

Figure 4: Histogram of standardized Residuals for Project Finance

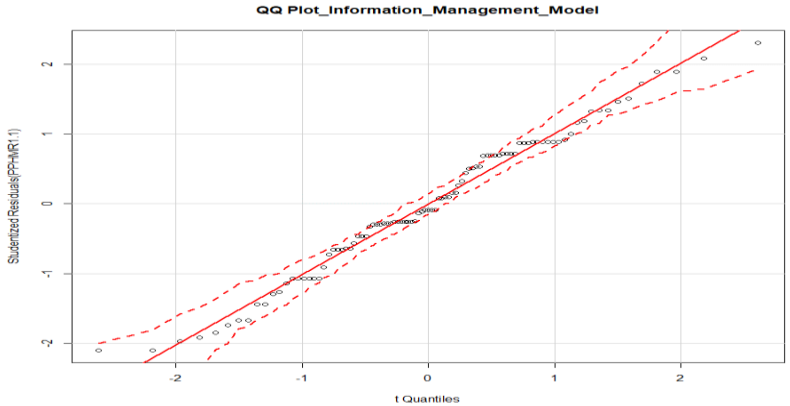

Figure 5: QQ plot for studentized residual for Information Management

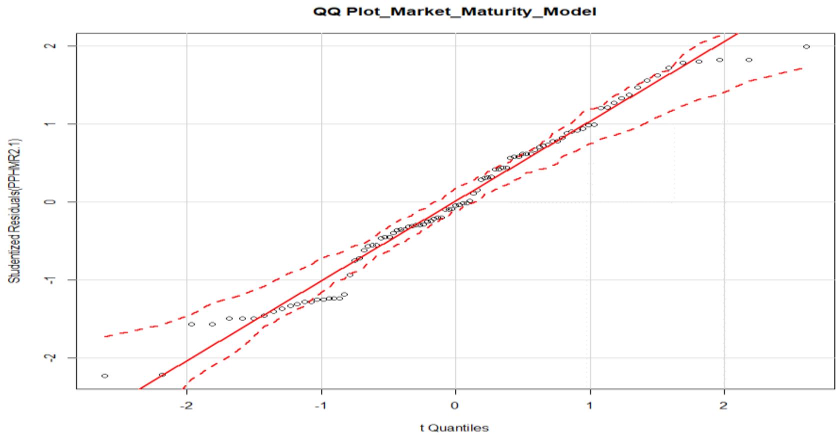

Figure 6: QQ plot for studentized residual for Market Maturity

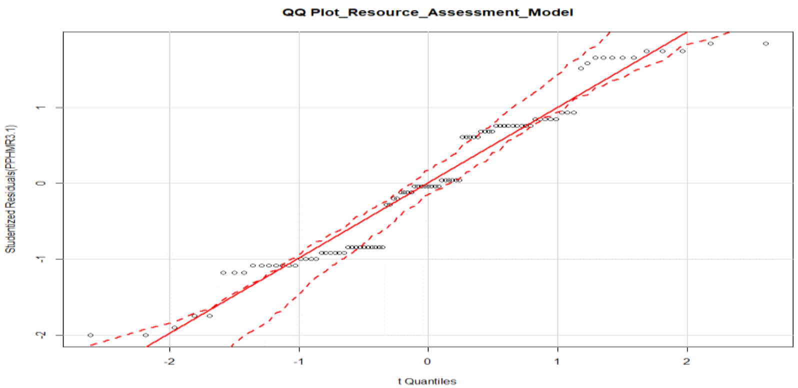

Figure 7: QQ plot for studentized residual for Resource Assessment

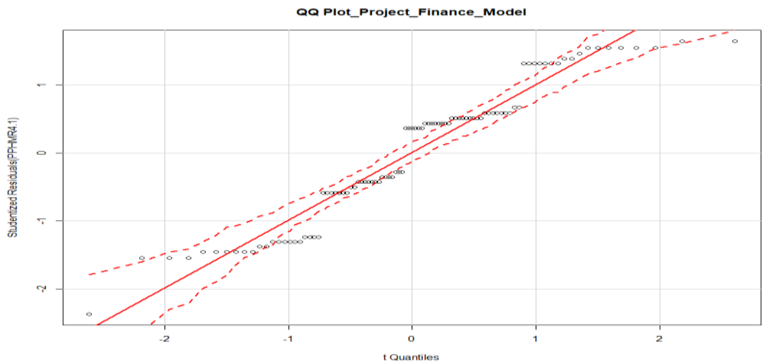

Figure 8: QQ plot for studentized residual for Project Finance

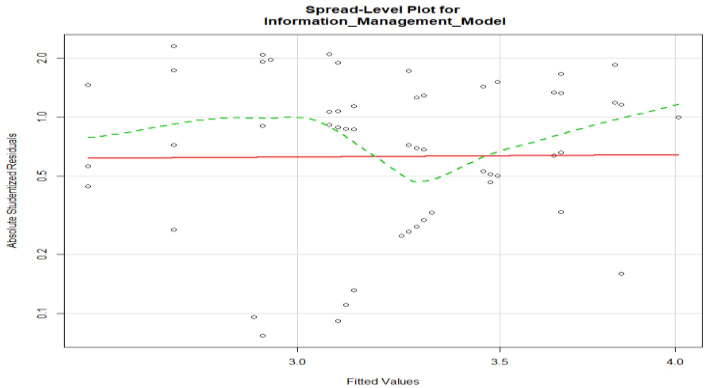

Figure 9: Studentized residuals vs. Fitted values plot for Information Management

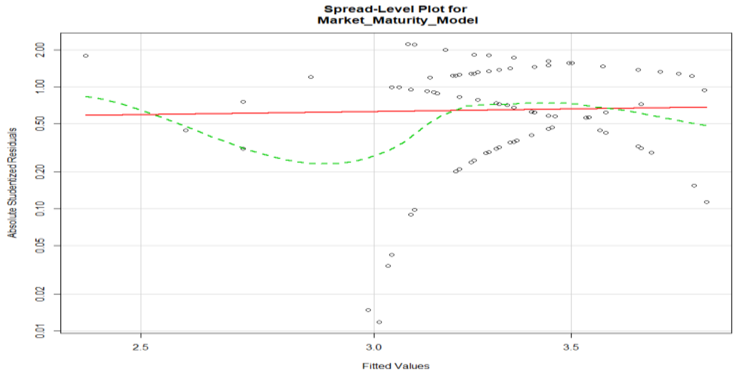

Figure 10: Studentized residuals vs. Fitted values plot for Market Maturity

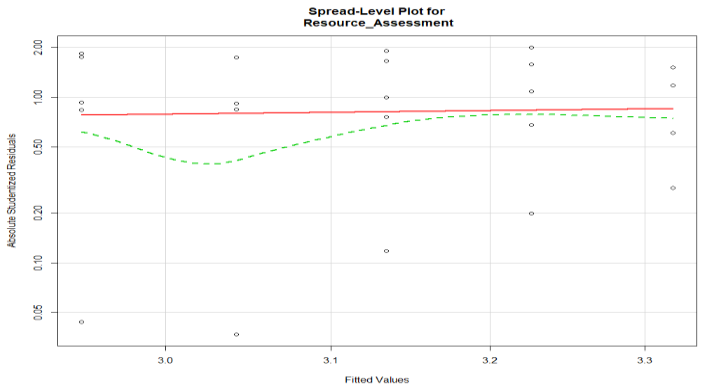

Figure 11:Studentized residuals vs. Fitted values plot for Resource Assessment

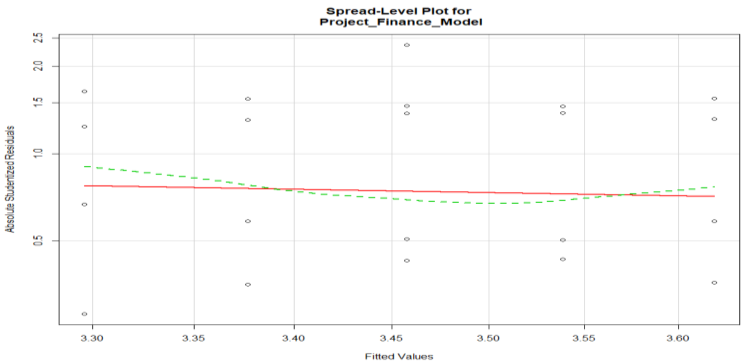

Figure 12: Studentized residuals vs. Fitted values plot for Project Finance

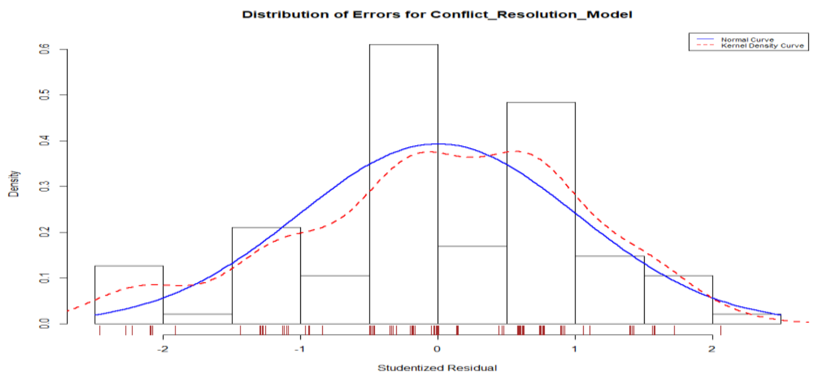

Figure 13: Distribution of Errors for Conflict Resolution Model

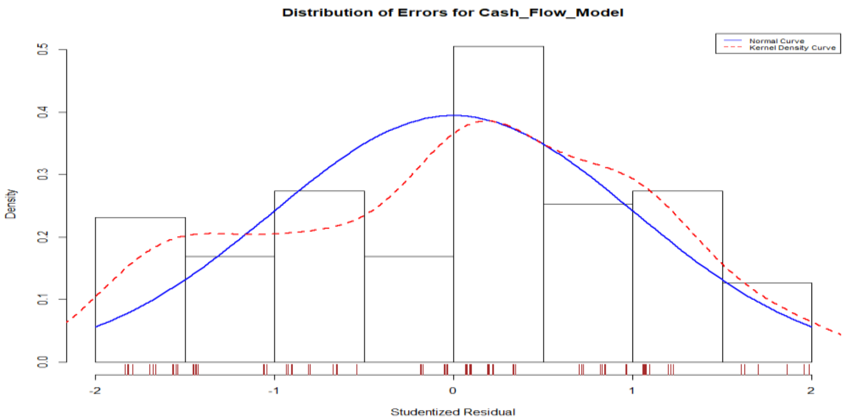

Figure 14: Distribution of Errors for Cash Flow Model

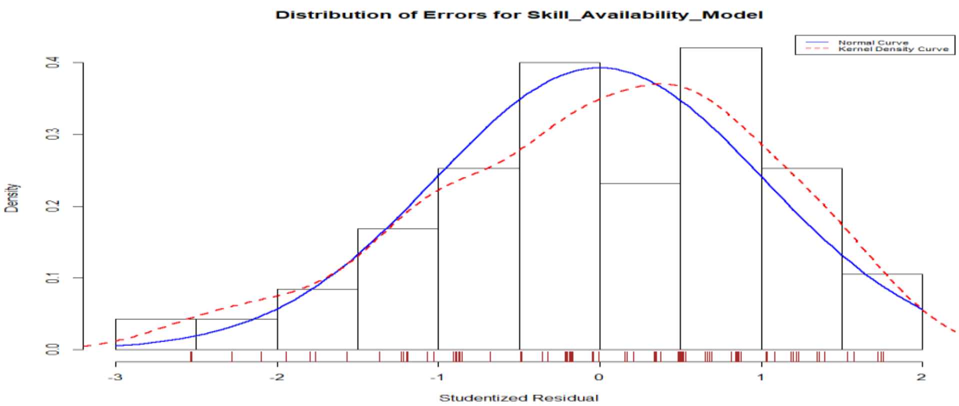

Figure 15: Distribution of Errors for Skill Availability Model

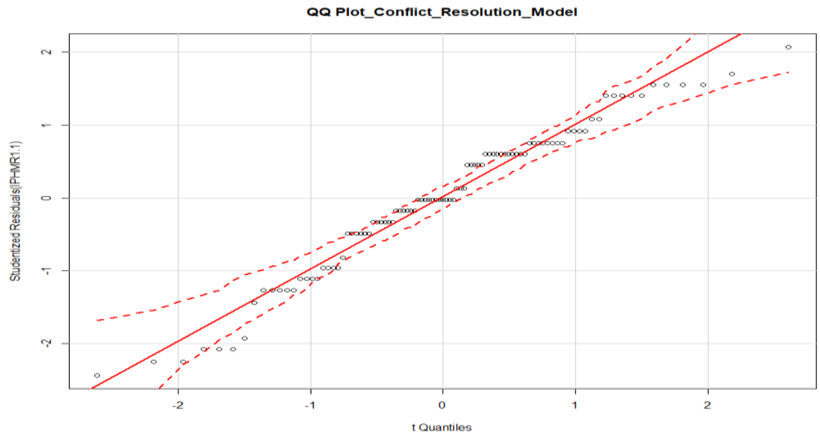

Figure 16: QQ Plot for Conflict Resolution

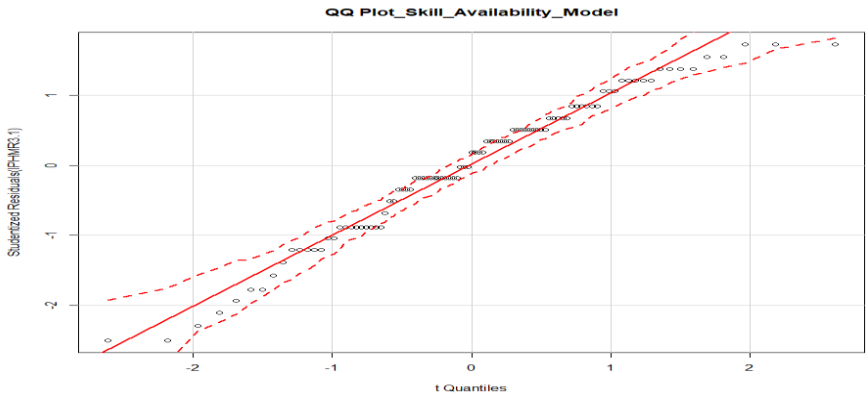

Figure 17: QQ Plot for Cash Flow Model

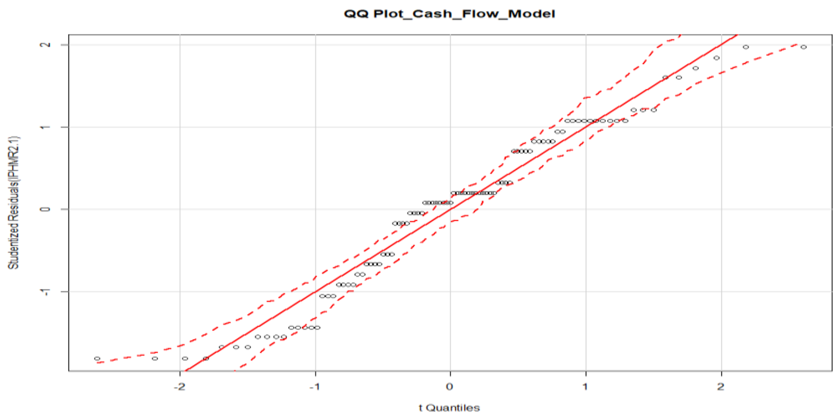

Figure 18: QQ Plot for Skill Availability Model

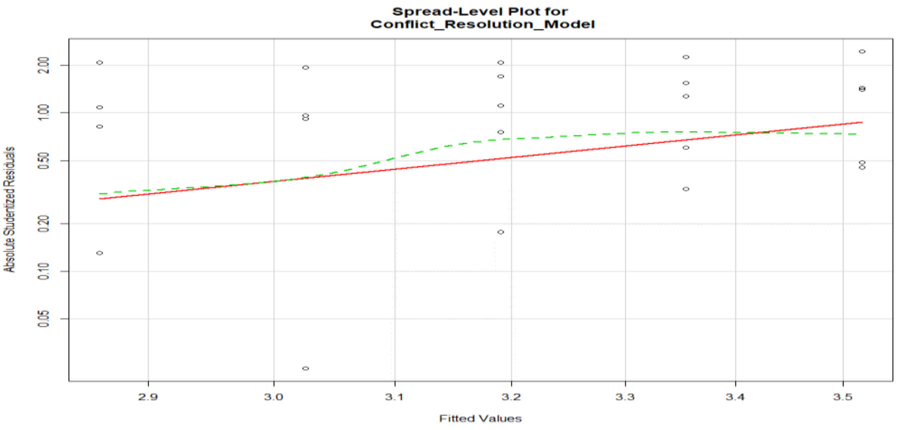

Figure 19: Studentized vs Fitted values for Conflict Resolution Model

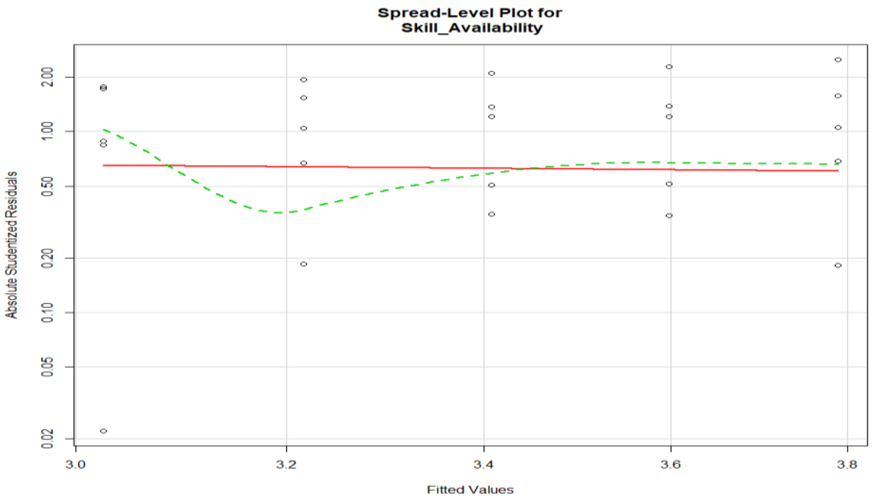

Figure 20: Studentized vs Fitted values for Cash Flow Model

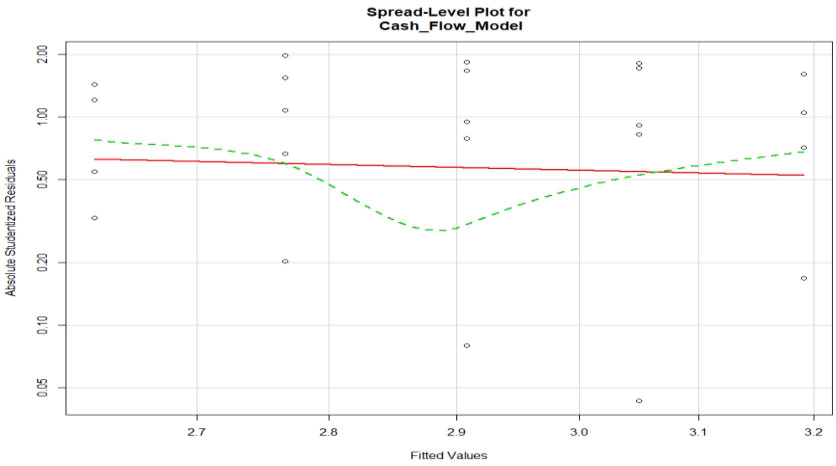

Figure 21: Studentized vs Fitted values for Skill Availability Model

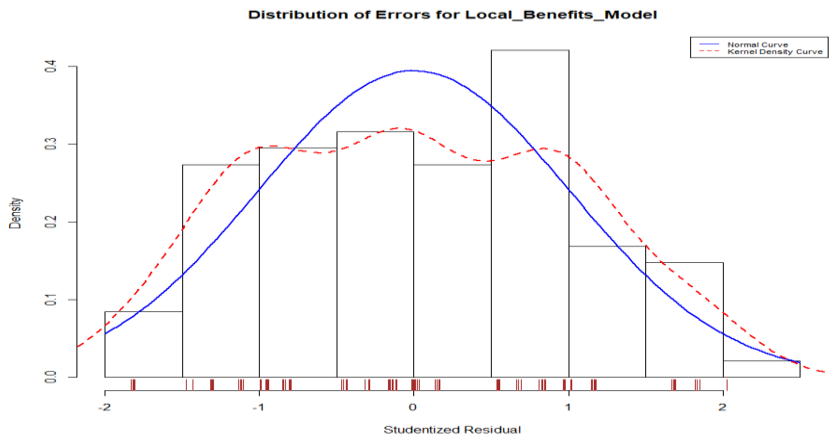

Figure 22: Histogram of Standardized Residuals for Local

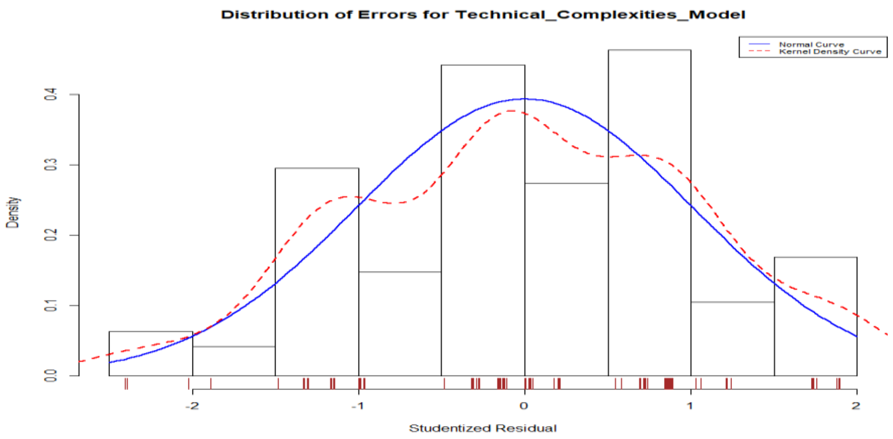

Figure 23: Histogram of Standardized Residuals for Government Regulation Model

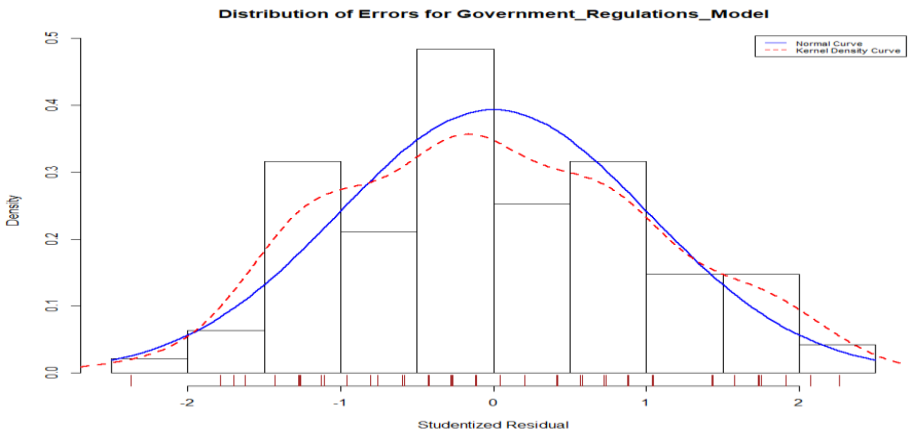

Figure 24: Histogram of Standardized Residuals for Technical Complexities Model

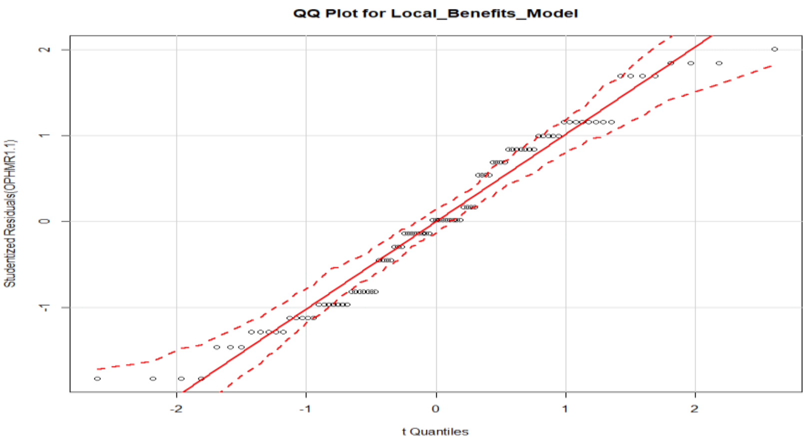

Figure 25: QQ Plot for Local Benefits Model

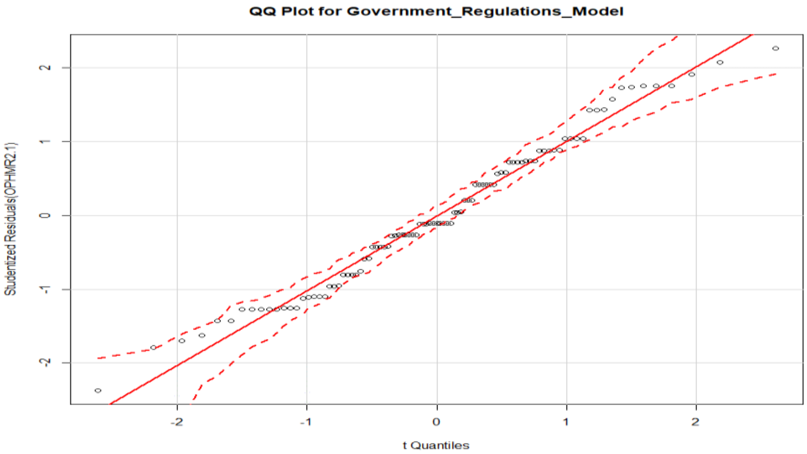

Figure 26: QQ Plot for Government Regulation Model

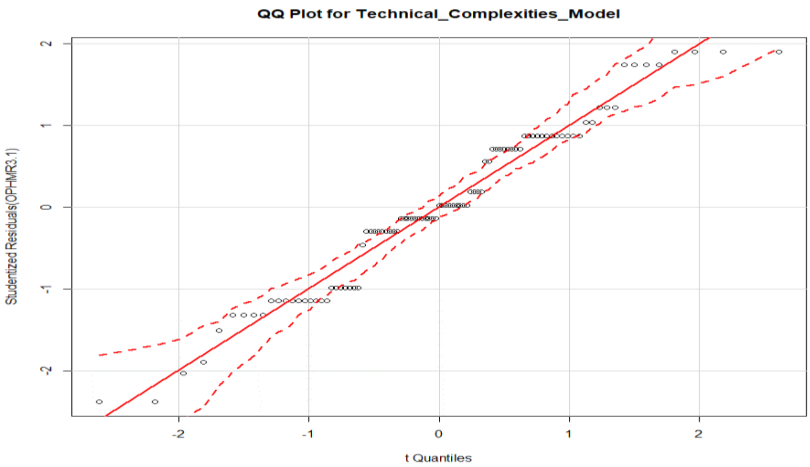

Figure 27: QQ Plot for Technical Complexities Model

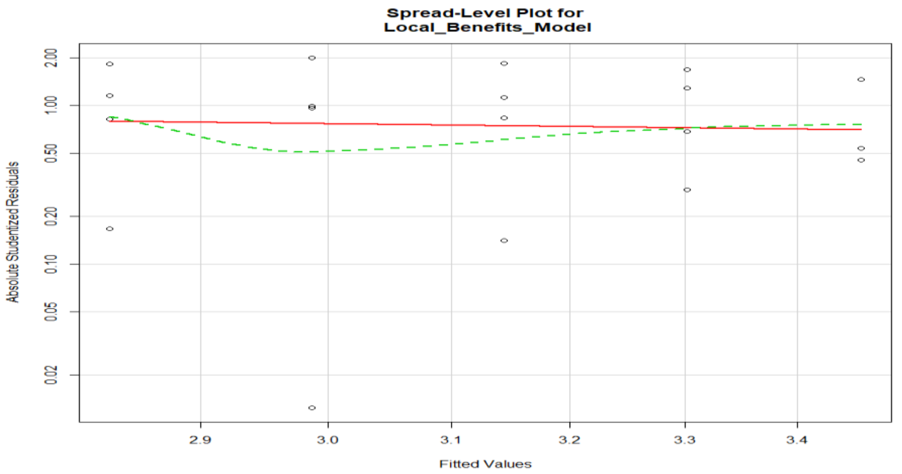

Figure 28: Studentized residuals vs. Fitted values plot for Local Benefits Model

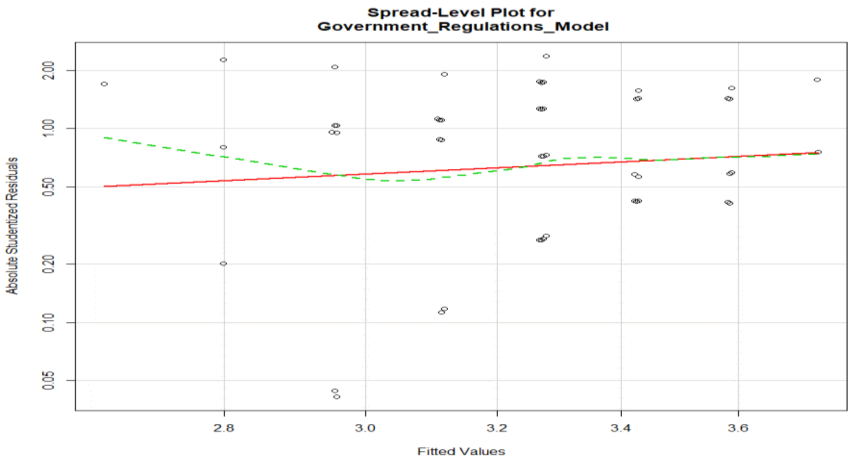

Figure 29: Studentized residuals vs. Fitted values plot for Government Regulation Model

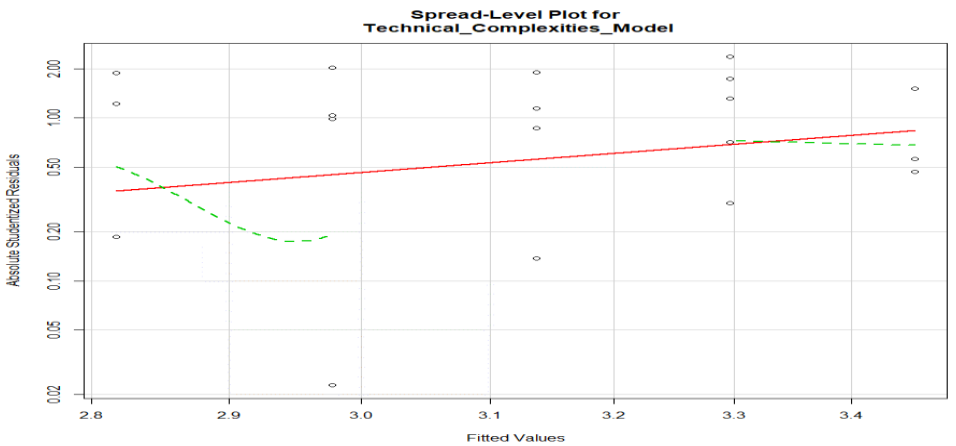

Figure 30: Studentized residuals vs. Fitted values plot for Technical Complexities Model

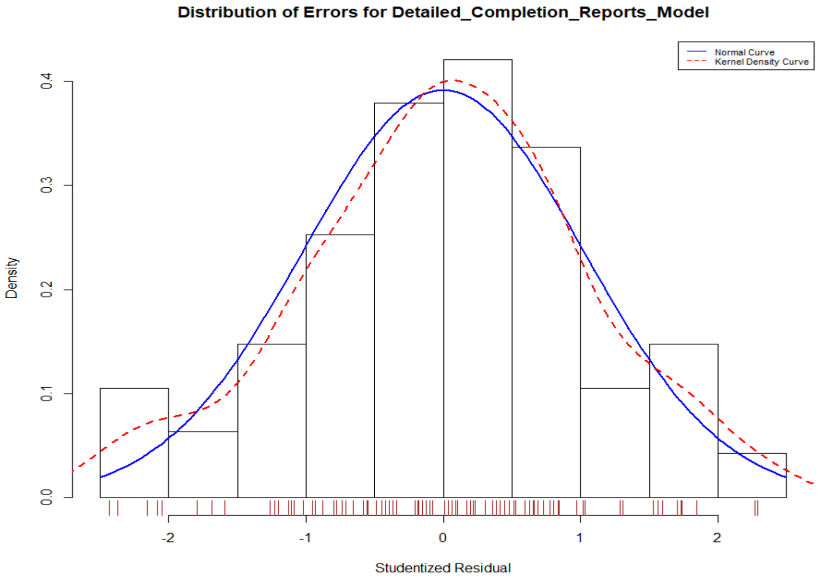

Figure 31: Histogram of Standardized Residuals for Detailed Completion Reports Model

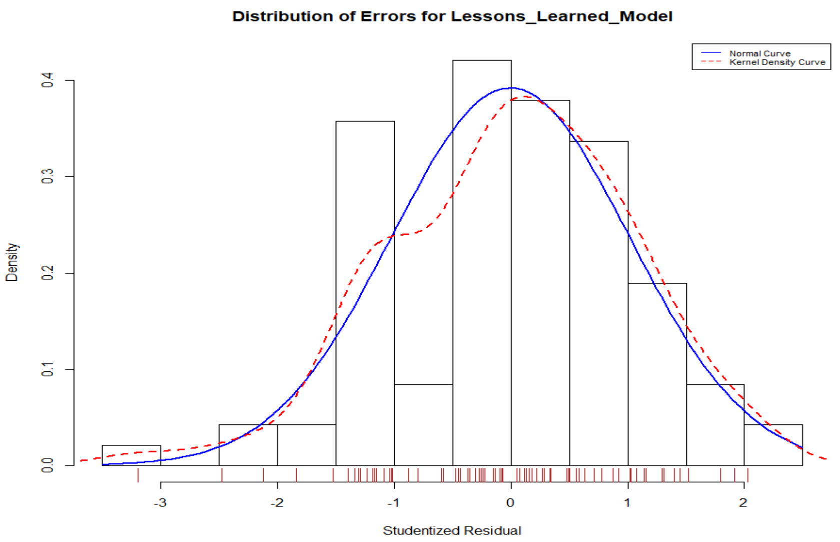

Figure.32: Histogram of Standardized Residuals for Lessons Learned Model

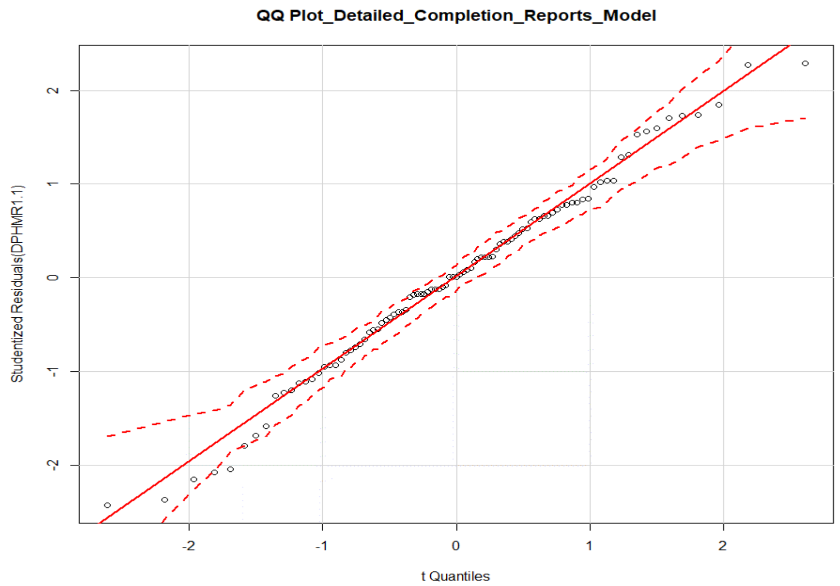

Figure 33: QQ Plot for Detailed Completion Reports Model

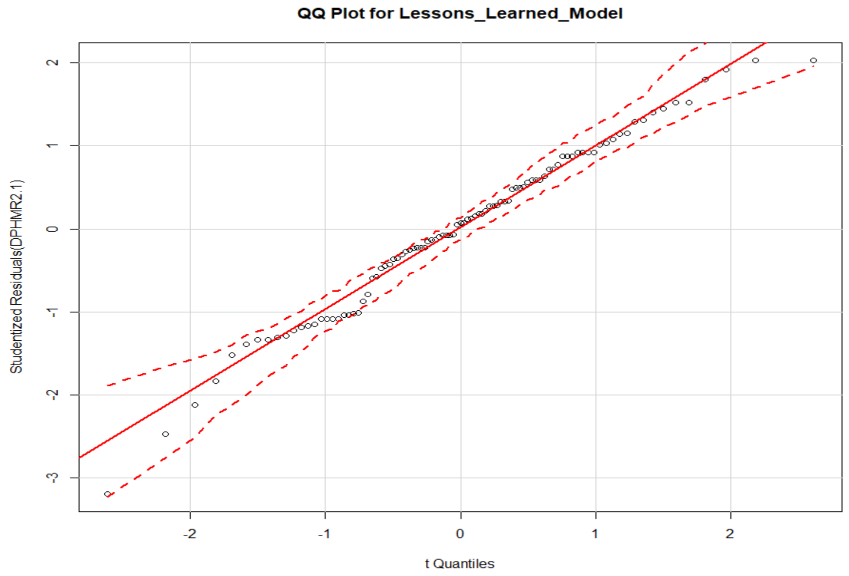

Figure 34: QQ Plot for Lessons Learned Model

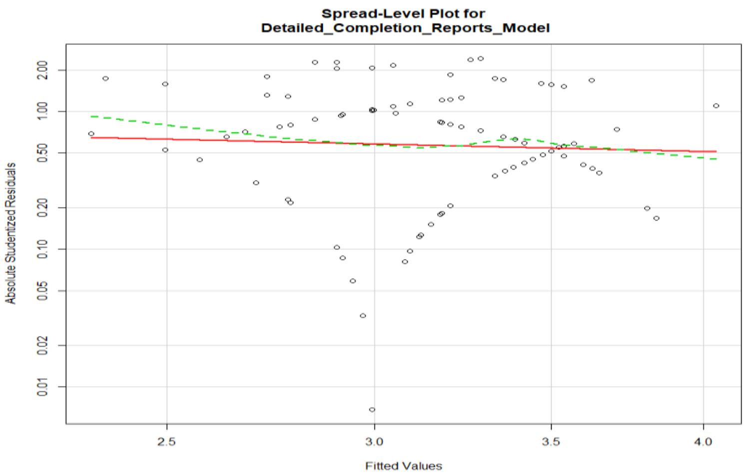

Figure 35: Studentized residuals vs. Fitted values plot for Detailed Completion Reports Model

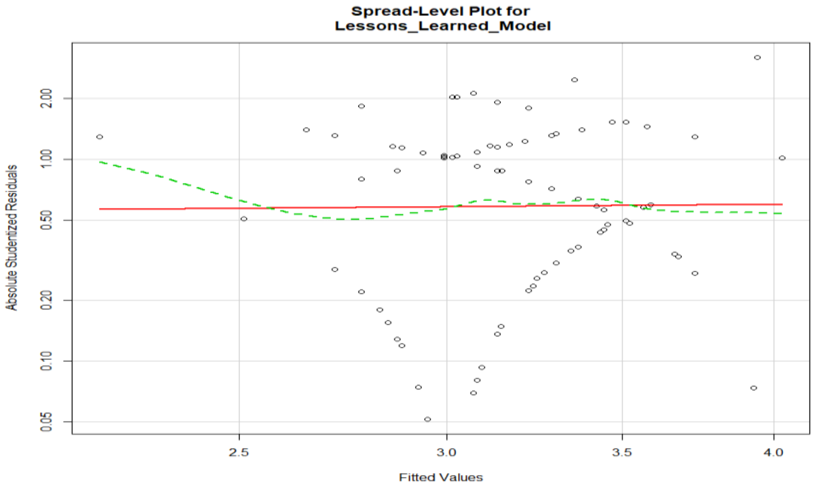

Figure 36: Studentized residuals vs. Fitted values plot for Lessons Learned Model

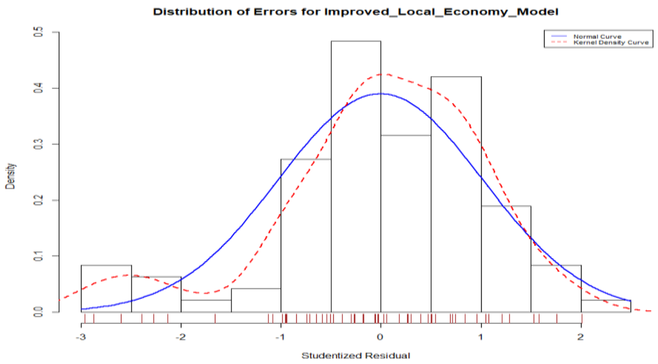

Figure 37: Histogram of Standardized Residuals for Improve Local Economy Model

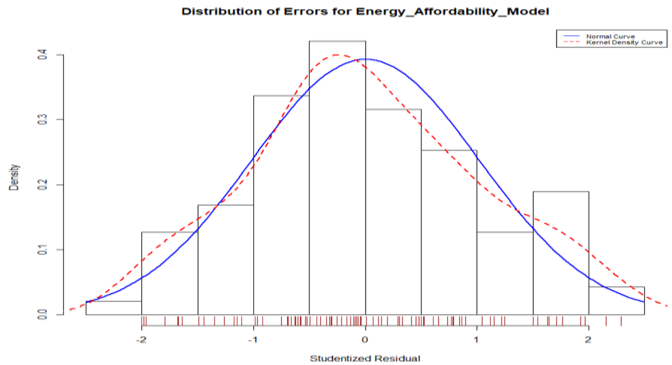

Figure 38: Histogram of Standardized Residuals for Energy Affordability Model

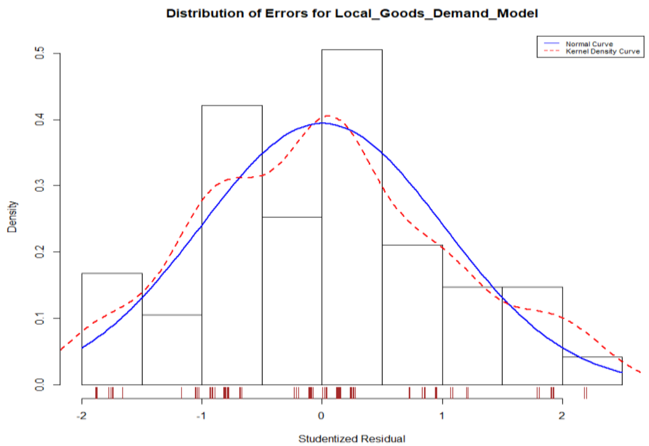

Figure 39: Histogram of Standardized Residuals for Local Goods Demand Model

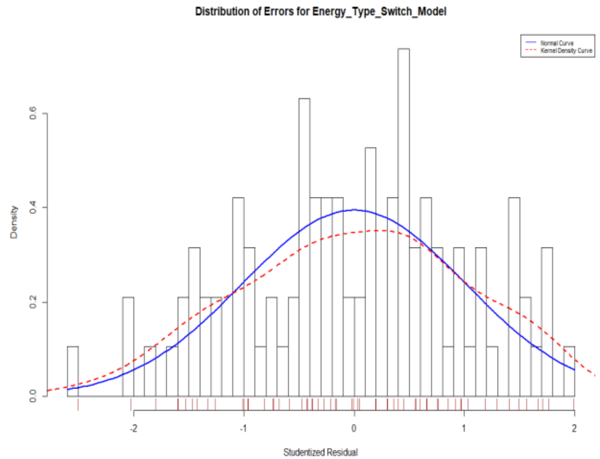

Figure 40: Histogram of Standardized Residuals for Energy Type Switch Model

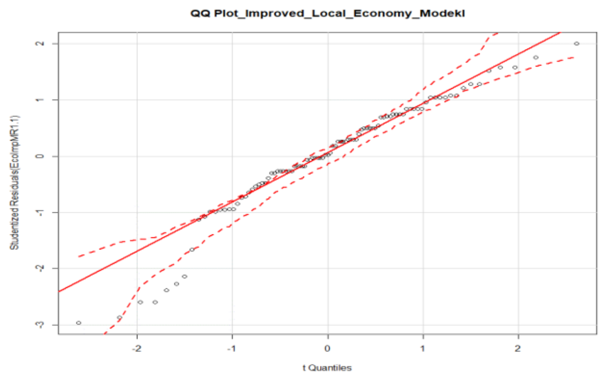

Figure 41: QQ Plot for Improve Local Economy Model

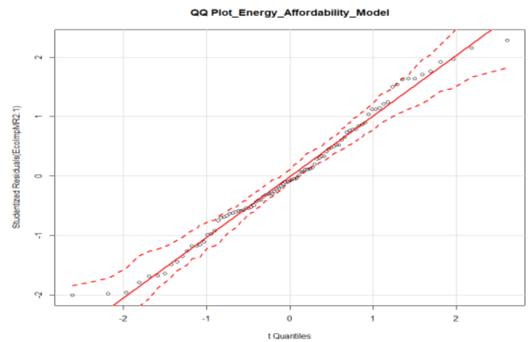

Figure 42: QQ Plot for Energy Affordability Model

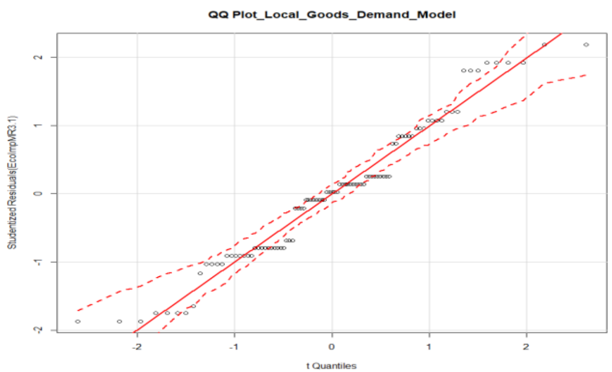

Figure 43: QQ Plot for Local Goods Demand Model

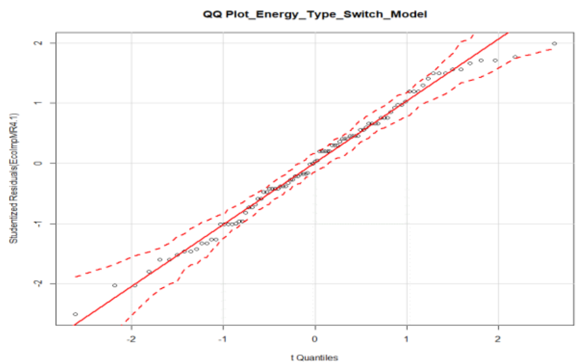

Figure 44: QQ Plot for Energy Type Switch Model

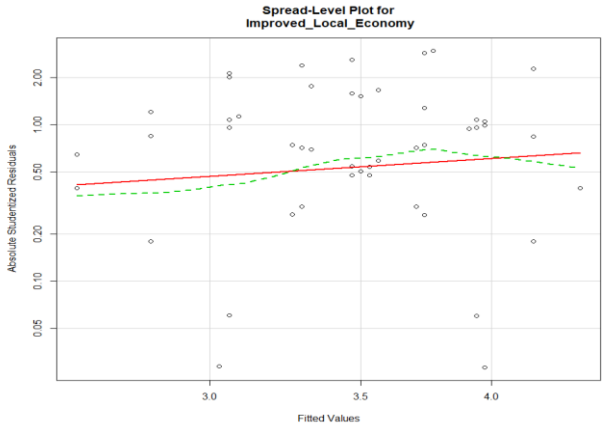

Figure 45: Studentized residuals vs. Fitted values plot for Improved Local Economy Model

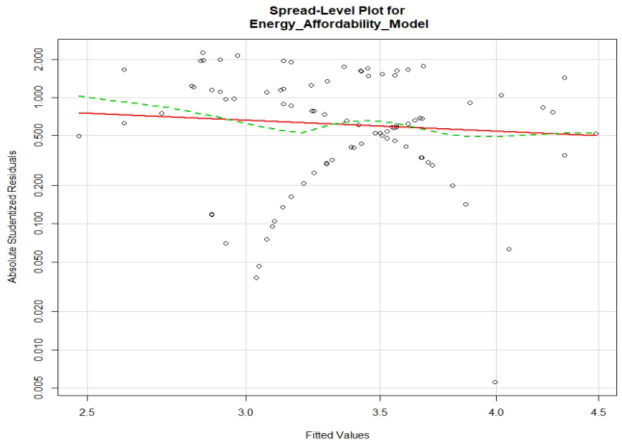

Figure 46: Studentized residuals vs. Fitted values plot for Energy Affordability Model

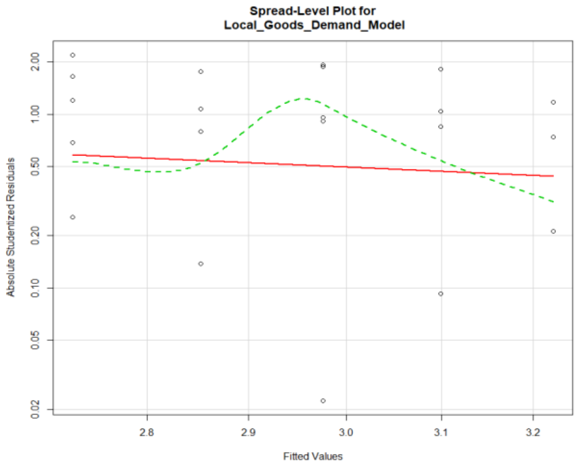

Figure 47: Studentized residuals vs. Fitted values plot for local Goods Demand Model

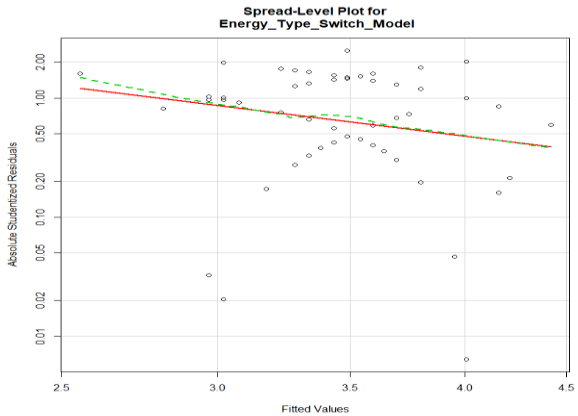

Figure 48: Studentized residuals vs. Fitted values plot for Energy Type Switch Model

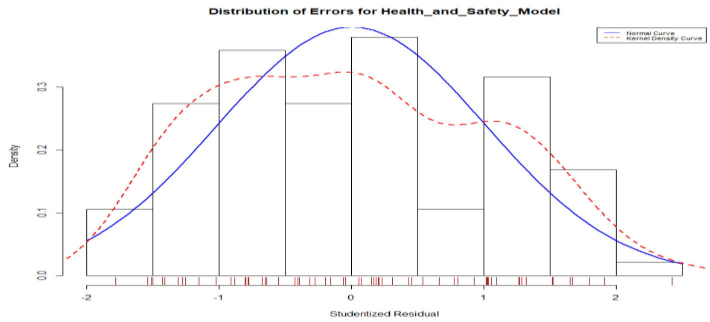

Figure 49: Histogram of Standardized Residuals for Health and Safety Model

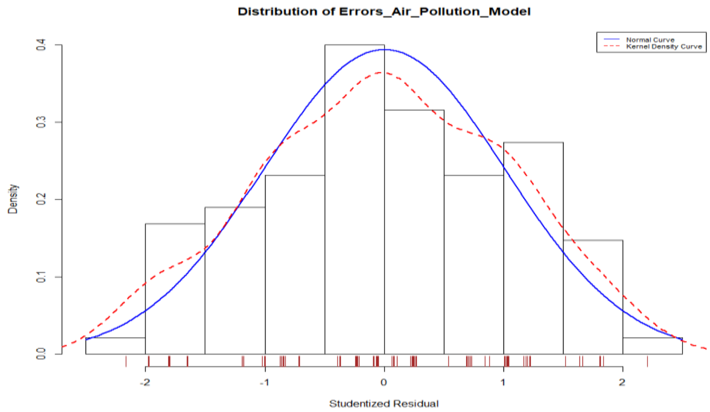

Figure 50: Histogram of Standardized Residuals for Air Pollution Model

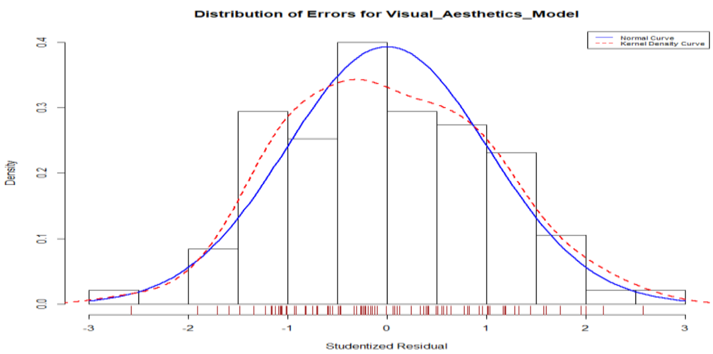

Figure 51: Histogram of Standardized Residuals for Visual Aesthetics Model

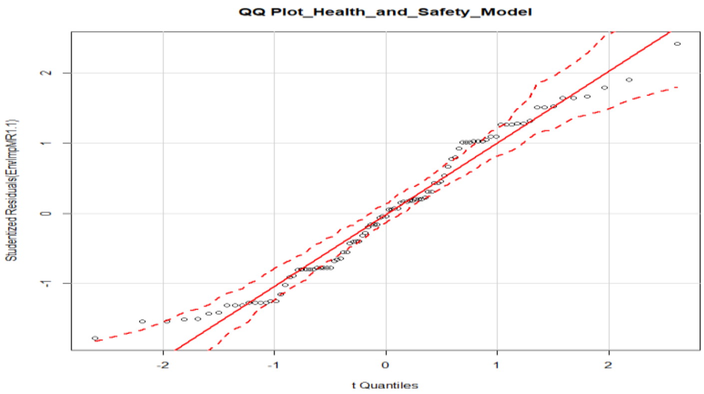

Figure 52: QQ Plot for Health and Safety Model

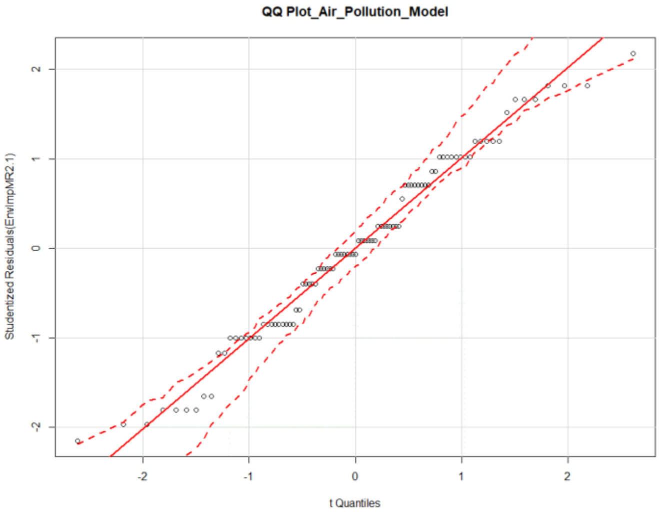

Figure 53: QQ Plot for Air Pollution Model

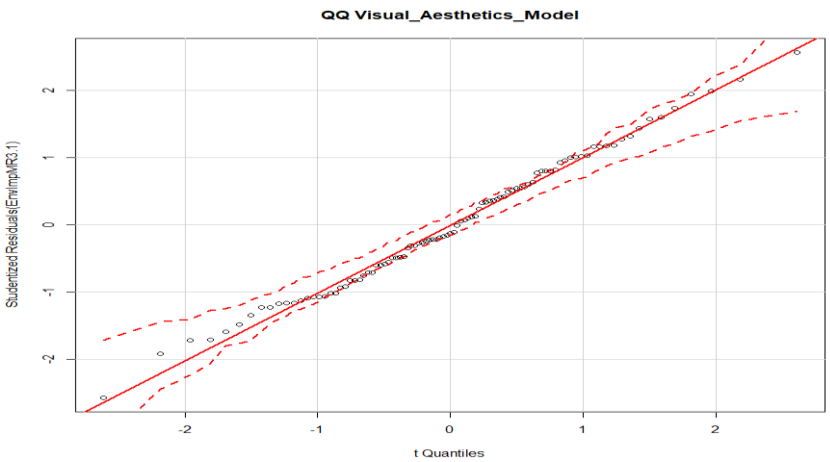

Figure 54: QQ Plot for Visual Aesthetics Model

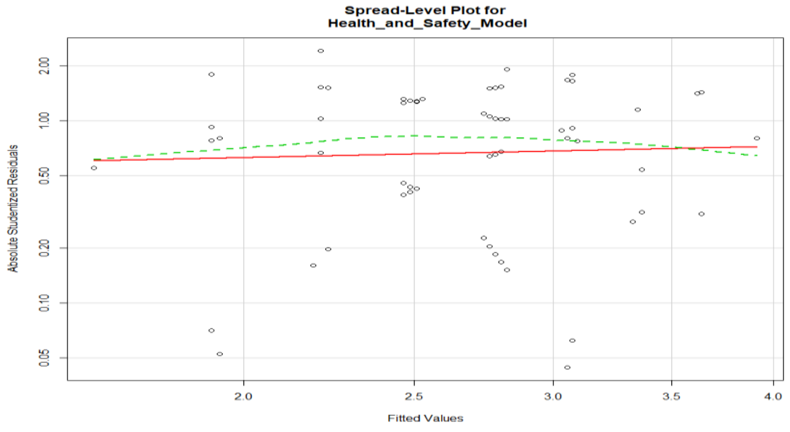

Figure 55: Studentized residuals vs. Fitted values plot for Health and Safety Model

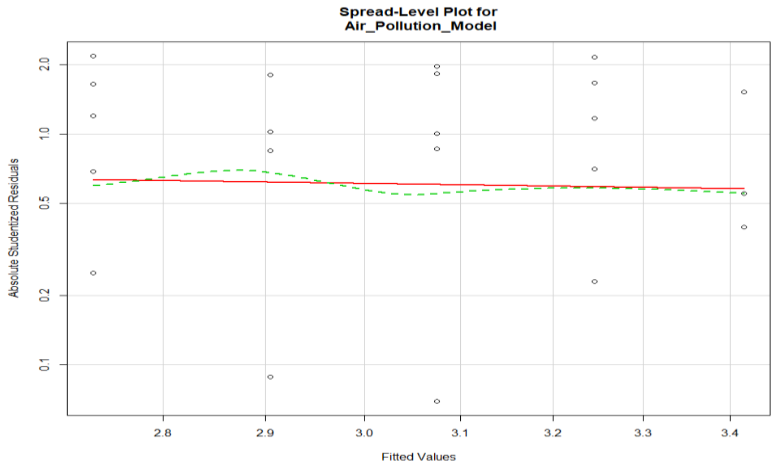

Figure 56: Studentized residuals vs. Fitted values plot for Air Pollution Model

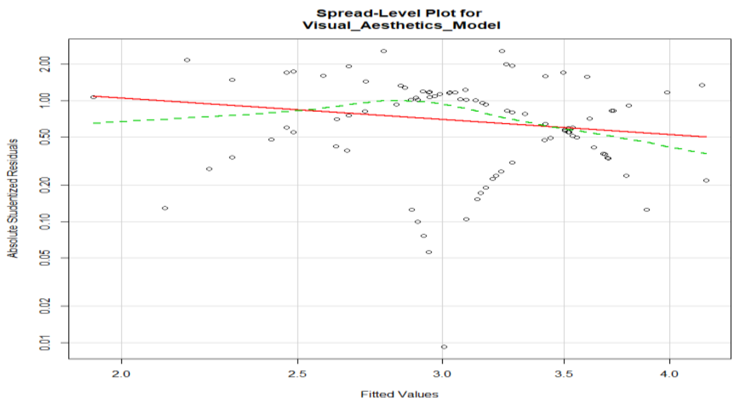

Figure 57: Studentized residuals vs. Fitted values plot for Visual Aesthetics Model

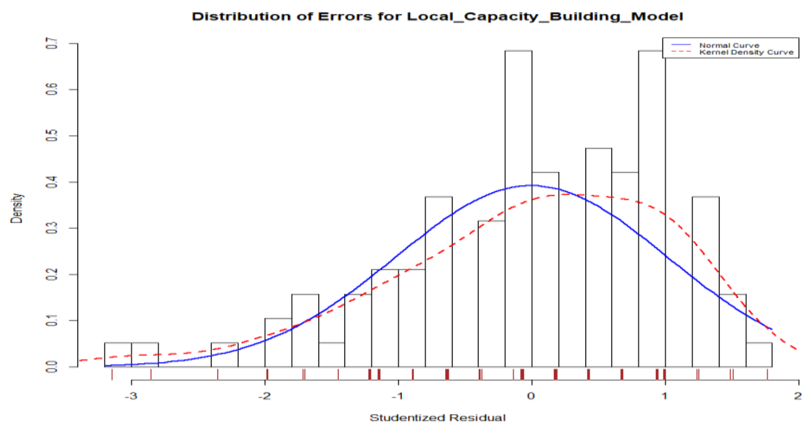

Figure 58: Histogram of Standardized Residuals for Local Capacity Building Model

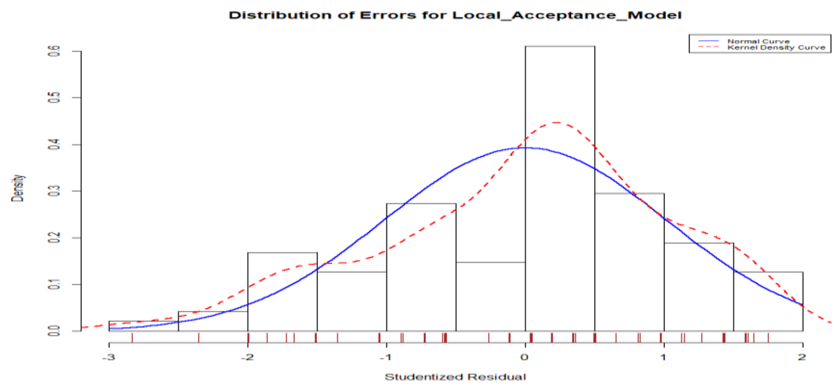

Figure 59: Histogram of Standardized Residuals for Local Acceptance Model

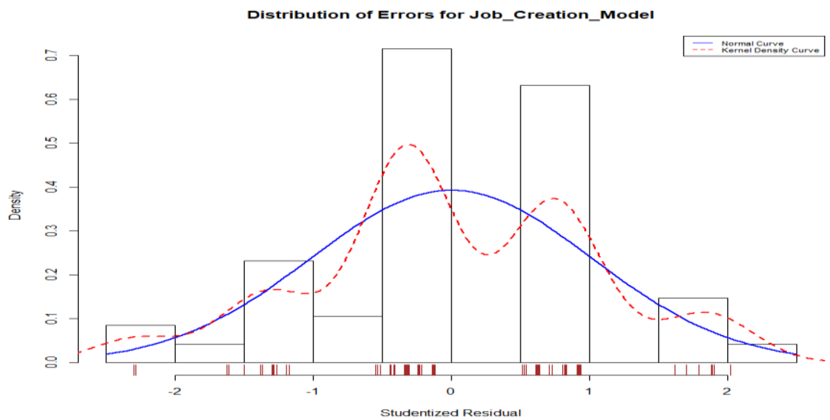

Figure 60: Histogram of Standardized Residuals for Job Creation Model

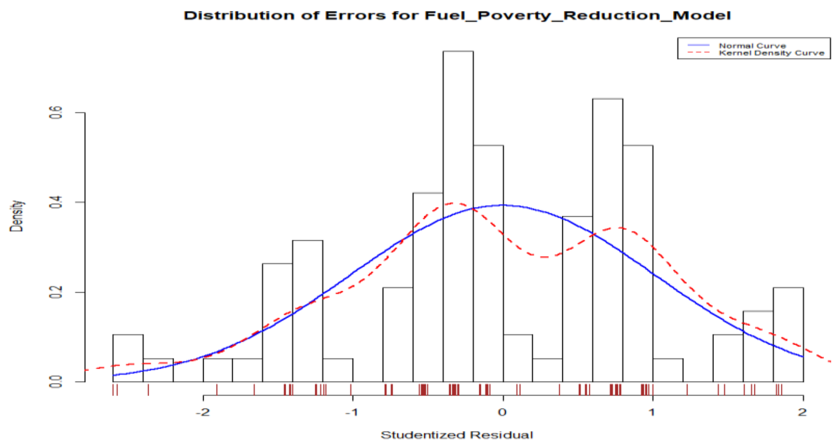

Figure 61: Histogram of Standardized Residuals for Poverty Reduction Model

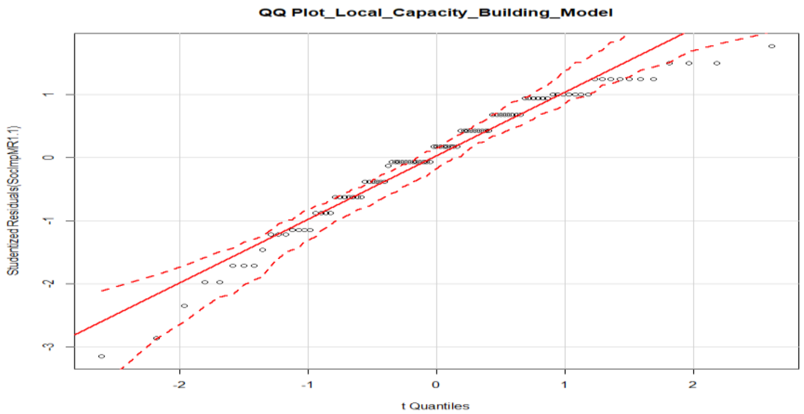

Figure 62: QQ Plot for Local Capacity Building Model

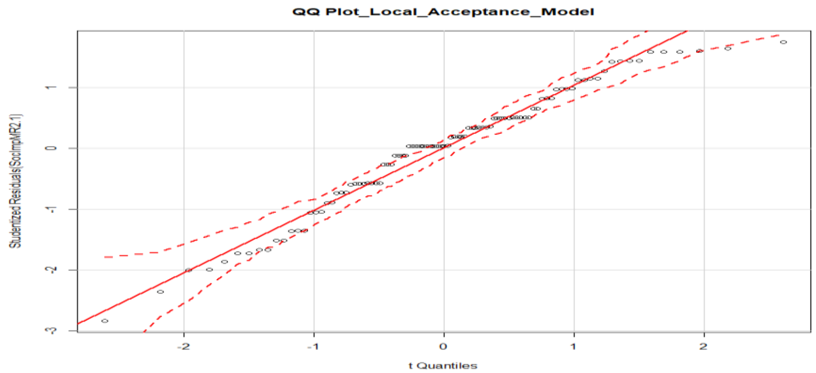

Figure 63: QQ Plot for Local Acceptance Model

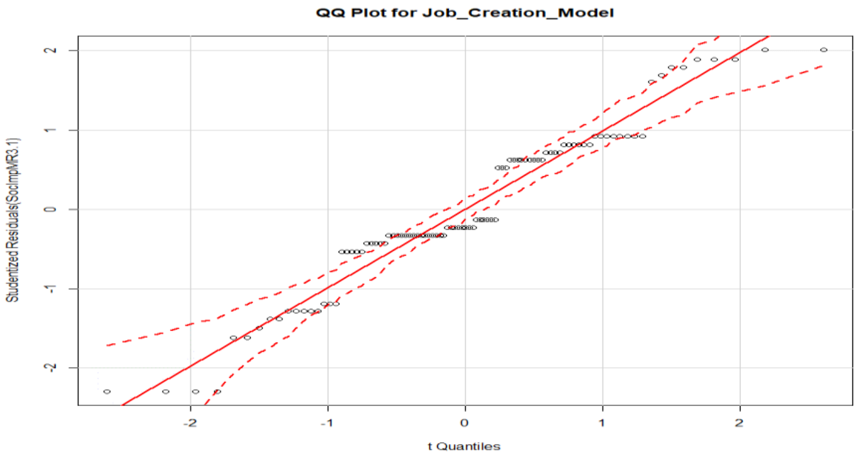

Figure 64: QQ Plot for Job Creation Model

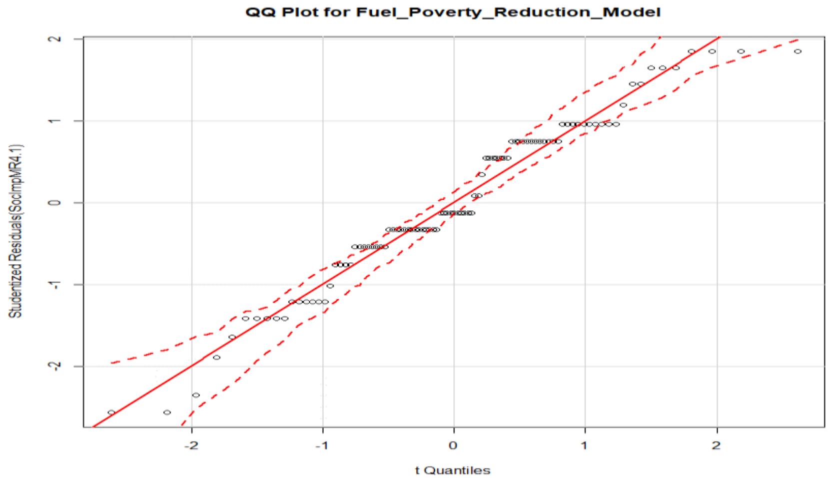

Figure 65: QQ Plot for Poverty Reduction Model

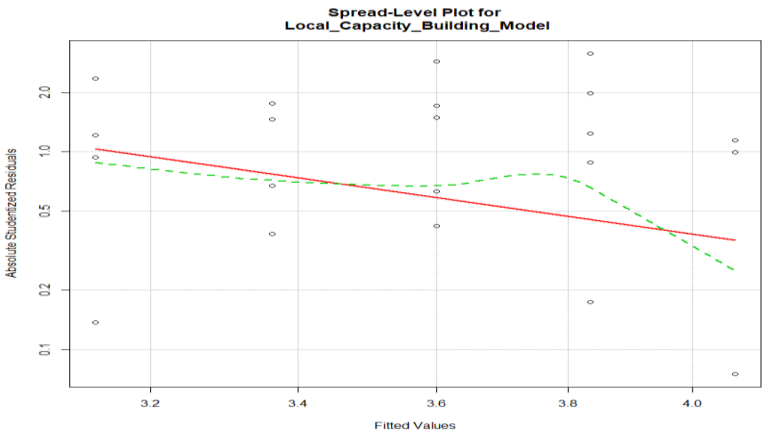

Figure 66: Studentized residuals vs. Fitted values plot for Local Capacity Building Model

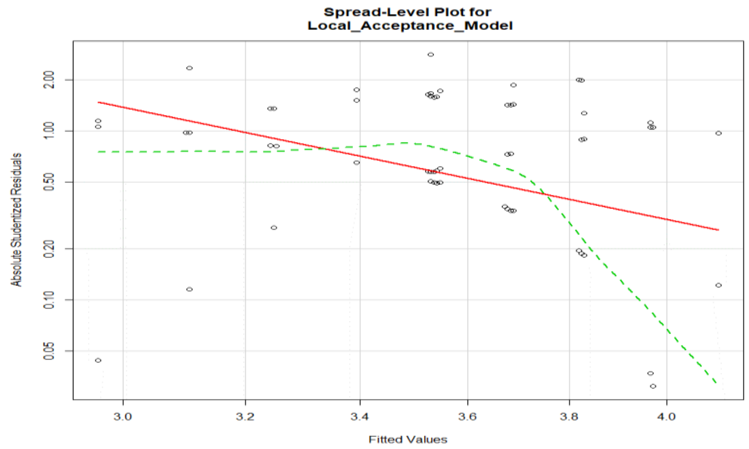

Figure 67: Studentized residuals vs. Fitted values plot for Local Acceptance Model

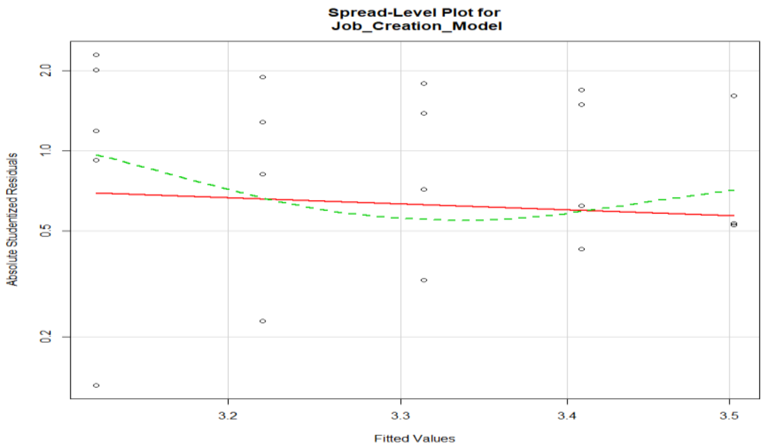

Figure 68: Studentized residuals vs. Fitted values plot for Job Creation Model

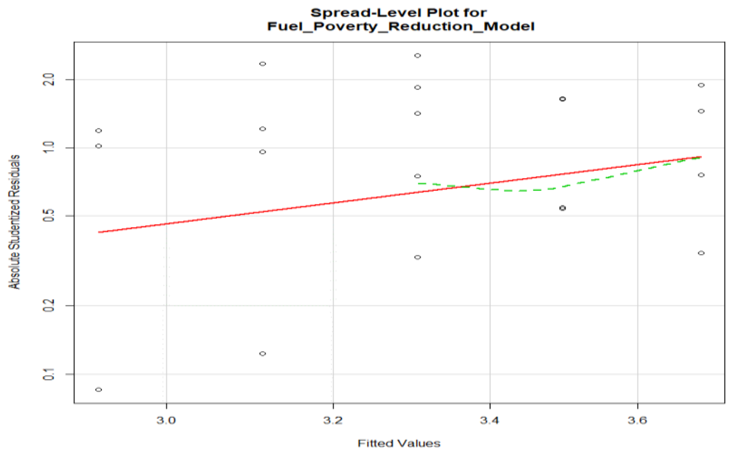

Figure 69: Studentized residuals vs. Fitted values plot for Poverty Reduction Model

APPENDIX F - INTERVIEW PROTOCOL AND REQUEST LETTER

To Whom It May Concern

11th December 2016

RE: Interview on effectiveness of Community Energy Project Business Models in delivering Community Energy Projects in the UK
Dear Jim,

I am contacting you on behalf of my PhD student, Ayi Iboh, who is currently undertaking research at Heriot-Watt University; the research explores the Impacts of Community Energy Ownership Models on the Nature and Performance of Community Renewable Energy Projects (CREPs) in the UK.

As a representative of the community and expert in the Community Energy Sector, I would appreciate it if you could assist Ayi in his research by agreeing to participate in a short interview with him. The interview seeks to obtain information on the efficiency of your Community Energy Business Models (CEBMoD) in managing Projects in your locality and in the UK. The interview is expected to take no more than 30 minutes of your time. In order to facilitate a smooth discussion, Ayi has prepared (attached) a 'snapshot' analysis of the UK Community Energy sector.
Heriot-Watt University has strong ethical guidelines for the collection and use of data and as a researcher in the University, Ayi will strictly follow these. The publication of the results will be anonymised and exclude any means by which respondents or their organisations can be identified.
Please reply by email to Ayi (aai11@hw.ac.uk) or myself if you are willing to take part in the interview and he will follow-up to arrange a suitable time.
In the meantime, please do not hesitate to contact me if you require further information about the research.

Kind regards

Dr Ibrahim Motawa
Email: i.a.motawa@hw.ac.uk
Telephone: +44 (0)131 451 4620

Interview Schedule

Questions

General Information:

1.1. Could you tell me about your professional experience, background and what led to your involvement in CEPs?

A. Ownership Model Structure and Impacts

1.2. How would you describe the current situation of the uptake of CEPs in the UK?
1.3. Can you briefly explain how your (insert CEBMoD type here) is working to achieve CEP goals in the UK?
1.4. Can you briefly explain how you operate as a (insert CEBMoD type here) **i.e.** your daily, weekly, monthly routine as the case may be?
1.5. Can you briefly summarise your (insert CEBMoD type here) short, medium and long term operational activities?
1.6. Where there any conflict of interest from any of the project stakeholders?
1.7. What would you say in your opinion, influenced the choice of MODEL deployed on that project?
1.8. Does your choice of a (insert CEBMoD type here) influence the performance of CREP?
1.9. What are the parameters for assessing if the project is performing or not?
1.10. Specific aspects of local ownership that enhances long-term performance of RE projects
1.11. what were the skill areas outsourced?
1.12. I understand members are mostly volunteers, how do you overcome volunteers' burnout?

B. Community Energy Project(s) Performance

1.13. What are the implications for the community and stakeholders investing in Renewable Energy Projects?
- Are these realisable?

1.14. How would you describe the process of securing planning consent for the project?
- What phase took the longest time to complete and why?

1.15. Any plans to embark on more projects?
- Probe: are there things your group would do differently?
- Membership,
- funding sources and applications
- feasibility assessments and
- project management
- planning and regulatory requirements
- the grid connection process, FITs, ROCs and RHI
- securing advice on State Aid, procurement and financial issues
- Community consultation and good governance etc.

1.16. Can you remember if there were any Institutional issues faced by your Group in any phase of the project implementation?

1.17. Comparatively, how would you describe people's impression about the project at inception and now?

C. Moving Forward

1.18. Do you require additional supports to sustain project?
- *Probe:* What are they?

1.19. So far, how successful is the project? (lessons learnt)
- What are your plans to mitigate these challenges on future projects?

D. Closing

- We have come to the end of the conversation;
- Do you have any other thing you would like to add to our discussion, or any comments you would want to make?
- I also ask if you would be willing to continue participation through occasional contact by email or telephone.
- Would you recommend any other person you think can provide additional information on:
    - *funding sources and applications*
    - *feasibility assessments and*
    - *project management*
    - *planning and regulatory requirements*
    - *the grid connection process, FITs, ROCs and RHI*
    - *Securing advice on State Aid, procurement and financial issues*
    - *Community consultation and good governance etc.*

Thank you again for your time and for your contribution towards the success of this research study. I will keep you updated on its final findings if you won't mind.

If you have any questions or concerns about this study, please contact me at the details provided in previous emails.

APPENDIX G - FRAMEWORK EVALUATION REQUEST AND INSTRUMENT

Request to participate in the Evaluation of Community Energy Ownership Model Framework

Hello Sir/Madam

I got the details of what your organisation is doing from your website and since this is related to my PhD research, I believe a member of your team can assist in evaluating the framework I developed as part of my PhD work. Please kindly pass this email to your colleagues. Anyone who is happy to participate can contact me directly for a copy of the framework and link to the online evaluation platform.

I want to assure you that Heriot-Watt University has strong ethical guidelines for the collection and use of data for research, I will strictly follow these.

I count on your assistance in this regard

Thank you

FRAMEWORK EVALUATION INSTRUMENT

SECTION A: Background Information on the respondent

1. Name (optional)…………………………………………………………………

2. Name of organization (optional)..

3. Academic Qualifications: HND B.Tech/BSc M.Tech PhD

4. Profession: ………………………………………………………………….

5. Years in Service (Community Energy Sector): ………………………………..

6. Designation of Respondent in the establishment: ,,,,,,,,,,,,,,,,,,,,,,.....................

SECTION B: Framework Evaluation

7. Using the scale below, please evaluate the framework based on the statement

Excellent	Above Average	Average	Below Average	Extremely Poor
5	4	3	2	1

Evaluation Statements	**Scale**				
	5	4	3	2	1
Framework clarity and conciseness					
Logical sequencing of phased activities in the framework					
Comprehensiveness of the framework					
Practical relevance and suitability of the framework to the UK community energy sector					

8. In your opinion, what are the limitations/weakness (if any) of the framework

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9. In your opinion, what are the strength (if any) of the framework

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10. Are you aware of similar framework for community energy project development in the UK or anywhere else? If yes, please provide details or link to it

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11. Do you think this framework will be useful to the sector? If yes or no, please give reasons

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12. Please provide any further remarks on the framework (if any)

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Thanks for your time and your useful contributions