ANALYSIS OF TECHNOLOGY TRANSFER IN CLIMATE CHANGE MITIGATION IN ZIMBABWE

BY

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ABSTRACT

This research effort explored technology transfer in Zimbabwe using climate change project as a case. The rate at which the technology transfer projects in climate change were failing inspired the research effort. The research sort to understand the effects of technology transfer frameworks used had on the successful implementation of the projects. A research framework was developed from literature to investigate the factors that influenced the implementation technology transfer initiatives for climate change mitigation in Zimbabwe.The first part of the study was quantitative which included the collection and analysis of survey data from stakeholders to test the proposed research framework and hypotheses. The second part of the study involved the collection and analysis of qualitative data related to a major players in technology transfer initiative to seek additional support for the findings of the quantitative data analysis and to identify additional factors that are not discovered in the quantitative part.The findings of this study suggested that characteristics of transfer media, characteristics of the transfer recipient, characteristics of the demand environment and characteristics of transfer object as well as the characteristics of the transfer agent tend to influence the implementation of technology transfer projects for climate change mitigation in Zimbabwe. This study has a number of theoretical and practical implications. It contributes to the state of knowledge in the technology transfer, climate change mitigation and intellectual property. The findings of this study are important and relevant to Government, Non-Governmental organisations, private companies and technology developers. Once the factors that facilitate or hinder the implementation of technology transfer projects for climate change are identified specific strategies can be developed to improve the success rate of technology transfer in climate change mitigation projects. Based on the finding of the qualitative and quantitative study a preliminary set of strategies is offered which could potentially increase success rate of technology transfer initiatives in climate change.

DECLARATION

This dissertation is my original work except where sources have been acknowledged. The work has never been submitted, nor will it ever be, to another University in the awarding of a degree.

STUDENT ………….. DATE 20/04/2014……………

Signature

SUPERVISOR... DATE......................................

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DEDICATION

This dissertation is dedicated to my daughters Precious and Markarious and most importantly their loving mothers

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

AMCOST	African Ministers Conference on Science and Technology
GDP	Gross Domestic Product
GEF	Global Environment Facility
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Cooperation Agency
LDC	Least Developing Countries
PV	Photovoltaic
R&D	Research and Development
STI	Science, Technology and Innovation
TRIPS	Trade Related Aspects of Intellectual Property Rights
TT	Technology Transfer
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

CHAPTER 1

INTRODUCTION

1.1 Background to the study

According to Makarau 2010 Zimbabwe's climate is changing. This change accelerated rapidly from early 1970s. These impacts have been devastating for the country:

Water, both ground water and surface, is already getting scarce. Many of the country's rivers are no longer perennially flowing but are drying up rapidly limiting fresh and clean water availability. The main reason is that the rains have become more sporadic and there has been unprecedented soil erosion and river siltation;

Until the Seventies, droughts used to recur roughly every 10 years. By the Eighties, their frequencies had increased to every 4-5 years, and by the late nineties, the continent was witnessing alternating wet and dry years every 3 years. Now the country experiences some form of drought every year. For example, since 2000, Zimbabwe had successive droughts from 2001 – 2003, 2004-05, and 2006-07. The 2009-10 summer agricultural season was affected by yet another drought associated with the El Nino. In general, areas being affected by these droughts are getting larger.

Tropical cyclones also, particularly those affecting the south-eastern southern Africa, have become more devastating. We now expect disasters affecting Zimbabwe every year. Scientific evidence indicates that these cyclones are set to increase in frequency and severity even more;

Seasons are also changing. Cold months appear to start as early as May and lasting as far long as August and at times spill into September. On the other hand, the onsets, cessations and durations of effective rainfall seasons have become more variable and unpredictable;

Hot months are getting warmer. Temperatures are becoming more extreme. Since the mid-Sixties, the average temperatures for Zimbabwe have increased by over 2^0C; the greatest increases in the last ten years. In fact, the five warmest years on record in Zimbabwe have occurred since 1987. Temperature projections indicate temperature increases of up to 5^0C Centigrade by 2050, under the business-as-usual scenarios.

There are now more epidemics for both people and animals than before. For example, malaria-prone zones have spread, including in Zimbabwe.

From just the above examples, it is not surprising that climate change is now regarded as the dominant factor in shaping Zimbabwe's development pathway. The future scenario is extremely bleak for the country whose economy is primarily agricultural. Disasters, which are expected to increase and affect more people, are already retarding the development of our country as we are forced to divert or channel resources towards food imports to avert hunger and poverty. With respect to agriculture, for example, since 1900, Zimbabwe has lost over 100 mm of rainfall and 15 rainy days a year. Yet the main summer growing season is only 5 months long. Nearly 70% of Zimbabwe's population is directly dependent on rain-fed agriculture which accounts for over 90% and almost all of them are engaged in subsistence agriculture. Irrigation in Zimbabwe is no longer an option, but a must.

In summary, Zimbabwe is now highly vulnerable to vagaries of weather and extreme effects of climate change. Already, the traditional agro-ecological zones in the country have shifted creating new challenges for our land resettlement and management programme. The time has now come for Zimbabwe to unequivocally commit itself to combating climate change. It is form this background that the Zimbabwean government sought to climate change mitigation strategies.

Article 4.5 of the United Nations Framework Convention on Climate Change (UNFCCC) states that developed countries “shall take all practicable steps to promote, facilitate, and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention.”(Verhoosel. 1998). In this context, technology transfer is designed to assist developing countries with responding to climate change through the diffusion and use of appropriate climate change mitigation and adaptation technologies.

Technologies for mitigating climate change are at the core of current discussions surrounding the post Kyoto regime. One part of these efforts has been focusing on technology transfer. As yet, there is no universal treaty on international technology transfer but only a variety of provisions scattered throughout a number of international legal documents (including kinds of international treaties, declarations and decisions, etc.) made by the World Intellectual Property Organization (WIPO) the institutions within the United Nations system and the World Trade Organization. Dechezleprêtre, et al. (2011) states that there were now about 28 multilateral agreements concerning technology transfer about half of which relate to the global environmental protection. In fact, technology transfer has been the focus of technology-related discussions in most multilateral environment treaties, including the United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol.

Based on the above mentioned frameworks by 1996 Zimbabwean government through the then Ministry of Mines, Environment and Tourism had made some progress in climate change issues.

The pre- and post-Rio consultations, the climate change studies and legislative endeavours were some examples of how Zimbabwe had positioned itself in the global debate on climate change. Since then a lot of projects were initiated that had to do the use of cleaner technologies adapted from developed countries the so called annex I in Climate Change circles.

A number of mitigation options had been assessed for Zimbabwe. Due to resource constraints, however, little work was done on policy options, the costs and benefits of these, or broader macro-economic interventions. The following possible measures were considered for implementation:

Table 1 Technology transfer first communication report

Industry	Introduction of More Efficient Coal-Fired Industrial Boilers Increase the use of Hydro-Electricity:
Forestry	Introducing Afforestation for Carbon Sequestration
Agriculture	Introduction of Minimum Tillage: Introduction of Biogas Digesters:
Rural areas	Photovoltaic Technology

Moreover, it is clear that significant divergences remain as to the obstacles that impede the effective transfer of technology for sustainable development, and the types of measures that can and should be taken in overcoming these obstacles.

This was in line with the Agenda 21 which is a non-binding, voluntarily implemented action plan for the United Nations with regard to sustainable development. One of the objectives of the implementation plan was to promote, facilitate, and finance, as appropriate, the access to and the transfer of environmentally sound technologies and corresponding know-how, in particular to developing countries, on favorable terms, including on concessional and preferential terms, as mutually agreed, taking into account the need to protect intellectual property rights as well as the special needs of developing countries for the implementation of Agenda 21 (Wilkins,2012).

In line with these objectives many projects were initiated in Zimbabwe to try and address the challenges since 1996. If implementation of technology transfer in Zimbabwe is to be successful it is of paramount importance that we first analyse and assess the current technology transfer initiatives were carried out in Zimbabwe. In the Zimbabwe's first National Climate Change Report that was submitted in 1996 to the United Nations Framework Convention on Climate Change (UNFCCC) there above mentioned projects were clearly spelt out as the flagship programs that were to be implemented. As part of the implementation of the technology transfer programs a Technology Needs Assessment report was also submitted to Subsidiary Body for Scientific and Technological Advice (SBSTA) in 2004. In the report several challenges in some of the sectors that were mentioned in the first national Climate change report were comprehensively pointed out. It is from the challenges that were raised in that and other reports that this study is motivated from. This research effort seeks to bring the technology transfer in the lens of intellectual property and the possible impacts it had on the programs implemented by Zimbabwe in mitigation of climate change.

The Global Environment Facility (GEF) is a financial mechanism that provides grants and concessional funds to developing countries for projects and activities that tackle environmental challenges which have global implications. It is jointly implemented by the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP) and the World Bank. GEF resources address climate change, biological Licences, international waters, and depletion of the ozone layer.

The clean development mechanism (CDM) of the Kyoto Protocol was established in 1998 as global policy with the aim of contributing to sustainable development and technology transfer in developing counties in addition to its main function to reduce GHG emissions. Again in this sense of technological transfer there are many frameworks that favours the transfer of technology to least developed countries referred to as the Annex II in the framework. It is in this regard that this research endeavour seeks to review the projects that were carried out in Zimbabwe in the lens of technology transfer and intellectual property.

Increased research and analysis on the links between transfer of technology and IP will be fundamental to overcome these apparent differences, and to develop effective technology-related international cooperative action on climate change.

1.2 Statement of the problem

Technology transfer projects for climate change mitigation have not been successful in Zimbabwe. Societies can respond to climate change by reducing GHG emissions and enhancing sinks and reservoirs. The capacity to do so depends on socio-economic and environmental circumstances and the availability of information and technology. To this end, a wide variety of policies and instruments are available to governments to create the incentives for mitigation action. Mitigation is essential to meet the UNFCCC's objective of stabilizing GHG concentrations in the atmosphere (UNFCCC; 2013). One of the suggested strategies under the mitigation programs is that the developing countries will implement their commitments depending on the financial resources and transfer of technology.

Technology transfer is a complex process that involves different actors with different roles. This research seeks to analyze and assess the challenges encountered by Zimbabwe in the implementation of technology transfer under the Zimbabwe climate change office. The institutional framework used in the implementation of the projects is analyzed and compare to the world best practices including questioning of the role of the national system of innovation.

1.3 Purpose of the Study

Technology is needed in Zimbabwe and other small developing countries as an engine of development, and the challenge is to ensure that it does indeed come, and that what comes does not contribute unduly to global climate change. As well, technology is needed in the fast growing developing economies to help blunt the impact of growth on global climate change. The substantial energy infrastructure being planned and put in place in Zimbabwe will, after all, be locked in for generations to come. It is for the above mentioned rationale that there is a reason for the reviewing of the challenges faced by Zimbabwe in that adaptation of technologies in this topical area of climate changes.

1.4 Objectives of the study

The objectives of this study are to

1. Analyze and assess how the technology transfer frameworks used in Zimbabwe influenced the implementation of the climate change mitigation projects.
2. To find out Intellectual property aspects considered in the implementation of the technology transfer projects for climate change mitigation in Zimbabwe
3. To identify and explore the role played by different stakeholders in the implementation of technology transfer projects in climate change mitigation
4. To come up with an appropriate strategy for the implementation of technology transfer projects in climate change mitigation.

1.5 Research Questions

Given the challenges encountered in the implementation of the above mention projects this research effort aim to investigate the following issues;

What Intellectual property issues influenced technology transfer projects for climate change mitigation in Zimbabwe?

In order to answer this broad question the following sub questions are going to be explored

1. How did the technology transfer frameworks used in Zimbabwe influence the implementation of the climate change mitigation projects?
2. How do the characteristics of, transfer media, transfer object, transfer agent, transfer recipient and demand environment influence technology transfer?
3. What were the Intellectual property threats to the implementation of the technology transfer projects in climate change mitigation?
4. What is the role of stakeholders in the implementation of the technology transfer projects in climate change mitigation?
5. What strategy can Zimbabwe use in the implementation of technology transfer projects in climate change mitigation?

1.6 Significance of the study

The study to be reported in this thesis is important for the following reasons:

The study will produce an analysis and assessment of the technology transfer frameworks in which the Climate Change projects are being carried out in Zimbabwe. It is important for policy and decision makers related to climate change and technology transfer in Zimbabwe. Since Zimbabwe is a country whose research infrastructure is not strong the Climate Change technology transfer projects provides with a low hanging fruits though the availability of funds for mitigation and adaptation.

Technology transfer involves many stakeholders currently there is no study in Zimbabwe that has analyzed the technology transfer in climate change and the IP issues involved. So this study will contribute to methodology and best framework for the implementation of the technology transfer initiatives in climate change in Zimbabwe. The study is also important in that the area of climate change has a lot of opportunities for the nation in terms of funding if there is a strategy that is well planned.

1.7 Scope of the Study

The study is expected to be based on quantitative and qualitative methods of analysis. I will collect information, then conduct analysis, and finally give recommendations .To achieve the research aim and objectives, data will be gathered mainly from primary sources and secondary sources whenever necessary. Information and data for analyses, as well analyses climate change projects involving technology transfer would be collected from questionnaire survey, report/documents reviews, journals and interviews.

Questionnaires and an interview guide will be designed and launched on all stakeholders who participated in the projects of technology transfer to date in climate government in Zimbabwe to explore the current status and implementation of the technology transfer projects.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter provides a review of the relevant literature upon which this thesis builds. In the first section the concept of technology transfer in the lens of climate change is introduced to gain an understanding of the context in which technology transfer works. The next section will introduce the technology transfer in climate change and review all the linkages that exist between the stakeholders involved in the implementation of technology transfer in climate change. Then in the third and fourth section literature on technology adoption, based on diffusion of innovations theory, critical mass theory and social exchange theory is discussed to shed light into the antecedents of a successful technology transfer from developed to developing countries.

2.1 Technology transfer definitions

Technology transfer at its best can act as a vehicle for change from unsustainable practices and improve quality of life but it is the problem of inducing sustainable change that means that any transfer must be carefully tailored with country stakeholders to meet their needs.

The IPCC report on methodological and technological issues in technology transfer (IPCC 2000) contains a broad definition of technology transfer which they define in terms of a set of processes ‘‘covering the flows of know-how, experience and equipment, for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, NGOs and research/education institutions.''

According to the IPCC (2000), technology transfer involves the process of ''learning to understand, utilise and replicate the technology including the ability to decide which technology to transfer and adapt it to local conditions and integrate it with indigenous technologies.''

Bozeman, (2000) in his overview of technology transfer, defines the concept as ''the movement of know-how, technical knowledge, or technology from one organizational setting to another''.

Roesner, Technology transfer has been used to describe the processes by which ideas, proofs-of concept, and prototypes move from research-related to production-related phases of product development.

Technology transfer basically consists of a "transfer" of technological knowledge, including a "transfer" of the capacity to assimilate, implement and develop a technology.

Thus a successful TT goes through the perilous phases of the assimilation and absorption of technological knowledge: adaptation to local conditions, absorption of subsequent improvements and generalisation of the transferred knowledge.

2.2 The nature of technology transfer

In all cases, the transferring of knowledge is different, more complex and costlier than the dissemination of information concerning a technology. (Stock and Tatikonda, 2000) posits that disseminating information is simpler and less costly than the activity of transferring technological capabilities to individuals, organisations and, on a wider scale, social aggregations that were previously lacking them.
(Cohen and Levinthal, 1990) argued that while a technology transfer can be considered a success if the technology in question has been put into operation and resulted in increased productivity in a certain economic activity, it is only the creation of technological capabilities in the host country that will ensure the long-standing efficient use of that technology in the country considered.

As conceived here, knowledge entails something more than information (Foray, 2004). Knowledge, in whatever field, empowers its possessors with the capacity for intellectual or physical action. The meaning of knowledge here is fundamentally as a matter of cognitive capability. Information, on the other hand, assumes the form of structured and formatted data that remains passive and inert until used by those with the necessary knowledge to interpret and process them.

The full meaning of this distinction becomes clear when the conditions governing the reproduction of knowledge and information are examined. While the cost of replicating information amounts for no more than the cost of making copies (next to nothing thanks to modern technology), reproducing knowledge is a far more expensive process since cognitive capabilities are not easy to articulate explicitly or transfer to others: “we can know more than we can tell” (Polanyi, 1966). Knowledge reproduction has therefore long hinged on the “master apprentice” system (where a young person’s capacity is moulded by watching, listening and imitating) or on interpersonal transactions among members of the same profession or community of practice.

These means of reproducing knowledge may remain at the heart of many professions and traditions, but they can easily fail to operate when social ties unravel, contact is lost between older and younger generations, and professional communities lose their capacity to act in stabilising, preserving and transmitting knowledge. In such cases, reproduction grinds to a halt and the knowledge in question is in imminent danger of being lost and forgotten (David and Foray, 2002).

When knowledge is differentiated from information, economic problems relating to the two can be distinguished. Where knowledge is concerned, the main economic problem is its reproduction and transfer (problem of learning), while the reproduction of information poses no real problem (the marginal cost of reproduction is close to zero).

The economic problem of information concerns essentially its protection and disclosure: that is, a problem of public goods. However, the codification of knowledge creates an ambiguous good. This good has certain properties of information (public good) but its reproduction, as knowledge requires the mobilisation of cognitive resources (Rivkin 2001).

According to Teece , empirical works about TTs by multinational companies (1977) showed that the transmission and absorption of the know how required to actually put the technology into operation involved substantial costs.

2.3 Technology Transfer under TRIPS

Least-Developed Country Members

1. In view of the special needs and requirements of least-developed country Members, their economic, financial and administrative constraints, and their need for flexibility to create a viable technological base, such Members shall not be required to apply the provisions of this Agreement, other than Articles 3, 4 and 5, for a period of 10 years from the date of application as defined under paragraph 1 of Article 65. The Council for TRIPS shall, upon duly motivated request by a least-developed country Member, accord extensions of this period.
2. Developed country Members shall provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer

to least-developed country Members in order to enable them to create a sound and viable technological base.

Incentivising foreign firms to enter such transactions is a clear opportunity for developed country governments to properly fulfil their obligations contained in Article 66.2 of the World Trade Organisation (WTO) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS).

The following recommendations are applicable to developed countries' TRIPS obligations:

- The transfer of technology should form the subject of a principal economic operation (and not be a *joint product* or *by-product*; i.e. contingent on other operations);
- The locus of decision-making regarding modes of learning and areas for focus must shift away from foreign bodies to local agents and authorities;
- In providing additional incentives to the technology-owning firms, governments should seek effectiveness and efficiency. To achieve this:
  - Governments should provide incentives in an effective way by only assisting projects that are socially beneficial but not very profitable for the firms that own and could transfer the technology; and
  - Conditions for the efficiency of the TT operations involve the choice of relevant partners both on supply and demand sides, selection of the right area for focus (related to a clearly expressed local demand for technology) and the creation of organisational forms that will favour the

consolidation of the transfer (absorption, adaptation and subsequent spill overs), as well as the related entrepreneurial dynamic;

- Governments should make as much use as possible of public-private partnerships (PPPs) as a mechanism for ensuring both the effectiveness of the intervention and the efficiency of the TT operation.

Technology transfers have to be operated in many domains (including export-oriented industry). But they must be particularly supported in those domains that correspond to the model of innovation central to economic growth in LDCs: that is, entrepreneurial activities meeting needs in local markets that are likely to generate domestic spillovers. In other words, TTs must offer a positive supply response to a demand for technology stemming from local entrepreneurs. Two factors are relevant here:

1. These domains are potentially important for growth because the spillovers generated in the course of such projects are likely to be captured by the local economy; and
2. These domains need additional incentives so the donor's intervention will be effective and respond fully to the TRIPS provision, which is not necessarily the case of export-oriented sectors in which the market incentives alone are sufficiently strong to motivate firms in rich countries to operate TTs.

2.4 Responding Properly and Effectively to TRIPS Article 66.2

The role and functions of developed country governments must be examined and evaluated with regard to the different arguments previously developed. In short, TRIPS Article 66.2, which in vague terms calls for the provision of additional incentives to the firms and other organisations of developed countries to undertake TTs to LDCs should be made more explicit. Practical means to achieve this include:

- Relying on the joint product and by-products logics only to ensure a satisfactory flow of consolidated technologies towards LDCs does not suffice. Above all, TTs as main operations must be developed. According to the new logic, the locus of decision-making regarding modes of learning and areas for focus will likely shift away from foreign bodies to local agents and authorities.
- In providing additional incentives to technology- owning firms, governments are seeking effectiveness. To achieve this, they should:
    - Provide effective incentives by offering assistance to projects that are socially beneficial but not profitable for the firms that own and could transfer the technology;
    - Ensure that conditions for efficient TT operations involve the choice of relevant partners on supply and demand sides, the selection of the right areas for focus (related to a clearly expressed local demand for technology) and the creation of organisational forms that will favour the consolidation of the transfer (absorption, adaptation and subsequent spillover), as well as the related entrepreneurial dynamic;

- Make use, as much as possible, of PPPs as a mechanism for ensuring both the effectiveness of the intervention and the efficiency of the TT operation.

TT between developed economies and LDCs involves the transfer, implementation and absorption of a technology from a mature technological structure to an entirely disarticulated production and knowledge system. Each consolidation phase – absorption of technology, adaptation to local conditions, assimilation of subsequent improvements, and generalisation – causes significant difficulties.

As opposed to a TT involving two entities of the same level of development, greater attention must generally be paid to

- Learning and training services;
- What is imported in terms of equipment (some sources of failure are importation of the wrong equipment, incomplete sets of equipment, or inappropriate equipment)
- The sufficient availability of high quality local raw material and components (a major source of failure is the inadequate supply of local raw material and components (see Ho, 1997));
- The local demand structure (products unsuited to the local market constitute another source of failure).

2.5 Capabilities

The term "capabilities" here draws on Enos (1996) to introduce an issue relevant for the least technologically advanced firms. The most technologically advanced firms can profitably absorb new knowledge and subsequent improvements, and undertake development to adapt the technology to specific conditions. They employ the skilled persons needed to appreciate and assimilate advanced technologies, and can draw upon their previous experience in carrying out each successive task. Technology transfer is in fact a decreasing cost activity. The more extensive the experience previously acquired by the transferring organisation in supplying subsidiaries with the technology in question, the narrower the gap between the technical capabilities of the two participating organisations, and the lower the transfer costs in relation to total project size (Mansfield, 1995).

Less advanced firms lack these prerequisites for technological progress: even if they draw upon outside suppliers for the tasks of planning, design, engineering, construction and initial operation, they are likely to find themselves incapable of operating the plant in a way that exploits its full potential, let alone securing the mundane day to day improvements that so markedly increase its performance. It may take all the technical and managerial resources of the less advanced firms to master the transferred technology and implement the necessary adaptations and developments. Mastering improvements as they come along may prove too great a challenge.

Mastering a given state of the art is not enough; what is critical is to master a progressive state of the art (Enos, 1996). In the knowledge economy, these tasks are never-ending.

No sooner have workers mastered one state of the art that they must begin to shift their attention to its successor.

Improvement can occur so rapidly that workers can never relax thinking they have absorbed the current set of knowledge, as the next phase of improvements is already upon them.

Building capabilities to increase a TT’s chances of success is thus a crucial matter. It points towards economic models of development that emphasise the accumulation of skills and learning capacities, rather than fixed assets or capital, in facilitating the TT process. This, in turn, calls for certain proper organisational structures.(Leonard, 1995)

2.6 Organisational design

Organisational structures are critical for the successful management of the whole TT process. What is at stake here is an idea that goes back to A. Marshall’s concept of the internal and external organisation of firms. The internal organisation of the receiving entity is central to the process of technology absorption and its adaptation to local conditions, as well as the assimilation of subsequent improvements. External organisation is critical to the process of broader dissemination and spill over from one particular entry point of the technology into the country.

These two organisational dimensions are likely to be “weak” in the case of LDCs. It is therefore critical to establish organisational structures that are dedicated to improve both internal and external dimensions in order to maximise the probability of TT success.

The terms “technology platform” or “production centre” are used to designate forms of organisation explicitly aimed at facilitating the learning of the technology, its adaptation to local conditions, the assimilation of subsequent improvements and its generalisation. These essentially involve technology development centres devoted to a specific domain and partly financed by public development assistance.

These centres provide a certain number of technological services to assure the development of appropriate innovations. They pinpoint and structure demand for technology from local entrepreneurs. They also ensure the updating of technological knowledge and its diffusion.

Crucially, they facilitate access to the financing of innovation by local banks, either by simply supporting the project in question, or creating credit lines from developed countries.

Technology platforms constitute an attractive organisational innovation when the TT involves countries with different levels of development. They represent a method of coordinating and adapting resources whose assembly is, by definition, problematic. They provide a better understanding of local technology demands. Finally – and perhaps most importantly – they “anchor” the technological development in the local economy, endeavouring to attach it to an industrial dynamic. (Chisholm, 1992)

A TT linking entities with very different development levels calls for sophisticated organisational forms if the success of the different consolidation phases is to be guaranteed.

However, these organisational forms are themselves heavily dependent on the chosen transaction modes, as discussed further below.

The consequence is that even if an LDC could benefit from "plugging" some of its activities into the global market, this should not preclude *the support of locally oriented innovation*, which can be critical for growth and social well-being. The development of capacities to produce locally oriented innovations allows the country to develop absorptive capacity, while at the same time the locally generated spill over from this same R&D may end up diffusing away from the local economy. There are vast areas of economic activity where innovation is needed to *serve local needs and local demands*, whereby "local" may mean a large fraction of the world population (Foray, 2010).

Finally, it may be that the most important innovations for LDCs are not purely technical but in fact reside in this "discovery process" of what the country should do in terms of specialisation in industry and service.

2.7 The centrality of local innovation and local spillover

Innovation should be widely distributed over the whole spectrum of economic activities across sectors (not just high tech) and types of innovations (not just formal R&D) (Bettencourt et al, 2007). As (Foray, 2007) correctly pointed out that in Least developed Countries, this means incremental, cumulative, and mostly informal (without R&D) innovations, developed mainly in "traditional" sectors or in services not qualifying as “high tech.” Although mostly dealing with low-tech activities, these innovations are generating local spill over and will ultimately impact the productivity of a wide range of sectors in the local economy.

If we regard information and communication technologies (ICTs) as the major general purpose technology of our time, ever expanding segments of LDC economies should adopt and “invent” new applications for ICTs in ways that increase productivity. General Purpose Technologies (GPT) foster economy-wide growth not simply or principally by innovation in the GPT itself, but rather when a wide and expanding range of other sectors adopt the advancing technology, generating new useful applications of the GPT. Therefore, the key issue for “secondary countries” (countries that are not at the frontier of the GPT) is how to allocate R&D and other innovative inputs so as to level the growth potential of the prevalent GPT. The main point is that it is not ICTs alone that cause growth, but rather that adopting sectors ought to establish innovation complementarities for economy-wide growth to take place. These types of innovation complementarities (adoption, local innovations in traditional sectors) may be less overtly innovative and therefore not be deemed as worthy of support or encouragement. Yet, ultimately, they constitute the key to economic growth.(Trajtenberg, 2009)

Any innovation policy in the case of LDCs should, therefore, pay attention to these issues. It should not aim just at increasing total R&D, but do so in a way that incentivises local innovation and spill over rather than global R&D and external leakages. Such a policy should develop absorptive capacity and ultimately impact the productivity of a wide range of sectors in the local economy.

This is the "model" of innovation that TT has to foster in an LDC context. From this perspective, government and donors should pay more attention to local demand for technology. Much of the discussion in TT literature has focused on the supply side – the willingness of technology holders to transfer technology (Arora, 2007). Very little attention has been paid to providing better knowledge of the structure of the demand for technology in a given country, region, or industry.

2.8 Discovering the next areas for focus

According to Hausman and Rodrick (2002), there is a key role for entrepreneurs in LDCs: to learn what the country is good at producing. For an LDC, there is great social value in discovering the relevant specialisation since this knowledge can orient the investments of other entrepreneurs.

It is also a misperception of LDCs' realities to assume that the production functions of all extant goods are common knowledge. But the entrepreneur who makes the initial "discovery" can capture only a small part of the social value generated by this knowledge; other entrepreneurs can quickly emulate such discovery. Consequently, entrepreneurship of this type – generating learning on what can be produced – will be undersupplied (Sherpherd and DeTienne, 2005).

If learning what a country is good at producing requires an investment and the return on this investment cannot be fully appropriated, this is a problem that is unlikely to be solved with legal protection. Indeed, entrepreneurs in LDCs are trying out technologies that already exist abroad.

The discovery may be that an existing good can be produced profitably in the country. Such discovery does not normally get legal protection no matter how high the social return. There is therefore a role for government policy, probably not fulfilled by the IP protection system determine the motivation for success of the TT and its consolidation (or not).Unpackaged is defined as the transfer of a technology not channelled through direct investment, trade, or infrastructure development.(Pietrobelli , 2001).

Joint ventures, licensing, and arrangements involving technical assistance, collaboration contracts, informal transfer of know-how, and consultancy are classified as unpackaged modes of TT. The technological knowledge is “disembodied” and transferred through software and wetware, not hardware.

In this case, the TT in itself constitutes the ***primary economic operation***. Here, the prime motivation for the operation is the success of the TT and the incentives directly linked to the TT (cost and profit) that control the operation. The main advantage of this mode is that it gives the host country control over technology selection, management decisions, and development of local skills.

2.9 Technology transfer models

While large scale research studies are sparse, two have made a major contribution to Bozeman attempted to solve the mystery by proposing the model in Fig. 1

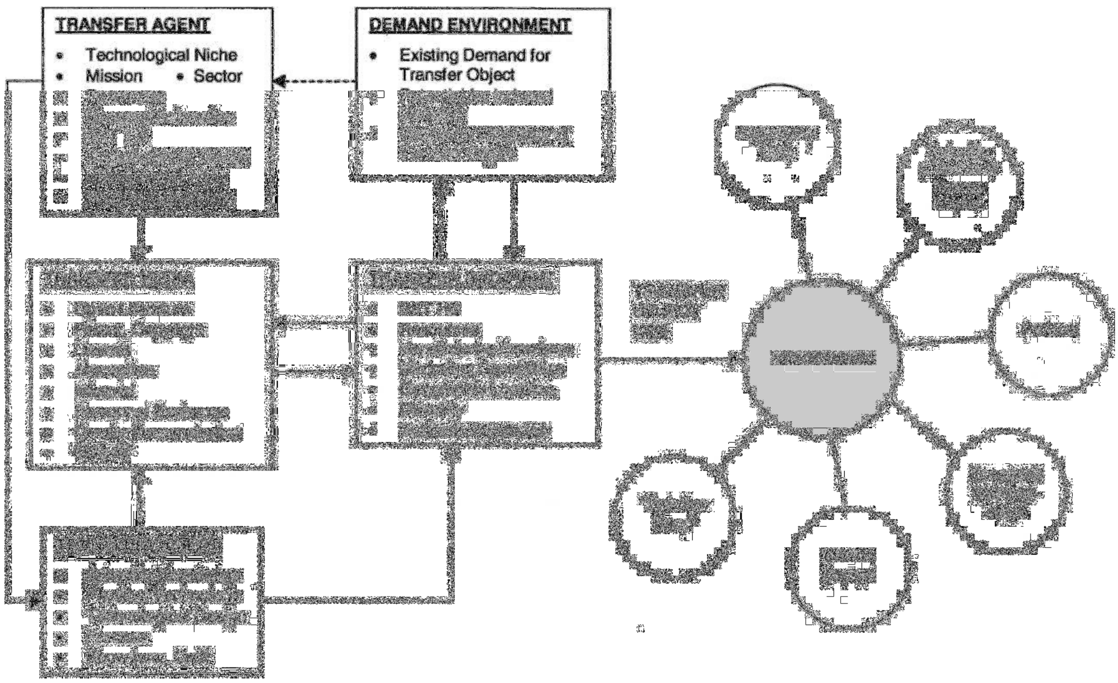

Figure 1 Contingent Effectiveness Model of Technology Transfer (Bozeman, 2000)

The Contingent Effectiveness Model draws its name from its assumption that parties to technology transfer have multiple goals and effectiveness criteria. The model includes five broad dimensions determine effectiveness:

2.10 Characteristics of the transfer agent

Characteristics of transfer agent refer to the nature of the institution transfering the technology , its history and culture. There are many transfer agent characteristics as depicted by Bozeman (2000) listing over 15 including organisational design, geographic location, political constraints (Larsen and Wigand, 1987, Etzkowitz 1994; 1998.) This study focuses on the following characteristics which are discussed in detail in Chapter 3

a) Organisational design

b) Political constraints

c) Technological niche

d) Geographic location

e) Resources

Technology transfer literature argues that different transfer agents can perceive technology transfer differently, researchers should take perception based characteristics which are inherent characteristics of the technology transfer that do not vary across settings and organisations.

2.11 Characteristics of the transfer media

Transfer media refers to the vehicle, formal or informal by which the technology is transferred. Research has shown that the transfer media provides a rich source that constraints or facilitate the transfer of technology. A number of transfer media have been studied in the literature including, formal literature, person to person copyright etc. This study focuses on the following

a) Patent, Copyright and utility models

b) Licences

c) Absorption

d) On site demonstration

e) Personnel exchange

f) Spinoff

2.12Characteristics of the transfer object

Transfer object refers to the content and form of what is, transferred, the transfer entity. Research has shown that the influence of the transfer object such as scientific knowledge and technological device as well as the know-how cannot be ignored. This study focuses on the following

a) Scientific knowledge
b) Physical technology
c) Technology design
d) Process
e) Know how

2.13 The demand environment

The demand environment refers to the factors market and non-market pertaining to the need for the transferred object. These factors taken together have a bearing on the success of technology transfer process. This study focuses on the following

a) Price for technology,
b) Substitutability,
c) Subsidy
d) Potential for induced demand.

2.14 Characteristics of the transfer recipient.

This refers to the organization or institution receiving the transfer object. In this study the following characteristics of recipient organisations will be considered.

a) Resources
b) Manufacturing Experience
c) Geographic Location
d) Licences
e) Business Strategy

2.15Technology transfer in Zimbabwe

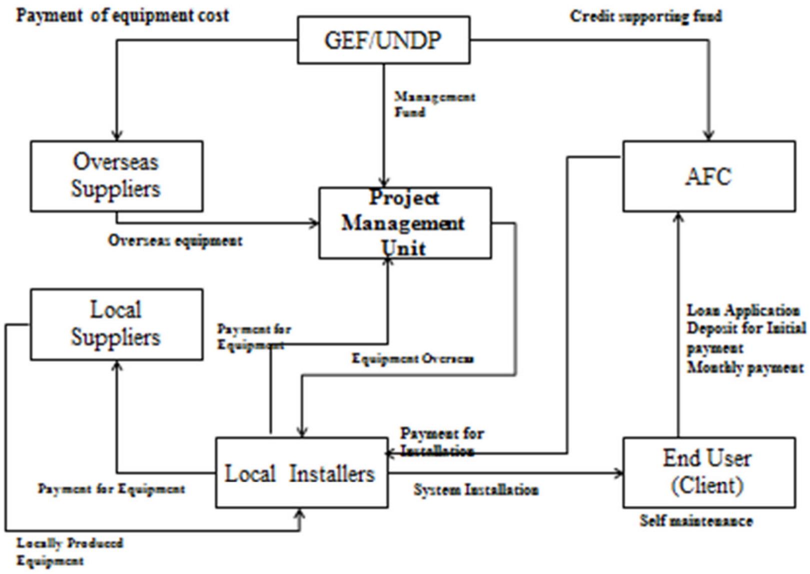

Figure 2 The GEF/UNDP Solar PV project scheme technology transfer flow (JICA, 1999)

The major players in the coordination and implementation of the GEF Solar project in Zimbabwe (see Fig. 2). The Project Management Unit (PMU) was set up by the Department of Energy (DoE) to oversee the day-to-day running of the project, facilitate the procurement of materials and equipment at the national level, and carry out training programmes for installers and end-users. The PMU was also given the responsibility of exploring the prospects for alternative funding assistance, conduct site visits, and establish an installation inspection team and national standards for solar components.

The credit scheme for the project was established and managed through the Agricultural Finance Corporation (AFC). The AFC was willing to participate despite the relatively low 15 per cent interest rate, compared to the market rate of 40 per cent. The credit scheme was provided with initial seeding of US$250,000 by the UNDP as a &pump-priming', whose role largely remained as facilitator of funds and necessary technical support not readily available within Zimbabwe.

The Standards Association of Zimbabwe (SAZ) and Solar Energy Industries Association of Zimbabwe (SEIAZ) prepared standards for installation and specification of PV systems and components. In addition, companies that had an interest to participate in the GEF Solar project were required to register with SEIAZ, and at the end of 1998 there were about 60 companies registered with SEIAZ. These companies operated in various ways as manufacturers of PV panel and components, distributors and installers of PV equipment and systems.

The majority participated as distributors and installers. Moreover, the national utility, Zimbabwe Electricity Supply Authority (ZESA), and two NGOs namely, Biomass Users Network (BUN) and Organisation of Rural Association for Progress (ORAP) took part in the project as installers.

Regarding end-users, rural households were arguably the main target group of the GEF Solar project to provide clean and high-quality lighting and replace the low quality, kerosene lanterns or paraffin candles currently used for lighting in most rural households in Zimbabwe.

The community service sector and Rural development centres (RDC) have also become major end-users of PV lighting systems, installed to provide electricity for community activities with the aim of reaching more people with minimal investment.

CHAPTER 3

RESEARCH METHODOLOGY

3.0 Introduction

This study employs both quantitative and qualitative techniques to investigate the technology transfer frameworks used in Zimbabwe influenced the implementation of the climate change mitigation projects. The first part of the study includes the collection and analysis of survey data from stakeholders to test the proposed research framework and hypotheses. The second part of the study involves the collection and analysis of qualitative data related to a major players in technology transfer initiative to seek additional support for the findings of the quantitative data analysis and to identify additional factors that are not discovered in the quantitative part.

3.1 Research Framework

Synthesizing the theoretical foundations and the pertinent literature reviewed in the previous chapter, the following research framework (Figure 3-1) was developed to investigate the factors that influenced the implementation technology transfer initiatives for climate change mitigation in Zimbabwe.

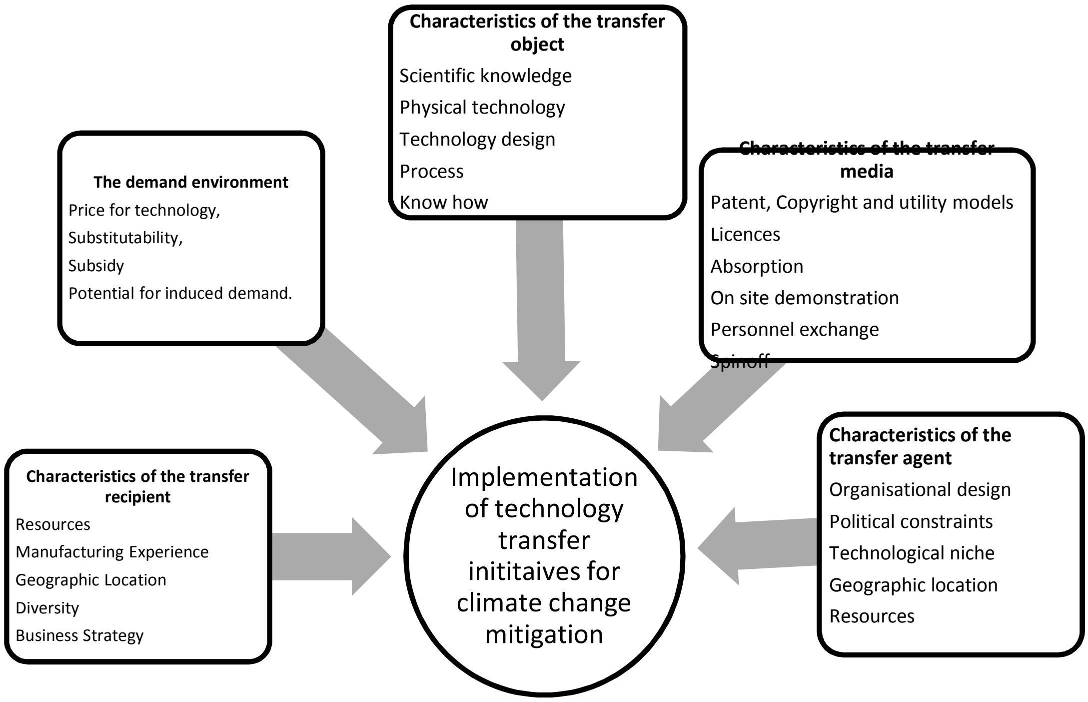

Figure 3 Research framework

3.1.1 Characteristics of the transfer recipient

Resources

This is the organisation ability to acquire, assimilate and apply ideas, knowledge, devices and artefacts effectively**.** Hence it can be hypothesised that:

> H_1: Resources will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation

Manufacturing Experience

This refers to size of the firms participating in the technology transfer initiative.

> H_2: Manufacturing experience has a positive effect on implementation of technology transfer initiatives in climate change mitigation

Geographic Location

This is where the recipient company is situated with reference to the transferring media.

> H_3: Geographic location has positive effect on implementation of technology transfer initiatives in climate change mitigation

Business Strategy

These are business models that are pursued by the recipient organisations

> H_4: Business strategy has a positive effect on implementation of technology transfer initiatives in climate change mitigation.

3.1.2 The demand environment

Price for technology

This is the, market price of the technology, cost of the product as compared to the previous products. It encompasses the relative advantages of the technology as compared to the status quo.

> H_5: Price of technology has a positive effect on the implementation of technology transfer initiatives in climate change mitigation

Substitutability

This refers to the condition of being able to replace the transferred product with another new product without altering the function

> H_6: The easier with which substitutability has a positive effect on the implementation of technology transfer initiatives in climate change mitigation

Subsidy

This is a financial aid supplied by a government, as to industry, for reasons of public welfare.

H_7: Subsidy will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation

Potential for induced demand

Induced demand, or latent demand, is the phenomenon that after supply increases; more of a good is consumed. This in turn aid technology transfer for the suppliers in the sense that they will realize more sales of their product.

H_8: Potential for induced demand will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation

3.1.3 Characteristics of the transfer object

Technology design

Technological design is a process used to generate products, services, and there are many models for the design process

H_9 Presence of the technological design will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation

Process

This is a series of actions or steps taken in order to achieve a particular end

H_{10} presence of the process will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation

Physical technology

These are the material specification and training manuals related to the product

H_{11} Presence of the physical technology will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation

Know how

This is the practical knowledge of how to achieve something

H_{12} Presence of know how will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation

Scientific knowledge

This is the stage at which the product is in terms of scientific and technological developments. This is characterised by novel application, latest technologies, modified technologies.

H_{13}: The stage at which a product in terms of scientific and technological advancement will have positive effect on the implementation of technology transfer initiatives in climate change mitigation.

Intellectual Property (IP)

IP is a branch or national or international Law that protects the rights which result from intellectual activity in the industrial, scientific, literary and artistic fields.

H_{14}: The category of IP protection will have an effect on the implementation of technology transfer initiatives in climate change mitigation

Licences

Licensing is permission granted by the owner of the IP rights to another entity to use the IP rights

H_{15}: The type of licence used will have an effect on the implementation of technology transfer initiatives in climate change mitigation

Absorption

This refers to total assimilation of the concept by the receiving organisation. Absorption of know how is required to actually put the technology into operation.

H_{16}: Absorption will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation

On site demonstration

This is the trial running of the technological product in the setting of the recipient by the technology supplier for a certain period of time whilst being monitored by the standard agency of the recipient country to ensure that it is working

H_{17}: Onsite demonstration will have a positive effect on the implementation of technology transfer initiatives in Zimbabwe climate change mitigation

Personnel exchange

These are pre-negotiation visits to the plants of the institutions by the recipient and transfer agent to exchange notes on their capabilities.

H_{18}: Personnel exchange will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation

Spinoff

A "Spin off" is defined as the creation of a company where the technology supplier invests its own resources to form and incubate the company through to a first round of venture capital investment.

H_{19}: Spin offs have a positive impact on the implementation of technology transfer in climate change mitigation projects

Organisational design

This is the structure of an organisation and the way in which the entity executes its business strategy

> H_{20}: Organisational design has an effect on the implementation of technology transfer in climate change mitigation projects

Political constraints

Extent to which political environment impedes future choice of technologies in the related field in this case climate change.

> H_{21}: Unsupportive political environment will have a negative impact on the implementation of technology transfer in climate change mitigation projects

Technological niche

This is a product for a small part of the technology market.

> H_{22}: Technological niche will have a negative impact on the implementation of technology transfer in climate change mitigation projects

Geographic location

This is where the donor company is situated with reference to the transferring media

> H_{23}: The Geographic location of the transfer agent will have an impact on the implementation of technology transfer in climate change mitigation projects

Resources

This is the organisation ability to supply money, equipment, feedstock, supplies to the recipient organisation

> H_{24}: The organisation ability to provide resources will have a positive impact on the implementation of technology transfer in climate change mitigation projects

3.2 Research Methodology

This study will employ both quantitative and qualitative techniques to investigate the technology transfer frameworks used in Zimbabwe influenced the implementation of the climate change mitigation projects. Research methodology is a "structured set of guidelines or activities to assist in generating valid and reliable research results" (Mingers 2001, p. 242). Even though it is always desirable to select a methodology that maximizes generalisability, realism, and precision (McGrath 1982), all research methodologies are inherently flawed in some respect (Dennis and Valacich 2001). The limitations of using one research perspective can be addressed by using an alternative approach that compensates for another's weaknesses.

Combining these methods may lead to a richer understanding of the phenomena under investigation. By incorporating multiple modes of analysis into the design, additional insights may be revealed that would otherwise remain undiscovered via a single methodological approach.

3.2.1 Research Methodology Quantitative

The quantitative part of the study included the collection and analysis of survey data from government departments to test the proposed research framework and hypotheses.

In this section, the research methodology and data collection process utilized in the quantitative study will be explained. First, the research methodology is justified. Then, the sample, unit of analysis and respondents are introduced. Afterward, the questionnaire development process is discussed in detail

3.2.1.1 Quantitative method

For the quantitative part of the study, survey methodology was found appropriate. Survey research is one of the most popular methods used by the technology transfer researchers (Bozeman. 2000). Survey research is the systematic gathering of information from respondents for the purpose of understanding and/or predicting some aspect of the behaviour of the population of interest (Tull 1986).Survey is a mode of inquiry that involves the collection and organisation of systematic data and statistical analysis of the results(de Vaus 1995, Marsh 1982, Glock 1967).

In this method

a) a large number of respondents are chosen to represent the population of interest,

b) systematic questionnaire or interview procedures are used to elicit information from respondents in a reliable and unbiased manner, and

c) Sophisticated statistical technique will be applied to analyse (Singleton, 1980).

The survey method is deemed appropriate is based on a number of reasons. One of them being the proposed research and hypothesis is to investigate the technology transfer frameworks used in Zimbabwe influenced the implementation of the climate change mitigation projects.. Therefore, it was necessary to employ a methodology that permitted theoretical propositions to be tested in an objective fashion. The main advantage of survey research is that it gives the researcher a quantitative method for establishing relationships and making generalizations about known populations.

Second, in order to test the hypothesized relationships, it was important to use a methodology that would allow the values and relations of constructs to be determined in a systematic way. Survey research is one of the most effective techniques available for the study of attributes, values, beliefs and motives (Sharma 1983). It is not an exaggeration to point out that this method is the only method where generalized information could be collected systematically from organizations (Sharma 1983). Third, in order to obtain a reasonable sample size to statistically test the research framework and hypotheses, as well as to increase the accuracy of the findings, it was necessary to obtain data from a large portion of the selected sample. Using a survey research methodology, the researcher can describe large and heterogeneous populations more efficiently and economically. Therefore, in order to answer the research questions and test the research framework and hypotheses, survey methodology served as an appropriate tool.

3.2.1.2 Sample, Unit of Analysis and Respondents

Sample.

The sampling frame for this study consisted of the all the stakeholders who participated in any of the technology transfer projects in climate change in Zimbabwe regardless of the time. More specifically, 79 individuals comprised the sampling frame which included five major clusters depending on the activities the carry out in the technology transfer initiatives. The five major classes are being the transfer recipient, demand environment, the transfer object, the transfer media and the transfer agent. Individuals fall in any one of these categories and can comment on any as they are all participants. The respondents will be stratified according to the 5 classes mentioned above then selected randomly among the actors.

Unit of analysis and Respondents

An important step in research design is to determine the unit of analysis – or the unit about which statements are being made. In this study proposed theory, data collection and statistical analyses were conducted at individual level. Therefore the unit of analysis for this study was the individuals that participated in the technology transfer initiatives.

3.2.1.3 Questionnaire development

In this section the operationalisation of the constructs and the efforts put forward to ensure content validity are discussed.

Special emphasis was given to the operationalisation of the constructs in the research framework. The items were primarily derived from previous tested survey instruments to take advantage of the well tested). Most of the constructs were operationalised by modifying these previously validated scales, as direct use of previous instruments was not always possible. A few new items were constructed based on the statements in the literature, which is a common approach followed by researchers when previous instruments are not available (Grover 1993). Moreover, each construct was measured by using multiple indicators to capture the underlying theoretical dimensions effectively (Premkumar and Ramamurthy 1995).

3.2.1.4 Data Collection Procedures

Web-based

In order to increase the survey response rate, a web-based version of the paper survey was also implemented as an additional convenience to informants. Web-based surveys offer a number of advantages to both the researchers and the survey respondents. They are easily accessible, easy to fill out, and consume less time for the respondents. For the researcher, web-based surveys offer a faster response rate and make the data collection and analysis processes easier. Web-based surveys offer automatic coding of the responses, which can be easily downloaded to a spreadsheet or a data analysis package avoiding manual data entry.

In the design and implementation of the web-based survey, the guidelines provided by Dillman (2000) for Internet surveys were followed. The Web-based survey was designed in a simple way to make it possible for the departments with older, less powerful computers and web browsers, and poorer Internet connections to easily receive and respond to the survey. An introductory message was provided at the beginning of the survey. The content of this introductory message was similar to that of the cover letter. It explained the details of the survey such as the purpose and importance of the study, confidentiality of the responses, voluntariness of the participation, etc. Acknowledgments included special thanks to my primary contact people in different departments for their contributions of time and effort throughout the development of the survey. Moreover the name and contact of the contact information of the primary investigator were included in this section.

Questions in the web-based survey were presented in a conventional format similar to the format of the paper-based survey (Dillman 2000). Since responding to web-based surveys might require knowledge of which computer functions to use, specific instructions on how to take each necessary action for answering the questions were provided as needed. As stated by Dillman (2000), the inappropriate use of colour is one of the biggest threats to effective web questionnaires. Therefore, the use of colour was restrained in the design of the web-based survey to maintain the measurement properties of the questions

Once the responses to the web-based survey started to arrive, the survey data and

unique identification numbers were immediately exported into separate excel spreadsheets in order to ensure the confidentiality of the responses. Then, based on the unique identification numbers the agencies that had already responded were removed from future mailing lists

3.2.2Research Methodology and Data Collection – Study II (Case Study)

The qualitative part of the study included the collection and analysis of qualitative data related to a major technology transfer initiative that is being carried out in Zimbabwe in the area of climate change. Specifically the purpose of qualitative data collection and analysis is to seek additional support for the findings of the quantitative data analysis, identify the issues that are not discovered in the quantitative part and thereby gain a better understanding on how technology transfer frameworks used in Zimbabwe influence the implementation of the climate change mitigation projects. This section begins by justifying the use of case study methodology to further explore the research question. Then, the unit of analysis and case selection process are outlined. Afterward, specific steps used in the data collection efforts as well as informant characteristics are discussed. Finally, the data analysis strategy and methods that were employed to increase the validity and the reliability of the findings are explained.

3.2.2.1 Case study

Given the purpose of the qualitative part of the study, a case study approach was found appropriate. In recent years, case study research has become a popular methodology in the technology transfer domain and has been used by many researchers such as Holger (2003) and Singh (2007).

Case study research involves systematically gathering information about a particular person, social setting, group, organization or an entire community to permit the researcher to effectively understand how it operates or functions (Berg 1995). According to Yin (1989, pg. 3), a case study is an inquiry that: "Investigates a contemporary phenomenon within its real-life context, when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used."

Key characteristics of case study research that apply to this research can be summarized as follows (Benbasat 1987, p. 371, Stone 1978, p. 146):

a) Phenomenon is examined in its natural setting.
b) Data are collected by multiple means
c) One or few entities (person, group, or organization) are examined.
d) No experimental controls or manipulation are involved
e) Changes in site selection and data collection methods could take place as the investigator develops new hypotheses.
f) The results derived depend heavily on the integrative powers of the researcher.
g) The focus is on contemporary events.
h) The research addresses "why" and "how" questions rather than frequency or incidence.

As it can be understood from these characteristics, case studies are very useful for studying contemporary issues in real-world settings when 'how' or 'why' questions are being posed and they contribute "uniquely to our knowledge of individual organizational, social and political phenomena" (Yin 1989- cf. Kumar and Crook 1999, p.25). In this respect, a case study approach is particularly useful for this study as the purpose of the study is to gain an understanding of individual, organizational, social and political issues that shape technology transfer frameworks used in Zimbabwe influence the implementation of the climate change mitigation projects.

Case studies are suitable for the exploration, classification, and hypothesis development stages of the knowledge building process (Benbasat 1987). However, they can also be conducted in order to provide an initial test of hypotheses (Dixon 1987).

Confirming theories or hypothesis by the presentation of supporting case study data (Foreman 1971, Stone 1978) is also possible. Therefore, I believe that the case study approach serves as an excellent tool to provide additional support for the findings of the quantitative data analysis and to explore the factors that were not discovered via the quantitative analysis

3.2.2.2 Unit of Analysis and Case Selection

In case study research "the unit of analysis identifies what constitutes a 'case' and a complete collection of data for one study of the unit of analysis forms a single case" (Darke et al. 1998). The unit of analysis may be an individual, a group, an organization or it may be an event or phenomenon.

The case that is investigated in this study focuses on a major technology transfer in climate change mitigation project (The rural Solar PV installations program) that has been carried out in Zimbabwe between the Ministries of Science, Energy, and Environment among other stakeholders. Therefore, the unit of analysis is this single technology transfer initiative. The purpose of this technology transfer initiative initiative is to facilitate climate change mitigation by using alternative energy sources.

From a case selection standpoint, this case proved to be an ideal one to study for a number of reasons. First, in order to satisfy the objectives of the qualitative part it was necessary to find a project that was being carried out between governments and stakeholders in the energy sector. In this respect, the rural Solar PV installations program provides a rich case to examine how the complex technology transfer frameworks used in Zimbabwe influence the implementation of the climate change mitigation projects.

Second, it was important to find a case where I was familiar with both the phenomenon and the setting under study. Since I work in one of the Ministries involved in the planning of the project about the technology transfer initiative this condition was satisfied. Third, it was necessary to find a case where access to data resources could be gained. Since the government of Zimbabwe agreed to support the study, to provide access to key informants in their agency, and help solicit the participation of other stakeholders the third objective was also met. Therefore, based on the purpose for which the case study was conducted and the resources available to me as the researcher, this initiative proved to be an ideal case.

3.2.2.3 Data Collection

The data for this case study was collected through two steps, which are discussed in the following subsections

Preliminary Data Collection

Collecting case study data from case participants can be a difficult process. Hence, it is important that the researchers prepare themselves with sufficient background information about the case. In order to become familiar with the case under investigation, I did the following

a) I collected secondary data about the technology transfer initiative on rural solar PV project initiative in Zimbabwe through the Web.
b) I attended a meeting of Interministerial Committee on the rural PV project to become familiar with the potential informants and gain a better understating of the case.
c) One of my committee members gave a short presentation about my research and afterward, I administrated a short questionnaire to the members of the Interministerial Committee on the rural PV project who were present at that meeting. The survey questionnaire and the findings can be found in Appendix I
d) I conducted some informal conversations with knowledgeable informants in government and other stakeholders.
e) Presented a paper on an international conference in sustainable energy were all stakeholders were present to get information from some of the technology suppliers abroad.
f) I discussed the case several times with my committee members.
g) I obtained feedback of a colleague who is an expert in technology transferrin climate change issues

Interviews

After the preliminary data collection step, I conducted semi-structured interviews with key informants. Although the primary focus of the study was the stakeholders in energy, it was necessary to interview knowledgeable individuals in the government that was implementing and overseeing the technology transfer initiative to gain a better understanding of the initiative and the influence technology transfer frameworks used in Zimbabwe on the implementation of the climate change mitigation projects.

Organisations and Informants

All the organisations and informants to be interviewed in this study will be chosen on the basis of their willingness to participate in the study and their proximity to facilitate data collection efforts and minimize costs.

3.2.2.3Interview Instruments

3.2.2.4 **Data Analysis Strategy**

In data analysis the researcher examines, categorizes, tabulates, or recombines the evidence collected to address the initial propositions of his/her study. Data analysis is one of the most difficult parts of the case study approach as there are not many previously developed strategies or techniques for this purpose (Eisenhardt 1989, Yin 1994).

Miles and Huberman's (1994) book is among one of few sources to guide researchers in qualitative data analysis process (Yin 1994). Miles and Huberman (1994) state that data analysis consists of three concurrent flows of activity: data reduction, data display and conclusion drawing/verification.

Data reduction is the "process of selecting, focusing, simplifying, abstracting, and transforming" the collected data (Miles and Huberman 1994, p.10). Researcher can reduce the data in written-up field notes or transcriptions by writing summaries, coding, teasing out themes, making clusters or partitions, etc.

Data display is an "organized, compressed assembly of information that permits conclusion drawing and action" (Miles and Huberman 1994, p.11). In this step, the researcher can make uses of matrices, graphs, charts, networks, etc. to organize the data into an easily understandable and analysable form. Conclusion drawing is the process of drawing meanings from data by "noting regularities, patterns, explanations, possible configurations, causal flows and propositions" (Miles and Huberman 1994, p.11). Conclusions drawn by the researcher are verified as he/she proceeds by checking back with previous notes, searching for opinions of other individuals, looking for replicate findings in another data set, etc. The techniques offered by Miles and Huberman (1994) and discussed above were used to guide the analysis of the qualitative data. The coding efforts used for data reduction process are explained below, whereas the data display and conclusion drawing processes are incorporated into the qualitative results discussion, which can be found in Chapter 4.

3.2.2.5 Coding

Each recorded interview was transcribed and stored in a Word document. After completing the majority of interviews, the interview data were coded. The following options were available for coding at this point:

a) Coding the data at the word level,

b) Coding the data at the line level,

c) Coding the data at the sentence level, and

d) Coding the data at the paragraph level.

Coding at the sentence level was initially considered but it was found that by coding only at the sentence level was resulting in a loss of meaning that needed to be captured. Therefore, to be able to conserve the completeness and meaningfulness of the interview data, coding at the paragraph level along with the sentence level were found appropriate for this study.

Prior to coding, all the transcripts were reviewed first and later each individual interview was coded one by one. Each sentence and/or paragraph was either (a) coded into one of the categories that were pre-determined based on the factors in the research framework, (b) coded into a new category that was not pre-determined but had emerged during the interviews, (c) coded into multiple categories, or (d) or not coded if it was found out to be unrelated to the technology transfer initiatives in climate change

3.2.2.5 Reliability and Validity

Even though there are no pre-established standards in qualitative research to ensure the quality of the data analysis and the accuracy of the findings, there are certain measures that can be taken to achieve this goal. A detailed discussion of these methods can be found in literature (Miles and Huberman 1994, Lincoln and Guba 1993, and Patton 2002). In this section, the methods that were employed to increase the validity and the reliability of the findings of this case study are briefly discussed.

The first and most important step in analyzing case study evidence is to have an analytic strategy to help the researcher to (a) treat evidence fairly, (b) produce compelling conclusions, and (c) rule out alternative interpretations (Yin 1984). For this purpose Yin (1984) suggests two general strategies:

(a) Relying on theoretical propositions that lead to the case study, and

(b) Developing a descriptive framework for organizing the case study.

The first approach is preferred in helping the researcher successfully analyse the case study evidence. One of the strengths of this study comes from using this more preferred approach. Parallel to this strategy, the case study objectives and design were guided by the research model, which was developed through a review of the pertinent literature that provided a strong theoretical foundation.

Another strength of the study comes from applying an iterative two-step data analysis process. As Yin (1998, p. 250) states, "case study investigators practice 'analysis' during data collection." Conducting data collection and data analysis hand in hand helped me to revise the data collection and/or data analysis processes according to the rich insights that I gained during data collection. The second step of data analysis, which was the major case study analysis, took place after the data collection is completed.

Miles and Huberman (1994) state that in qualitative research, the issues of validity and reliability depends on the skills of the researcher. According to the authors in order to establish reliability and validity, the researcher should:

(a) have some familiarity with the phenomenon and the setting under study,

(b) develop strong conceptual interests, and

(c) Use a multi-disciplinary approach as opposed to focusing on a single discipline.

To gain familiarity with the case, I utilized a number of data collection methods and collected data from various resources. This preliminary data collection process is discussed above in Section 3.2.2.4 . In order to develop strong conceptual interest and understanding, I collected and analysed quantitative data in an overlapping fashion with the qualitative data collection and analysis. To avoid the problems associated with a single-discipline focus, I conducted a detailed literature review in the domains of technology transfer, climate change, and Zimbabwean experiences and developed a research framework by synthesizing well-established theory bases from different disciplines.

In addition to the strategies explained above, the following principles discussed in

Yin's study (1984) were followed to establish validity and reliability of the study findings: (a) using multiple sources of evidence, (b) creating a case study database, and (c) maintaining a chain of evidence.

By using multiple sources of evidence (triangulation) researcher can address an extensive range of historical, attitudinal, and behavioural issues (Yin 1984). In this study triangulation of resources included interviewing members from a variety of stakeholders (technology suppliers, manufactures, technology recipients) and interviewing multiple government departments. Triangulation of methods included using different forms of qualitative methods (initial questionnaire that collected qualitative data, informal meetings, observations, secondary data collection, etc.).

Creating a case study database requires organizing and documenting the data collected for the case study. For this purpose as suggested by Yin (1984) the case study notes were stored in a manner to ensure easy retrieval of data. Moreover, individual tables summarizing major findings of each interview were created. These tables included direct quotes from interviewees.

Maintaining a chain of evidence requires that one can move from one portion of the case study to another with clear cross referencing to methodological procedures and to the resulting evidence (Yin 1984). In order to maintain a chain of evidence to increase the reliability of information provided in the case study, I provided direct quotations from the interviews to support the study conclusions, and made every attempt to ensure that that no original evidence was lost and the study conclusions could be traced back to the original data.

3.3 Chapter summary

This chapter introduced the methodologies to be used both the quantitative and qualitative and developed the research framework to be used for the study. The researcher proposed the used of quantitative techniques and case study together to get a deeper understanding of the projects in technology transfer for climate change mitigation.

CHAPTER 4

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Research Results and Findings STUDY 1 Survey

Introduction

This chapter provides a comprehensive discussion of the data analysis techniques utilized in the quantitative part of the study and the results obtained. First, survey response rate and analyses of missing data and non-response bias are discussed. Second, sample characteristics are reported. Third, the steps taken to establish validity and reliability of the survey instrument are explained. Fourth, the statistical tests that are performed to test the research framework and hypotheses are discussed and the results obtained from these tests are presented. Finally, themes that emerged from a series of open-ended questions are reported.

4.1.1 Survey Response

In this section, survey response rate and analyses of missing data and non-response bias are discussed.

4.1.1.1 Response Rate

The sampling frame for this study consisted of all the stakeholders who participated in any of the technology transfer projects in climate change in Zimbabwe regardless of the time. There are five main groups in which the stakeholders are classified in technology transfer initiatives. The Ministry of Energy keeps a register of individuals falling in the following classes

a) Overseas suppliers
b) Local suppliers
c) Local installers
d) End users
e) Steering committee (Government , Funders, NGO etc.)

From the register the sample size was 93, out of these individuals 78 of them returned the survey, yielding a response rate of 83%. Of the 78 surveys returned all of them were incomplete on potential for induced demand, substitutability and subsidy hence were dropped from subsequent analyses, yielding 78 usable responses and a usable response rate of 83 %.

4.1.1.2 Analysis of Missing Data

Missing data refers to "information not available for a subject (or case) about whom other information is available." (Hair et al. 1998, p. 38). Missing data might be caused by the respondent's refusal to answer one or more questions.

In this study, systematic patterns of missing data were not encountered in the data set

In this study, systematic patterns of missing data were not encountered in the data set except for the questions on potential for induced demand, substitutability and subsidy. Hair et al. (1998) recommends that in the cases where a non-random pattern of missing data is present, the most efficient solution is to delete the case(s) or variable(s) with missing data. Therefore, these questions and the associated responses were removed from further consideration. In other cases where random missing data were infrequent, the missing data were addressed via mean replacement, as recommended by Hair et al. (1998).

4.1.1.2 Analysis of Non-Response Bias

Non-response bias is an important source of bias in survey research. If it is not addressed properly, it can lead to conclusions that differ systematically from the actual situation in the population. Extrapolation methods, which compare early respondents to late respondents, can be used to predict non-response bias (Armstrong and Overton 1977 and Churchill 1991). Since late respondents require prompting to respond and are therefore apparently less eager, they are likely to be similar to non-respondents. Thus, if late respondents and early respondents do not differ in certain characteristics, it is less likely that non-respondents will differ significantly from respondents (Compeau and Higgins 1995). Consistent with prior research, non-response bias was assessed by using extrapolation methods. The midpoint of the data collection period was used as the cut-off point for distinguishing between early and late respondents

To ensure that the early respondents and late respondents did not systematically differ, these two groups of respondents were compared based on demographic data including organisation characteristics (number of employees, population of the area served, and budget) and respondent characteristics (agency tenure, position tenure, age, gender, and education) using independent samples t-tests to check for equality of means. SPSS was used as the statistical analysis tool.

Table 2 Assessment of non-Response bias

	N	Mean	Std.Dev.	t-value	d.f.	Sig*
1. Num employees				0.774	116	0.441
Early respondents	42	60.55	117.24			
Late respondents	36	43.81	103.36			
2. Population				-.014	115	.989
Early respondents	42	25,700.57	63,114.54			
Late respondents	36	25,883.86	72,080.60			
3. Budget				-.118	80	.907
Early respondents	42	3,044,462.51	5,702,742.44			
Late respondents	36	3,216,150.72	7,303,817.62			
4. Age				.550	113	.584
Early respondents	42	3.04	1.01			
Late Respondents	36	2.93	1.15			
5. Education				-.084	112	.933
Early respondents	42	1.36	0.61			
Late Respondents	36	1.38	0.63			
* p-value of 2-tail t-test						

Before conducting the t-tests, Levene's statistic was calculated for each analysis to ensure comparable variances between groups. Levene's statistic tests the null hypothesis that the error variances are equal across groups (Rosnow and Rosenthal 1991). If the significance value for the Levene test is not significant ($p > 0.05$), then the t-test results that assume equal variances for both groups can be used. If the significance value for the Levene test is significant ($p < 0.05$) then the t-test results that do not assume equal variances for both groups must be used.

4.1.2 Sample Characteristics

The final sample consisted of 16 Overseas suppliers (21.05%), 23 Local suppliers (30.26%), 25 Local installers (32.89%), 6 End users (7.89%) and 8 Steering committee (7.89%). The number of employees in the departments varied from 1 employee to 704 employees. The average number of the employees in the respondent departments was 52.18(SD110.3) employees. The population of the area served by the organisations ranged from 188 to 460000, with an average population of 25,766.37.The annual operating budgets of the organisations varied from $9,600 to $35,000,000 with an average value of $3,105,181.51 annually(SD=$6,270,979.28).

Of the total individual respondents that have reported their gender (N=76), 87.9% (N=66) were males and 12.1% (N=10) were females. 0% (N=0) of the respondents were between the ages (20-30), 31.6% (N=24) of the respondents were between the ages (31-40), 48.7% (N=37) of the respondents were between the ages (41- 50), 18.4% (N=14) of the respondents were between the ages (51-60), and 0% (N=0) of the respondents were 61 years old or above

Table 3 Sample characteristics

	N valid	N missing	Mean	Median	Mode	Std Dev	Minimum	Maximum
# Employees	76	2	52.18	17	1.00[a]	110.3	1	704
Population	76	2	25,766.37	7,000.00	2,000.00	66,766.07	188.00	460,000.00
Budget	76	2	3,105,182	765,000	3,000,000	6,270,979	9,600	35,000,000
Department tenure	76	2	12.81	12.08	2.00[a]	9.31	.04	40.00
Position tenure	76	2	5.72	3.00	1.00[a]	6.28	.00	25.00

Table 4 Demographic characteristics

	Frequency	Percent	Valid Percent
1. Department type			
Overseas suppliers	16	21.05	21.05
Local suppliers	23	30.26	30.26
Local installers	25	32.89	32.89
End users	6	7.89	7.89
Steering committee	6	7.89	7.89
Valid	76	100	100
Missing	0	0	0
Total	76	76	76
2. Age Group			
20-30	0	0	0
31-40	24	31.6	31.6
41-50	37	48.7	48.7
51-60	14	18.4	18.4
61+	0	0	0
Valid	76	100	100
Missing	0	0	0
Total	76	100	100
3. Gender			
Male	45	59.2	59.2
Female	28	36.8	36.8
Valid	74	98.7	98.7
Missing	2	1.3	1.3
Total	76	100	100
4. Education			
PhD	19	25.0	25.0
Master	44	57.9	57.9
Bachelor	8	10.5	10.5
Diploma	4	5.3	5.3
Valid	76	100	100
Missing	0	0	0
Total	76	100	100

4.1.3 Assessment of Validity and Reliability

In this section the steps that were taken to establish validity and reliability of the survey instrument are discussed.

4.1.3.1 Assessment of Convergent and Discriminant Validity

In order to claim the validity of an instrument it is necessary to have both convergent and discriminant validity (Trochim 2002). Convergent validity refers to the state when items measure their intended construct and no other construct, whereas discriminant validity is confirmed when the construct as a whole differs from the other constructs (Straub 1989).

There are two types of approaches that can be used to assess the validity of an instrument: classical and contemporary approaches (Bagozzi et al. 1991). Classical approaches include multitrait-multimethod (MTMM) technique (Campbell and Fiske 1959) or principal components factor analysis (Straub 1989), whereas the contemporary approaches include confirmatory factor analysis utilizing maximum likelihood extraction such as structural equation modeling (SEM). In recent years the use of SEM techniques for instrument validation and testing has become popular in the technology transfer domain. However, the use of this technique requires a large sample size. As a rule of thumb, 20 observations per each item would be needed to analyse a comprehensive measurement model. Therefore, given the number of factors in the model and the sample size, the most commonly used classical approach to instrument validation "principal components factor analysis" was adopted to refine the measurement items and to test validity.

Factor analysis is a multivariate statistical technique that is used to analyse the structure of the correlations among a large number of variables based on a set of common underlying dimensions (Hair et al. 1998). Factor analysis helps the researcher to determine whether a certain set of items do or do not constitute a construct (Straub 1989). In factor analysis, (a) separate dimensions of the structure are identified and the extent to which each variable is explained by each dimension is determined, and (b) the number of variables is reduced through summarization and data reduction (Hair et al. 1998).

To test for instrument validity principal component factor analysis utilizing promax with Kaiser normalisation rotation technique was performed. SPSS statistical package was used. As stated by Hair et al. (1998) the choice of an orthogonal or oblique rotation should be made on the basis of particular needs of a given research problem. If the purpose is to reduce the number of original variables, regardless of how meaningful the resulting factors may be, orthogonal rotation methods will be appropriate. However, if the purpose of the factor analysis is to obtain several theoretically meaningful factors or constructs, an oblique solution is the appropriate approach. In this study, promax rotation, an oblique rotation method, was chosen over orthogonal rotation methods since the independent variables are not assumed to be completely unrelated. This conclusion is reached because, "realistically, very few factors are uncorrelated, as in orthogonal rotation" (Hair et al. 1998, p. 111).

4.1.3.1.1 Adherence to Assumptions in Factor Analysis

Hair et al. (1998) recommends that the researcher should ensure that the data matrix has sufficient correlations to justify the application of factor analysis. The Kaiser- Mayer Olkin's Measure of Sampling Adequacy (MSA) test and Bartlett's Test of Sphericity were conducted to assess the suitability of the survey data for factor analysis.

Table 5 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.777
Bartlett's Test of Sphericity	Approx. Chi-Square	718.087
	df	78
	Sig.	.000

Table 4 shows the results of these tests. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy is a statistic which indicates the proportion of variance in the variables which is common variance, i.e. which might be caused by underlying factors. This index ranges from 0 to 1, reaching 1 when each variable is perfectly predicted without error by the other variables. The measure can be interpreted with the following guidelines: (.90) or above is marvelous, (.80) is meritorious, (.70) is middling, (.60) is mediocre, (.50) is miserable and below (.50) is unacceptable. In this study, Kaiser-Mayer Olkin's Measure of Sampling Adequacy (MSA) is .766, which is close to meritorious.

The Bartlett test of Sphericity is a statistical test for the presence of correlations among the variables (items). It indicates whether your correlation matrix is an identity matrix, which would indicate that the variables (items per specific construct) are unrelated. The significance level gives the result of the test. Small values (less than .05) indicate that the data do not produce an identity matrix and, hence, are suitable for factor analysis. Larger values indicate that the data produce an identity matrix and, hence, are not suitable for factor analysis. In this study, significance level for Bartlett's Test of Sphericity is .000, which means that the data are appropriate for factor analysis.

4.1.3.1.2 Factor Analysis Results

Data were factor analyzed using principal component factor analysis utilizing promax rotation with Kaiser normalisation technique and missing cases were replaced by means. Following Chin et al. (1997) and Nunally and Berstein (1997), a combination of the Kaiser-Guttman Rule (Eigenvalues greater than one) and scree plot were utilized to determine the most appropriate component solution.

Table 6 Principal Component factor analysis

Items	Resources	Manufacturing Experience	Geographic Location	Licences	Business Strategy	Price for technology,	Scientific knowledge	Technology design	Process	Physical technology	Know how	Political constraints
Resources	.942											
Resources	.960											
Manufacturing Experience		.821										
Manufacturing Experience		.869										
Geographic Location			.634									
Geographic Location			.634									
Licences				.975								
Licences				.961								
Licences				.871								
Business Strategy					.950							
Business Strategy					.950							
Price for technology						.868						
Price for technology						.859						
Scientific knowledge							.873					

Scientific knowledge							.918					
Technology design								.881				
Technology design								.881				
Process									.922			
Process									.893			
Physical technology										.834		
Physical technology										.834		
Know how											.927	
Know how											.946	
Political constraints												.813
Political constraints												.850

The factor analysis indicated that the pool of items captured twelve distinct factors including the dependent variable. The items that did not load properly or had cross loadings were dropped. Absorption, on site demonstration, personnel exchange, spinoff, technological niche and resources were no longer considered for subsequent analysis

The ultimate solution demonstrated both convergent validity and discriminant validity. Referring to Table 5, convergent validity was established because all the items loaded strongly on their associated factors (loading >.50) and each of the factors loaded stronger on their associated factors rather than on any other factors (Chau and Tam 1997).

As mentioned above, twelve factors were extracted from this study (eleven independent variables and one dependent variable). Resources, manufacturing experience, geographic location, Licences, business strategy, price for technology, scientific knowledge, technology design, process, physical technology, know-how and political constraints

Table 6 gives a summary of the Eigenvalues, variance explained, and cumulative variance explained by the factor solution. The extraction sums of squared loadings group gives information regarding the extracted factors or components. For principal components extraction, these values will be the same as those reported under initial Eigenvalues.

In a good factor analysis, a few factors explain a substantial portion of the variance and the remaining factors explain relatively small amounts of variance, which is the case in these results. Even though there is no absolute threshold that can be adopted, in social sciences where information is often not precise as in natural sciences, a combination of factors that accounts for 60% of the total variance (and in some cases even less) is deemed satisfactory (Hair et al. 1998). The results in the table below show that first few factors accounts for a large percentage of the total variance and the twelve factors that are extracted account for 89.000% of the total variance. Based on these findings it can be concluded that these twelve factors can be used to investigate the research question.

Table 7 Eigenvalues and total variance explained

Component		Initial Eigenvalues			Extraction Sums of Squared Loadings		
		Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
dimension0	1	5.991	46.084	46.084	5.991	46.084	46.084
	2	2.091	16.086	62.170	2.091	16.086	62.170
	3	1.291	9.931	72.101	1.291	9.931	72.101
	4	1.145	8.810	80.911	1.145	8.810	80.911
	5	.595	4.575	85.486			
	6	.471	0.624	86.110			
	7	.316	0.432	86.542			
	8	.296	0.274	86.816			
	9	.278	0.136	86.952			
	10	.188	0.443	87.395			
	11	.172	.326	87.721			
	12	.095	.733	89.454			
	13	.071	.546	89.000			

Extraction Method: Principal Component Analysis.

4.1.3.2 Assessment of Reliability

An important step in instrument validation is to test the instrument for reliability to ensure measurement accuracy (Straub 1989) that is to minimize the measurement error. Reliability refers to the state when a scale yields consistent measures over time (Straub 1989). Several types of reliability are defined in the literature. Internal consistency tends to be a frequently used type of reliability in the technology transfer domain. In this study Cronbach's alphas, which are calculated based on the average inter-item correlations, were used to measure internal consistency. As stated by Straub (1989, p. 151.), "high correlations between alternative measures or large Cronbach's alphas are usually signs that the measures are reliable."

Table 8 Reliability Analysis

	Cronbach's Alpha
Resources	.721
Manufacturing Experience	.719
Geographic Location	.723
Licences	.823
Business Strategy	.690
Price for technology	.693
Scientific knowledge	.686
Technology design	.700
Process	.715
Physical technology	.750
Know how	.760
Political constraints	.753
Technology transfer initiative	.678

The Cronbach's alpha values range from 0.686 to 0.823. There is no standard cut-off point for the alpha coefficient, but the generally agreed upon lower limit for Cronbach's alpha is .70, although it may decrease to .60 (Hair et al. 1998) or even .50 (Nunnally 1978) in exploratory research. In order to make sure that the low Cronbach alpha value for the dependent variable construct does not cause a problem, a more stringent test of reliability, which involves assessing the amount of variance captured by a construct's measures in relation to the amount of variance due to measurement error, was also performed (Fornell and Larcker 1981). In order to claim reliability, the variance extracted by the construct's measure (Average Variance Extracted-AVE) should be greater than 0.50. Referring to table 7 the reliabilities in this study is deemed acceptable.

4.1.4 Hypothesis Testing

In this section, the statistical tests that are performed to test the research framework and hypotheses are discussed and the results obtained from these tests are presented. First, the required sample size is explained. Then, the regression analysis and results from hypotheses testing are reported. Finally, the assumptions of regression analysis are assessed.

4.1.4.1 Regression Analysis

The stepwise multiple regression method was used to test the hypotheses of the study. SPSS was used as the statistical analysis tool. The dependent variable for this test was participation in technology transfer initiatives in energy for climate change mitigation and the independent variables were resources, manufacturing experience, geographic location, Licences, business strategy, and price for technology, scientific knowledge, technology design, process, physical technology, and know-how legislation were found to be the determinants in technology transfer initiatives in Zimbabwe.

Political constraints, substitutability, subsidy, potential for induced demand, licences, absorption, on site demonstration, personnel exchange, spinoff, technological niche and resources were statistically excluded from the model by the stepwise regression method.

Table 9 Regression results

Independent Variables	Beta	t-value	Decision
Resources	.435***	4.492	Accepted
Manufacturing Experience	.292**	3.017	Accepted
Geographic Location	-.201*	-2.148	Accepted
Licences	.284*	2.887	Accepted
Business Strategy	.123	.798	Rejected
Price For Technology	.225*	1.758	Accepted
Scientific Knowledge	.142	1.060	Rejected
Technology Design	-.087	-.845	Rejected
Process	.186	1.293	Rejected
Physical Technology	-.016	-.084	Rejected
Know-How	.197	1.498	Rejected
Model Summary Adjusted R^2 Square= .353			
Beta: Standardised regression coefficients (β) * denotes significance at the p<.1 ** denotes significance at the p<.05 *** denotes significance at the p<.01 Two tail tests			

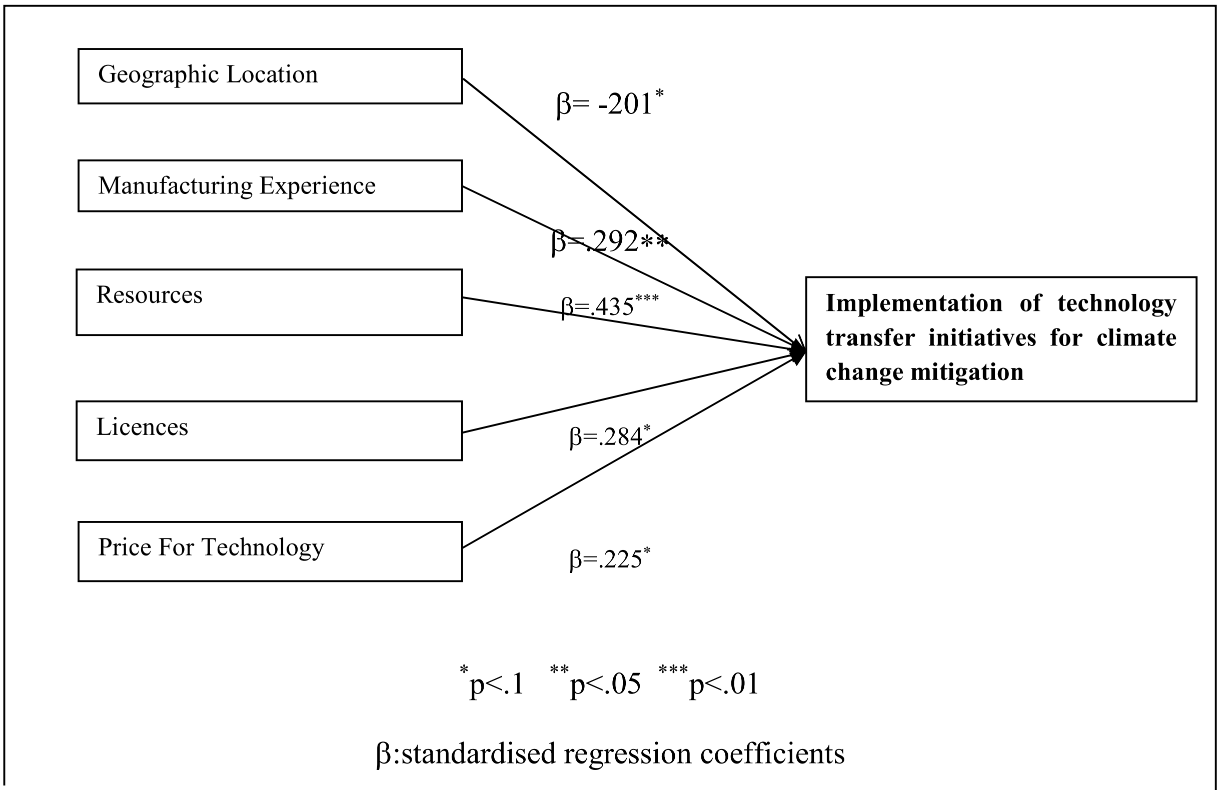

Figure 4 Regression results for Implementation of technology transfer initiatives for climate change mitigation

Stepwise multiple regression consists of an automatic search procedure that develops the best subset of the independent variables. Basically, this search method develops a sequence of regression models, at each step adding or deleting an independent variable. The criterion for adding or deleting an independent variable can be stated equivalently in terms of error sum of squares reduction, coefficient of partial correlation, t statistic, or F statistic (Neter et al. 1996). In order to ensure that the excluded variables were not removed due to their significance being masked by multi-collinearity, correlations between the excluded and included variables were examined. Therefore, it can be concluded that none of the excluded variables were dropped from the model due to multi-collinearity

The results of the multiple regression shows that there is a regression relation between the dependent variable and the set of five independent variables. $F^* = 14.432 > F_{.05,5,75} \cong 2.29$ and $p=.000 <.05$) at the $\alpha=.05$ level. Moreover, the results show that the five independent variables remaining in the model explain up to 35.3% (Adjusted R^2) of the variance in implementation of technology transfer initiatives for climate change mitigation.

The results obtained from the hypothesis testing are summarised in table 5

Table 10 Results obtained from the hypothesis testing are summarised below

Item	Hypothesis	
Resources	H_1: Resources will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Supported
Manufacturing Experience	H_2: Manufacturing experience has a positive effect on implementation of technology transfer initiatives in climate change mitigation	Supported
Geographic Location	H_3: Geographic location has positive effect on implementation of technology transfer initiatives in climate change mitigation	Supported
Business Strategy	H_4: Business strategy has a positive effect on implementation of technology transfer initiatives in climate change mitigation.	Not Supported
Price for technology,	H_5: Price of technology has a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Supported
Substitutability	H_6: The easier with which substitutability has a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported
Subsidy	H_7: Subsidy will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported
Potential for induced demand	H_8: Potential for induced demand will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported
Technology design	H_9 Presence of the technological design will have a positive effect on the	Not

	implementation of technology transfer initiatives in climate change mitigation	Supported
Process	H_{10} presence of the process will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported
Physical technology	H_{11} Presence of the physical technology will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported
Know how	H_{12} Presence of know how will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported
Scientific knowledge	H_{13}: The stage at which a product in terms of scientific and technological advancement will have positive effect on the implementation of technology transfer initiatives in climate change mitigation.	Not Supported
Intellectual Property	H_{14}: The category of IP protection will have an effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported
Licences	H_{15}: The type of licence used will have an effect on the implementation of technology transfer initiatives in climate change mitigation	Supported
Absorption	H_{16}: Absorption will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported
On site demonstration	H_{17}: Onsite demonstration will have a positive effect on the implementation of technology transfer initiatives in Zimbabwe climate change mitigation	Not Supported
Personnel exchange	H_{18}: Personnel exchange will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported
Spinoff	H_{19}: Spin offs have a positive impact on the implementation of technology transfer in climate change mitigation projects	Not Supported
Organisational design	H_{20}: Organisational design has an effect on the implementation of technology transfer in climate change mitigation projects	Not Supported
Political constraints	H_{21}: Unsupportive political environment will have a negative impact on the implementation of technology transfer in climate change mitigation projects	Not Supported
Technological niche	H_{22}: Technological niche will have a negative impact on the implementation of technology transfer in climate change mitigation projects	Not Supported
Geographic location	H_{23} :The Geographic location of the transfer agent will have an impact on the implementation of technology transfer in climate change mitigation projects	Not Supported
Resources of transfer agent	H_{24}: The organisation ability to provide resources will have a positive impact on the implementation of technology transfer in climate change mitigation projects	Not Supported

Hypotheses H_1 examined the effects of resources of the receiving entity on the implementation of technology transfer initiatives in climate change mitigation. Specifically the hypothesis H_1: Resources will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation.The analysis revealed a β coefficient that was significantly different than 0 ($p=.000<.001$) and in the hypothesised direction. Therefore the results supported the hypothesis.

Hypotheses H_2 examined the effects of manufacturing experience on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypothesis suggested that manufacturing experience of recipient organisation has a positive effect on implementation of technology transfer initiatives in climate change mitigation.The analysis revealed a β coefficient that was significantly different than 0 ($p = .022 < .05$) and in the hypothesized direction. Therefore, the results supported this hypothesis

Hypotheses H_3 examined the effects of geographic location on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypothesis suggested that geographic location has positive effect on implementation of technology transfer initiatives in climate change mitigation. The analysis revealed a β coefficient that was significantly different than 0 ($p = .004 < .05$) and in the hypothesized direction. Therefore, the results supported this hypothesis.

Hypotheses H_4 examined the effects of the business strategy of the recipient organisation on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypothesis suggested that business strategy has a positive effect on implementation of technology transfer initiatives in climate change mitigation. The analysis did not yield a β coefficient that was significantly different than 0 ($p = .557 > .05$) and eliminated this variable from the model. Therefore, the results obtained from the multiple regression tests did not support this hypothesis.

Hypotheses H_5 examined the effects price for technology on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypothesis suggested that price of technology has a positive effect on the implementation of technology transfer initiatives in climate change mitigation. The analysis revealed a β coefficient that was significantly different than 0 ($p = .000 < .05$) and in the hypothesized direction. Therefore, the results supported this hypothesis.

Hypotheses H_6 examined the effects of substitutability of the product on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypothesis suggested the easier with which substitutability has a positive effect on the implementation of technology transfer initiatives in climate change mitigation. Hypotheses H_6 was not tested, as it was found that the items used to measure substitutability did not demonstrate sound psychometric properties during the final stage of the instrument validation.

Hypotheses H_7 examined the effects of subsidy on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested that subsidy will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation. Hypotheses H_7 was not tested, as it was found that the items used to measure substitutability did not demonstrate sound psychometric properties during the final stage of the instrument validation.

Hypotheses H_8 examined the effects of potential for induced demand on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested that potential for induced demand will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation. Hypotheses H_8 was not tested, as it was found that the items used to measure substitutability did not demonstrate sound psychometric properties during the final stage of the instrument validation.

Hypotheses H_9 examined the effects of technological design on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested that presence of the technological design will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation. The analysis did not yield a β coefficient that was significantly different than 0 ($p = .638 >$

.05) and eliminated this variable from the model. Therefore, the results obtained from the multiple regression tests did not support this hypothesis.

Hypotheses H_{10} examined the effects of process on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested that presence of the process will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation. The analysis did not yield a β coefficient that was significantly different than 0 ($p = .731 > .05$) and eliminated this variable from the model. Therefore, the results obtained from the multiple regression tests did not support this hypothesis.

Hypotheses H_{11} examined the effects of physical technology on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested that presence of the physical technology will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation. The analysis did not yield a β coefficient that was significantly different than 0 ($p = .548 > .05$) and eliminated this variable from the model. Therefore, the results obtained from the multiple regression tests did not support this hypothesis

Hypotheses H_{12} examined the effects of know-how on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested that presence of the know-how will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation. The analysis did not yield a β coefficient that was significantly different than 0 ($p = .658 > .05$) and eliminated this variable from the model. Therefore, the results obtained from the multiple regression tests did not support this hypothesis

Hypotheses H_{13} examined the effects of scientific knowledge on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested the stage at which a product in terms of scientific and technological advancement will have positive effect on the implementation of technology transfer initiatives in climate change mitigation. The analysis did not yield a β coefficient that was significantly different than 0 ($p = .315 > .05$) and eliminated this variable from the model. Therefore, the results obtained from the multiple regression tests did not support this hypothesis

Hypotheses H_{14} examined the effects of intellectual property on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested the category of IP protection will have an effect on the implementation of technology transfer initiatives in climate change mitigation. The analysis did not yield a β coefficient that was significantly different than 0 ($p = .419 > .05$) and eliminated this variable from the model. Therefore, the results obtained from the multiple regression tests did not support this hypothesis.

Hypotheses H_{15} examined the effects of licences on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested that the type of licence used will have an effect on the implementation of technology transfer initiatives in climate change mitigation. The analysis revealed a β coefficient that was significantly different than 0 ($p = .016 < .05$) and in the hypothesized direction. Therefore, the results supported this hypothesis.

Hypotheses H_{16} examined the effects of absorption licences on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested that absorption will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation. Hypotheses H_{16} was not tested, as it was found that the items used to measure absorption did not demonstrate sound psychometric properties during the final stage of the instrument validation.

Hypotheses H_{17} examined the effects of onsite demonstration on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested that onsite demonstration will have a positive effect on the implementation of technology transfer initiatives in Zimbabwe climate change mitigation. Hypotheses H_{17} was not tested, as it was found that the items used to measure absorption did not demonstrate sound psychometric properties during the final stage of the instrument validation.

Hypotheses H_{18} examined the effects of onsite demonstration on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested that onsite demonstration will have a positive effect on the implementation of technology transfer initiatives in Zimbabwe climate change mitigation. Hypotheses H_{18} was not tested, as it was found that the items used to measure absorption did not demonstrate sound psychometric properties during the final stage of the instrument validation.

Hypotheses H_{18} examined the effects of personnel exchange on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested that onsite demonstration will have a positive effect on the implementation of technology transfer initiatives in Zimbabwe climate change mitigation. Hypotheses H_{18} was not tested, as it was found that the items used to measure absorption did not demonstrate sound psychometric properties during the final stage of the instrument validation.

Hypotheses H_{19} examined the effects of spinoff on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested that spin offs have a positive impact on the implementation of technology transfer in climate change mitigation projects. Hypotheses H_{19} was not tested, as it was found that the items used to measure absorption did not demonstrate sound psychometric properties during the final stage of the instrument validation.

Hypotheses H_{20} examined the effects of organisational design on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested that organisational design has an effect on the implementation of technology transfer in climate change mitigation projects. . The analysis did not yield a β coefficient that was significantly different than 0 ($p = .362 > .05$) and eliminated this variable from the model. Therefore, the results obtained from the multiple regression tests did not support this hypothesis.

Hypotheses H_{21} examined the effects of political constraints on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested that political constraints have an effect on the implementation of technology transfer in climate change mitigation projects. The analysis did not yield a β coefficient that was significantly different than 0 ($p = .317 > .05$) and eliminated this variable from the model. Therefore, the results obtained from the multiple regression tests did not support this hypothesis.

Hypotheses H_{22} examined the effects of technological niche on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested that technological niche have an effect on the implementation of technology transfer in climate change mitigation projects. Hypotheses H_{22} was not tested, as it was found that the items used to measure absorption did not demonstrate sound psychometric properties during the final stage of the instrument validation

Hypotheses H_{23} examined the effects of geographic location on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested that geographic location have an effect on the implementation of technology transfer in climate change mitigation projects. The analysis did not yield a β coefficient that was significantly different than 0 ($p = .243 > .05$) and eliminated this variable from the model. Therefore, the results obtained from the multiple regression tests did not support this hypothesis.

Hypotheses H_{24} examined the effects of resources of transfer agent on implementation of technology transfer initiatives in climate change mitigation. Specifically, the hypotheses suggested that the organisation's ability to provide resources will have a positive impact on the implementation of technology transfer in climate change mitigation projects. Hypotheses H_{24} was not tested, as it was found that the items used to measure absorption did not demonstrate sound psychometric properties during the final stage of the instrument validation

4.1.4.5 Evaluating the Results for the Assumptions of Regression Analysis

In the section above, statistical significance test was used to evaluate the relationship between independent and dependent variables. In regression analysis there are also two other basic issues that need to be addressed:

a) measuring the degree and impact of multicollinearity, and
b) meeting the assumptions underlying regression. Each of these issues is considered in the following subsections.

4.1.4.5.1 Test of Multicollinearity

One of the issues that needs to be addressed in multiple regression is the impact of multicollinearity. Collinearity refers to the association (correlation) between two independent variables, whereas multicollinearity refers to the correlation among three or more independent variables. Multicollinearity reduces a single independent variable's predictive power by the extent to which it is associated with other independent variables

(Hair et al. 1998). Existence of multicollinearity can affect the interpretation of the results. Highly collinear variables can distort the results or make them unstable and thus not generalizable. Therefore, in order to maximize the prediction power from a given set of independent variables, it is important to test for multicollinearity.

In this study multicollinearity was tested by calculating VIF (Variance Inflation Factor) and tolerance values as suggested by Hair et al. (1998). SPSS was used to conduct these tests.

VIF measures "how much the variance of the estimated regression coefficients are inflated as compared to when the independent variables are not linearly related" (Neter et al. 1989, p. 408). The VIF's for all the factors were significantly lower than the upper limit 10, suggesting that there were no multicollinearity effects. In addition, tolerance values for each factor were calculated. Tolerance is the proportion of each variable's variance not shared with the other independent variables. Small tolerance values (below 0.2 or 0.1) indicate collinearity. Table 10 the results of the multicollinearity test. In this study all tolerance values were above .932, indicating very low level of multicollinearity. For this data, none of the variables appeared to be highly correlated with other variables, meaning that the model does not suffer from multicollinearity effects.

Table 11 Collinearity statistics

Independent variables	Collinearity statistics	
	Tolerance	VIF
Resources	.932	1.073
Manufacturing Experience	.932	1.073
Geographic Location	.955	1.073
Price for technology,	.953	1.073
Licences	.932	1.073

4.1.4.5.2 Test of Underlying Assumptions

It is suggested that certain assumptions should be met while conducting regression analysis, to ensure the validity of the results obtained from the analysis. The assumptions that apply to this study are, linearity, homoscedasticity, and normality. The following paragraphs discuss each one of those assumptions, the tests utilized to assess these assumptions and the results obtained.

The assumption of linearity was tested through an analysis of residuals and partial regression plots as recommended by Hair et al. (1998). First a scatter-plot of the studentized residuals and the predicted values was created using Stata, which is a powerful statistical package developed by the Stata Corporation. The scatter-plot did not exhibit a nonlinear pattern, thus ensuring that the overall equation was linear. Second, partial plots for each independent variable in the model were created to ensure each independent variable's relationship with the dependent variable is also linear.

Homoscedasticity is another assumption of regression, which deals with the constancy of the residuals across values of independent variables. The assumption suggests that the "variance of the residuals at every set of values for the independent variable is equal" (Miles and Shevlin 2001, p.99). In this study this assumption was tested through an examination of the residuals as recommended by Hair et al. (1998). The analysis of studentized residuals showed no pattern of increasing or decreasing residuals, which indicated that the assumption of homoscedasticity was met.

The assumption of normality was tested by using a normal probability plot and performing the Kolmogorov-Smirnov goodness-of-fit test, as recommended by Hair et al.(1998). In the normal probability plot, a normal distribution is indicated by a straight diagonal line and the residuals are plotted along the diagonal. If a distribution is normal, the residual data points closely adhere to the diagonal. The normal probability plot was created using SPSS, which showed that the values fell along the diagonal with no substantial or systematic departures. Thus, the residuals appeared to represent a normal distribution. The Kolmogorov-Smirnov test can be used to test the null hypothesis that the population distribution from which the data sample is drawn conforms to a normal distribution. A low significance value (generally less than 0.05) indicates that the distribution of the data differs significantly from a normal distribution. The

Kolmogorov-Smirnov statistic was calculated using SPSS, which showed that the distribution follows a normal distribution ($p = 0.20$).

4.2 RESEARCH RESULTS AND FINDINGS STUDY II (CASE STUDY)

In this section, the results of the case study are presented. First, a description of the case is provided, followed by a discussion of the findings. Evidence of the findings is presented via the inclusion of supporting quotes from the interviews that were conducted.

4.2.1 Description of the Case The rural Solar PV project in Zimbabwe

The Global Environment Facility (GEF) is a financial mechanism that provides grants and concessional funds to developing countries for projects and activities that tackle environmental challenges which have global implications. Mechanisms for technology transfer are to facilitate the support of financial, institutional and methodological activities:

(a) To enhance the coordination of the full range of stakeholders in different countries and regions;

(b) To engage them in cooperative efforts to accelerate the development and diffusion, including transfer, of technologies, know-how and practices to and between countries, particularly developing countries, through technology cooperation and partnerships; and,

(c) To facilitate the development of projects and programmes to support such ends

It is jointly implemented by the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP) and the World Bank. GEF resources address climate change, biological Licences, international waters, and depletion of the ozone layer. Since its creation in 1991, GEF has funded more than 41 renewable energy projects in 26 developing and transition countries, amounting to a total of over $480 million, under its climate change programme (Martinot, 2000). While one of the principal aims of GEF has been to promote the development of markets for renewable energy, equal attention is paid to ensuring that development and social objectives are not neglected. There were a number of reasons why Zimbabwe qualifieded for GEF funding. Firstly, Zimbabwe was one of the first countries to sign and ratify the UN Framework Convention on Climate Change (UNFCCC) in quick succession, and by doing so affirmed its commitment to the global principle of common and differentiated responsibility. Secondly, as one of the founders of the GEF, Zimbabwe was rightly placed to qualify as one of the recipient countries of initial GEF funding. Thirdly, the 1996 World Solar Congress was held in Zimbabwe, and to have a high-profile solar project in progress at the time of the conference was regarded as an important public relations &manoeuvre'. Finally, at the time of project approval Zimbabwe had a reasonably strong economy; stable political climate as well as a relatively well-developed human and capital infrastructure, rendering it a suitable experimental site for PV dissemination project. The Zimbabwe GEF Solar project was approved for funding in 1992 and has been funded up to date for every 5 years. The project had a number of aims, all of which were intended to enhance the long-term sustainability of the PV industry. In addition to supporting the PV industry, the project was also concerned with the improvement of living standards in rural areas and to contribute to the reduction of regional share of GHG emissions. Other laudable objectives also included:

- enhancing and upgrading indigenous solar manufacturing and delivery infrastructure;
- developing an expanded commercial market in ruralareas by providing low-interest financing;
- establishing new credit mechanisms specifically designed to benefit low-income rural households; and
- integrating of solar lighting activities with other ongoing programmes.

Further, attention was focused on the lessons to be learnt from this programme for other similar initiatives in Southern Africa and beyond.

The current status of technology transfer initiative for climate change mitigation under the auspices of the rural PV project in Zimbabwe consists of the following stakeholders.

a) An Inter-Ministerial committee made up of the following ministries
    - Energy and Power development
    - Rural and Urban Development
    - Environment
    - Science and Technology
    - Agriculture

- State for presidential affairs

b) 23 companies registered as overseas suppliers

c) 12 Companies registered as local component manufacturers and supplier

d) 3 Association that represent recipients

e) NGOs, UN organisations represented through UNDP

The above stakeholders meet every month with one person representing each registered organisation for the progress meetings.

4.2.2 Findings

In this section, the findings of the case study are presented, organized by the major factors that were discovered during data analysis. The factors that were earlier theorized to investigate the factors that influenced the implementation technology transfer initiatives for climate change mitigation in Zimbabwe (please refer to Chapter 3 for a description of these factors) are discussed first, followed by the new factors that surfaced during the field investigation. Table below summarizes the key study findings.

Resources

Resources of the recipient organisation emerged as a frequently cited aspect that had an effect on the implementation of technology transfer initiatives in climate change mitigation in several projects. The case study showed that all the participants believed that the level of resources in terms of capacity to acquire assimilate and even their own Research and Development capacity had a bearing on the success of the project.

> “You cannot just start receiving technology from an entity without your own scientist and engineers with the capacity to manipulate even the

> primitive machinery within the same technological class" (Informant from local installers)
>
> "The original plan was we were supposed to deal with companies that have a track record in the technological field …..It means we can operate at the same level as they have the necessary expertise that can contribute to success of the projects."(Informant from a technology supplier)
>
> "What motivates me is dealing with an institution or an organisation that has the capacity in terms of finances. It meant that I can roll my product into the market easily and very soon the technology will be taken into the market at a very fast pace. It was the main thing and dealing with a shelf company without a scientist and people knowledgeable in the technologies in questions made my life very difficult"

Informants from the Interministerial committee pointed out that particularly that creating linkage between institutions that had technical capacity to even reverse engineer certain parts of an old technology made the project implementation faster.

Manufacturing Experience

One of the most frequently cited factor related to the success of implementation of technology transfer initiatives was related to the manufacturing experience of the recipient organisation. It was discovered that firms that have been in manufacturing business for some time and general had a large number of employees would be better off in rolling out new products from technology transfer initiatives.

> "Company A has got money and they know what they are doing. They wanted an improved product and they had the internal capacity to produce it once the technological information was availed to them."(Informant from the Interministerial committee)
>
> "Yes, that's why most of the projects failed. Companies went there because of the cheap loans which were availed to them by the project management unit which did not consider the companies individual track records. They got the money but did not have the technical skills to manage or even manufacture. There was need to go through a vetting process to the participating companies so

> that it would be ascertained whether they had the manufacturing capacity."(Informant from local installers.)
>
> "Then it was a money issue this entire fly by night companies without track record came for the grant. How do you expect the project to succeed? We are not doing it properly, as we rolled the programme like a promotion."(Informant from NGO)

Geographic Location

Geographic location was another factor that affected the success of implementation of technology transfer initiatives in climate change mitigation projects

> "It is very easy to work, very user friendly to adopt a technology from an organisation which is closer to our company proximity wise. When dealing with a company that has a regional headquarters in South Africa it made life easier for us as they were easily accessible for technical solution to problems we faced. It was cheaper to fly our engineers down to South Africa that waiting for communication with the Germany based companies. It would be noble if the committee try to deal with those companies that are already operating in the region."(Informant from a local manufacturing company)
>
> "Yes we did a pilot project in Chile, we established ourselves in the country before we started rolling our technologies there. The Companies found it easier working with them in their own environment that waiting to come to India for consultations. Since then in any Climate change we are now participating in foreign countries we have opened offices there. This has resulted in better success rate."(Overseas manufacturer)
>
> "Initially we thought there was no need to bring all these parties together but from the rate, at which the projects have failed, we have come up with an incubator system where the entire stakeholders meet and we now pay all their living expense from time to time. This was due to the fact that most overseas manufacturers were not willing to stay a single day after offloading their technological product."(Informant from the Interministerial committee)

Business Strategy

Business strategy of the recipient organisation emerged as an important factor in the implementation of technology transfer initiatives in climate change mitigation in Zimbabwe. In general organisations that seemed to be profit oriented in their business approach succeeded as compared to counterparts that were doing technology transfer as if doing good to the environment and ought to be done.

> "Once again it just depends on the approach by the recipient organisation, of the projects that our company participated in if I had a choice I will never deal again with NGOs and church organisations. They do not have the appetite of doing business; everything is about charity to the environment. Dealing with companies that wanted to make profit made sure our technology is rolled out and problems were solved amicably in a business manner. Not for profit making organisation made the reputation of products to appear bad as they were not in the habit of communicating technical problems faced by our products with the consumers. Since it was church programme no complaints sort of approach, it is wrong attitude for business."(Informant from an over seas supplier)

> "Oh not again, dealing with the so called not for profit organisations without any business plan."(Informant from Interministerial committee)

Price of technology

It was also found that the price of technology contributed significantly in the implementation of technology transfer initiatives in climate change mitigation in Zimbabwe.

> "One of the problems we have had was to know how the price tag on the technology was determined. As a user of the very technology there were at times better technologies which were far cheaper as compared to the one participating in the project. The solar panels were cheap at first during the first phase of the project but the components were very expensive especially the ones that were made locally. We were actually ripped off to the extent that we discovered we were locked into the system. We could not get out as it was not compatible with other providers which were not part of the project. Something has to be done to avoid such scenarios later in these projects if Zimbabwe has to use technology for combating climate change."

Substitutability

It was found that substitutability in these novel technologies was something that would come at a price.

> "For a technology to be easily replaced with another one sort of compatibility it must be expensive to design. This cannot be done in these kinds of projects where government are funding to improve people lives. The electorate won't tolerate very expensive projects." (Informant from overseas suppliers)

> "This had nothing to do with the project; we never considered in the first place we were just interested in the provision of energy though we ended up depending on certain suppliers for components." (Informant from local user)

Subsidy

There were mixed feelings as far as subsidy was considered for the success of technology transfer initiatives. It was found that if subsidy was given on the technology then the other components and parts had to be included for it to have a positive effect on the success of the projects.

> "In each of these cases when we decided to participate the presence of subsidised price enhanced our chances to participate in the technology transfer project. Though analysing the other issues led to reservations as parts as they were not subsidised. The cost will skyrocket once you require repairs for the system as they were not defined in the subsidy." (Local manufacturing informant)

> "I don't understand how subsidies will work in these projects; probably if the government is paying part of the price to the technology supplier it becomes the donated product. From my experience vandalism to such projects in which people are given for free makes it difficult as recipients do not claim ownership. There is need to make sure that all the stakeholders contribute meaningfully to otherwise it makes another dead aid project."(Informant from overseas suppliers)

On the other had some activists for the environment concurred and advocated for subsidies

> "I want subsidised price for buying these solar panels, as we are cleaning the environment the government must support our actions. They ought to pay especially developed countries that have caused so much global warming."(Informant from local recipient)

Potential for induced demand

During the case study potential of induced demand worked mostly for overseas suppliers and local manufacturer to venture into these projects.

> "Business wise it makes sense to participate in project that you feel that if I bring one unit in a country as a sample then all other take it up creating such a huge demand. Even for this project for us to agree to participate it was due to the fact that we knew that if participate now since there is a lot of energy deficit even after the project is gone our products still will be selling in Zimbabwe." (Informant from overseas supplier)

> "I cannot set up a whole manufacturing plant without putting that in mind. I am banking on the fact that the government is failing to provide enough energy in the rural areas and the world is moving towards renewable energy. This then creates an environment that favours solar power systems all over Zimbabwe."

Technological design

During the case study from all the stakeholders involved this was also cited as key issue that affected success of the projects.

> "I will not participate in any project if the design parameters were not to be included. This has to be shown in the Memorandum of Agreement between the parties as technology transfer itself refers to these aspects. There is also need to actually operationalize the design by also including some aspects of research and development phases of the technology as this can help to reduce over dependence on scientist from the donor organisation once the project is up and running." (Local Manufacturer)

> "This is the heart of technology transfer, otherwise it won't succeed, before entering the projects we were willing to provide all the technical specifications but the problems were at some instances the recipients organisations technicians were not up to task when it required them to understanding the technical specifications. This was the main determinant of the price of the technology as we had to consider all the research and development that had gone for the development of the design. It also included making sure that non-disclosure agreements were signed so that the recipient won't give the specifications to our

competitors. A lot of legal work went through these processes."(Overseas supplier informant)

"We were given all the information on how to install except that in some instances some of the components were missing for certain sizes. This made our life so difficult as consumers and our lead times per customer prolonged. Also the customers wanted a copy of the flow diagrams when doing installations of which we had non-disclosure agreement with manufacturer not to give them. Customers ended up threatening not to do business with us if we were not giving them lay out manuals."

Process

It was also highlighted during the interviews that the process which entails all the series of actions or steps taken in order to achieve a particular end needed to be included in the transfer package.

"Basically to my knowledge I would find the biggest problem with the manuals if some information about the manufacturing process is not included. This is a critical point that determines the success and failure of the project. It is equally as important as the design of the technology and I feel there is no need to separate the two aspects. It entails the technology itself as failure to follow the process as entailed in the invention leads to a different product with different specifications."(Informant from local manufacturer)

"Had we not given them the process parameters for the manufacturing line there would not have been a project to talk about? We are actually surprised that you are asking such a question…How can you talk about technology transfer process without entailing the learning of the process. Actually we invited their own engineers for attachment for six months in our plant the sent our own to them for 3 months the once after every 2 months" (Informant overseas supplier)

The Interministerial committee and the project management units had this to say

"This aspect we overlooked it when we were setting up the Interministerial committee and drafting the main terms of reference. Some projects failed due to the fact that there was no enough disclosure of the processes and it only came to our knowledge during the evaluations and when we were trying to resuscitate the projects. It is from this background that we ought to include it in the standard operating procedures if we are to succeed."(PMU informant)

> "…Actually the process is the technology transfer in the project."(Informant from local installers)

Physical technology

Physical technology is one of the characteristics of transfer object that was frequently cited and discussed at length during the case study. These varied opinions from being a necessity for the technology transfer initiative to be successful to a less prominent approach

> "As mentioned above this is a prerequisite and we took it to ourselves to translate the manuals from Japanese to English and have them authenticated. The material specification was defined according to international standards and in some cases we actually introduced the local manufacturers to some of our own suppliers of certain equipment so that they would be able to finish up the manufacturing process with little or no dependence on us at all. It was first time for most companies to work with certain raw materials. This was also aided by the experience in manufacturing as we have noted in the discussion above…." (Informant from overseas suppliers)

> "Where would you start without material specification, it would tantamount to reverse engineering and not technology transfer. And the manual were also important…." (Informant from local manufacturer)

> "This was one of our own shortcomings as we did not have it in the standard operating procedures and it was not included in the expression of interest calls. We have to improve on this aspect as it qualifies and aides to the smooth flow implementation of the projects" (Informant from Interministerial committee)

Know how

An interesting finding of the study concerned the practical knowledge on how to accomplish something though it was directly related to physical technology, process and technological design.

> "Quality control is an important aspect in the entire value chain for product roll out. In the curriculum to train the local manufacturers we made it a point that the quality control aspects were included. We took them to our on bureau of standards at least that they appreciate the standards which we expect from them. We made it a point and made sure that it was included in the Memorandum of Agreement." (Informant from overseas suppliers)

> "The problem was our own standards bureau lacked the capacity as they did not have the technical skills to grade the products. The did not have standards for the product and we just had to rely on voluntary actions…..The other issue of concern was that we were not given all the necessary research and development aspects that would have left us in a better position in understanding the product."(Informant from local manufacturer)

> "They did train us before we started the installations but it was not adequate. Training and knowledge transfer should not be a once off affair. We encountered difficulties and at times we ended up embarrassed in front of clients when we faced technical problems." (Informant from local installer)

Scientific knowledge

It could not be ascertained in all the interviews and the variable was then dropped. The interviewees could not understand as it required understanding the stages in technological development of a country.

Intellectual Property

An interesting finding to the study was related to the intellectual property aspects that that protected the technology being transferred. The case study showed that even though most of the technologies were protected through patents, utility models made local installers more likely to participate in the project. On one hand overseas suppliers preferred the use of patents and trade secrets in some of the agreements especially in the manufacturing of components.

"And again it was a lot of legal terms and lawyers business, they would take us through all the patents that they held as a company, Told us that the licences we were being given were exclusive licences to manufacture on their behalf. When we came back we had to go to the company secretary to explain to us some of the implications on the Non-Disclosure agreements that we were made to sign and we had to even change the way we managed our information systems. Prior to this project in our company everyone dad access to information willy nilly but after this project access to information was now on an need to know basis. With regards to training manuals we were told only to make copies after seeking consent with them and actually they were serialised and to be kept in certain safes of which their monitors had access each time they visited our manufacturing facility." (Informant from local manufacturer)

"This is the heart of technology transfer. We made sure that the recipients are appraised on our IP portfolio. The problem we had is that the IPR laws in the countries did not protect utility model and one of our technology was a utility model. We could not just give them our technology for free as anyone will then copy. The management suggested that in that scenario we cancel our participation in the project. The manuals were protected by copyright. Trade secrets we protected them by signing of non-disclosure agreement and we gave a information management system that we inspected from time to time. The government came to our rescue as they negotiated a bilateral trade agreement with the recipient country government and our IP related aspects originating in our country were protected as in each of the projects." (Informant from overseas manufacturer)

"They were not part of the PCT and made life difficult for registering our patents "(Informant from overseas suppliers.)

"We did not know about patents and how they are used, we just wanted the technology but we were told it was patented so we were not supposed to make more units of the solar panels as per initial agreement of the JICA programme. They told us to stop manufacturing after the project of which it was difficult so we started paying royalties to the overseas companies." (Informant from local manufacturer)

Licences

Licences were another factor that was cited in some of the interviews.

"An exclusive licence is always advantageous as we were the only ones offering the product countrywide. It was difficult to negotiate it with the foreign technology suppliers." (Informant from local manufacturer)

> “As an entity that was into selling products we preferred non-exclusive licences to as many dealers as possible so that we have a better market share.” (Informant from overseas suppliers.)

> “The licences enabled us to sell our products and this project was very important even for our own business. Previously some companies were selling counterfeits of our products and these exclusive licences that we granted through this technology transfer projects helped us in removing the counterfeits in the Zimbabwean market. Some of the companies that were trading in the counterfeits actually became our allies.”(Overseas supplier informat)

Absorption
This refers to total assimilation of the concept by the receiving organisation it was difficult to assess during the interviews. It involves administering a questionnaire to determine the level of understanding of the technology in each of the projects. This was could not be ascertained in the interviews.

On site demonstration
On site demonstration emerged as frequently cited aspect of technology transfer that could enhance success. One of the dimensions was that trial running of the technological product in the country of destination was a crucial step though it was not done in any of the projects from the observed participants.

> “Onsite demonstration is important, technology transfer can’t just be a delivery as if it is information. It involves transfer of tacit knowledge and skills through experience. It’s not just information” (Steering committee member informant)

> “This requires additional funding I the project design and prior negotiations as it has cost implications. it is the right thing to do but at the moment all projects we participated in it was not done. We chose partners with a capacity to run the pilot on their own. This is the basis of knowledge transfer anyway.” (Overseas manufacture informant)

Personnel exchange
This is one of the most frequently cited aspects in the technology transfer projects in the case study.

> "The visits were not conducted due to the fact that no one was willing to incur expenses that were not agreed in the memorandum of understanding. Only pre-negotiation visits were done to just have a fill of how they were running their own projects overseas." (Local manufacturer informant)

Spinoff

Another thing that was discovered in the study is that technology transfer can be enhanced by crating companies specifically based on the project.

> "That is a great idea, the company executives makes sure that the company survives buy selling the products. They have a different view and approach to business" (Overseas supplier)
>
> "We never thought of that but it is a brilliant idea."(NGO informant)
>
> "As an investor I would be interested in these technology based products especially for climate change mitigation projects." (Local installer informant)

Personnel exchange

The case study also showed that personnel exchange, especially the ones in less developed countries to the source of technological product was a very important characteristic of the transfer media.

> "In this project the technical experts from abroad educational qualifications at times were inferior to our own experts; surprisingly they could do what our own experts couldn't do. So it's not about qualifications then it's about what you can do for the organisation. The guys are exposed to advanced technology at a very early age in their education and their level of creativity is so high. By the time our own experts returned they had a different view even in terms of performance and being initiative at work. Funds being available personnel exchange should be a requisite in technology transfer projects" (Local manufacturer informant)
>
> "This is very important way for determining levels of success in the projects. When our experts went down there to be interned at the countries we transferred the technology they brought with us different report on the working culture etc. and at times recommend the best way to achieve results. At time the recipient companies did not want it they thought we would be imposing ourselves on them" (informant from overseas manufacturer)

Organisational design

> ”As an organisation we are there to generate income and get a return on all investments that we make. It is from this background that we participated in these climate change products. The problem we faced some of the customers thought our prices were to high since these were donated products.”(Local installer informant.)
>
> “Our main aim was to steer our own company o be regional and powerhouse in renwable energy technologies. Participating in these technology transfer projects for climate change offered such an opportunity. We also wanted to recruit and retain researchers and scientist as it was part of our vision as Company.” (Local manufacturer informant)
>
> “Our mission was to become global leaders in green technologies and an opportunity that would make us contribute to a better energy efficient future we would take without having second thoughts.”(Overseas supplier)

Political constraints

In terms of political constraints, it was observed that government needs to exert every effort to obtain an environment where technology transfer can thrive.

> “The legal framework in the country was not good in terms of protection of intellectual property when we started the projects though there were indications that they we both signatories to the TRIPS and UNFCCC. So we knew our products will eventually be protected.”(Informant from overseas supplier)
>
> “This is the reason why we did not participate in most of the early projects we were waiting for them to enact the IP laws”(Informant from overseas manufacturer)
>
> “Working with the government was always difficult; there are just too many offices to visit for a single approval. I think they need to just have a one stop shop for all these activities”(Informant from local manufacturer)

Technological niche

Most respondents did not understand the question and was removed from the final analysis

Geographic location

This was merged with the previous as we got the same views

> This also had the same implication as the one from "It is very easy to work, very user friendly to adopt a technology from an organisation which is closer to our company proximity wise. When dealing with a company that has a regional headquarters in South Africa it made life easier for us as they were easily accessible for technical solution to problems we faced. It was cheaper to fly our engineers down to South Africa that waiting for communication with the Germany based companies. It would be noble if the committee try to deal with those companies that are already operating in the region."(Informant from a local manufacturing company)
>
> "Yes we did a pilot project in Chile, we established ourselves in the country before we started rolling our technologies there. The Companies found it easier working with them in their own environment that waiting to come to India for consultations. Since then in any Climate change we are now participating in foreign countries we have opened offices there. This has resulted in better success rate."(Overseas manufacturer)
>
> "Initially we thought there was no need to bring all these parties together but from the rate, at which the projects have failed, we have come up with an incubator system where the entire stakeholders meet and we now pay all their living expense from time to time. This was due to the fact that most overseas manufacturers were not willing to stay a single day after offloading their technological product."(Informant from the Interministerial committee)

Resources of transfer agent

Merged with resources above

4.2.3 Chapter summary

The researcher presented findings which will be a basis of the next chapter. In this chapter the researcher sought to find trends and themes as in line with the objectives of the research. From the themes gathered the researcher concluded that a lot still need to be done in the implementation of technology transfer projects for climate change.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter discusses the findings, limitations, and contributions of the study, and future research directions. First, detailed discussions of the results obtained in the quantitative and qualitative studies are provided. Then, the limitations of the dissertation are addressed. The theoretical and practical contributions are presented, followed by a discussion of future research directions. Finally, conclusions are drawn concerning the dissertation effort.

5.1 Introduction

The purpose of this dissertation effort was to assess how the technology transfer frameworks used in Zimbabwe influenced the implementation of the climate change mitigation projects. To achieve this goal, a research framework was developed and two separate, but related studies were conducted. The findings of these studies generally support the proposed research framework. Table 12 provides a summary of the findings from the quantitative and qualitative studies. In the following subsections, these findings are discussed in greater detail and recommendations concerning how to improve the implementation of the projects.

Table 12 Findings of the study

Item	Hypothesis	Quantitative study*	Qualitative study**
H_1	Resources will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Supported	Supported
H_2	Manufacturing experience has a positive effect on implementation of technology transfer initiatives in climate change mitigation	Supported	Supported
H_3	Geographic location has positive effect on implementation of technology transfer initiatives in climate change mitigation	Supported	Mixed
H_4	Business strategy has a positive effect on implementation of technology transfer initiatives in climate change mitigation.	Not Supported	Supported
H_5	Price of technology has a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Supported	Supported
H_6	The easier with which substitutability has a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported	Moderate
H_7	Subsidy will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported	Supported
H_8	Potential for induced demand will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported	Supported
H_9	Presence of the technological design will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported	Supported
H_{10}	Presence of the process will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported	Mixed
H_{11}	Presence of the physical technology will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported	Supported
H_{12}	Presence of know how will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported	Supported
H_{13}	The stage at which a product in terms of scientific and technological advancement will have positive effect on the implementation of technology transfer initiatives in climate change mitigation.	Not Supported	Supported

H_{14}	The category of IP protection will have an effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported	Supported
H_{15}:	The type of licence used will have an effect on the implementation of technology transfer initiatives in climate change mitigation	Supported	Supported
H_{16}:	Absorption will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported	Not Supported
H_{17}	Onsite demonstration will have a positive effect on the implementation of technology transfer initiatives in Zimbabwe climate change mitigation	Not Supported	Weak Support
H_{18}	Personnel exchange will have a positive effect on the implementation of technology transfer initiatives in climate change mitigation	Not Supported	Weak Support
H_{19}:	Spin offs have a positive impact on the implementation of technology transfer in climate change mitigation projects	Not Supported	Mixed
H_{20}:	Organisational design has an effect on the implementation of technology transfer in climate change mitigation projects	Not Supported	Not Supported
H_{21}:	Unsupportive political environment will have a negative impact on the implementation of technology transfer in climate change mitigation projects	Not Supported	Not Supported
H_{22}	Technological niche will have a negative impact on the implementation of technology transfer in climate change mitigation projects	Not Supported	Not Supported
H_{23}	The Geographic location of the transfer agent will have an impact on the implementation of technology transfer in climate change mitigation projects	Not Supported	Removed
H_{24}:	The organisation ability to provide resources will have a positive impact on the implementation of technology transfer in climate change mitigation projects	Not Supported	removed

* Supported: Statistically significant ($p <= .05$), Not supported: Statistically insignificant ($p > .05$).

** Supported: Frequently cited, Moderate Support: Moderately cited, Weak Support: Rarely cited, Mixed: Cited in both directions.

5.2 Conclusions

Technology transfer is a difficult and complex process, particularly for in the case for Zimbabwe which suffers from a limited exposure to foreign technologies and a weak absorptive capacity. It was also discovered that Intellectual property rights play a major role in technology transfer. The many ramifications of sharing patents, goodwill, copyright and other rights are ever evolving and both parties must ensure that adequate care is taken while dealing with issues concerning agreements. The technology transfer projects should have a post project strategy for a wide range of possible scenarios as in some of the cases when the project ended the companies could no longer supply the required components for repairs and this created a sentiment within the public that the technologies were bad.

Based on the above findings it can be argued that characteristics of the transfer recipient have a big impact on the success of technology transfer project. It was discovered that technological strength has invariably played an important role in the entire technology transfer process and the concurrent technology absorption and assimilation know why exercises. Firms do well when diversifying into areas that are related or aligned to their existing knowledge base. There is an existing relationship between existing technology base, technology being acquired and technology exploitation in renewable energy. Government should play a role in selecting participants in future projects considering their manufacturing experience, business strategy and resources among other.

Another important finding that came out of the study pertained characteristics of transfer media. A general issue pertaining to transfer media is the influence of intellectual property policies. Consideration of intellectual property law, patents and patent law is important as most international informants concurred in the case study. It can be argued that improving the awareness on the part of local participants especially the government officials will aid to the success of most of these mitigation projects.

Another important aspect that may have been overlooked in the technology transfer initiatives climate change projects in Zimbabwe was the underestimation of the importance of the interactive processes between the donor (vendor, intermediary, R&D organisation etc.) and the recipient, necessary for successful transfer. The project failed to recognise that technology transfer seldom involves just a simple one off transaction but is a process or a dialogue between a diversity of actor in the two parties and involves a continuing relationship to the point where real benefit accrues to the recipient companies.

Some challenges that need to be addressed if technology creation is not to impede the transfer process includes lack of the following:

- information relevant to strategic planning and market development;
- science, engineering and technical knowledge, especially in the private sector;
- institutions with the mandate and resources to equip people with the requisite knowledge and skills;
- research, development and testing facilities;
- technology development and adaptation centres;
- joint industry-government planning and collaboration

A national collaborative technology transfer team should be formed to represent a broad range of interests, including sectoral ministries--such as energy, transportation, agriculture, forestry, and water resources--environmental agencies, climate change delegates, private companies and trade associations, technical institutions, and non-government organizations. The ministries that implement energy and other sector specific programs and policies are particularly important because they often have the controlling or regulatory authority necessary to implement technology transfer actions. Climate officials should be involved as well, even if they do not have implementation responsibilities, so that they could integrate the work of the team with key climate change issues and identify opportunities to build on other climate change work. Government should play a key role in facilitating these partnerships. In particular, effective inter-ministry cooperation would maximize synergies between various programs and avoid conflicts with other government programs and objectives.

5.3 Recommendations

- There is need to equip local stakeholders with human resources, the technical experts as it was discovered during the study that a strong technological base of the acquirer is very helpful in implementing successful technology transfer.
- Manufacturing experience should be used when considering companies to participate in future climate change projects, so in the call for expression of interest to participate in the projects a minimum number of years in manufacturing should be considered.

- Establishing a program with an academic institution as a postgraduate diploma or certificates in the product to be produced is important and it made sure that the relevant stakeholders will be educated in the areas of transferred technology. The Ministry responsible for education should be included in the Interministerial committee with a view of introducing such tailor made programs that are technology based.
- Generally there was a lack of understanding of intellectual property issues as revealed mostly by the case study. There is need to start programs for IP awareness as it provide environment for dissemination of R&D products for the benefit of the society. In this case once the local entrepreneurs are aware of IP related issues they will be in position to negotiate with international holders of IP assets resulting in increased foreign direct investment and investments in these green technologies.
- From the study it was discovered that negotiations of non-exclusive licenses were important to improve the roll out of technologies to all parts of the country. So there is need for the committee to select as much participants with capacity to participate in the climate change projects.
- Formation of incubators could increase the survival rate of the innovatory technology as it had just emerged from the research world into Zimbabwe. The presence of company incubators would enhance the opportunities for networking, providing tenants (companies) with the appropriate technical and other support infrastructures and services (Salvador, 2010).

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APPENDIX 1

APPENDIX A

PAPER-BASED VERSION OF THE SURVEY

Introduction

This questionnaire is designed to study the implementation of technology transfer initiatives climate change Zimbabwe. The data collected will provide information needed to better understand the status of technology transfer projects for sustainable energy and advice the best policy to the government towards technology transfer

If this questionnaire is to be useful, it is important that you answer each question frankly and honestly. There are no right or wrong answers we are interested mainly in technological aspects, organisational aspects and operational dimensions in technology transfer initiatives in Zimbabwe. Your answers to questions are completely confidential. All questionnaires will be taken to Africa University for analysis. No one in the energy industry will ever have access to individual answers.

1. **Which areas of sustainable energy have you participated in technology transfer initiatives for climate change in your working experience? Please mark all that apply**.
   - ☐ Solar
   - ☐ Wind
   - ☐ Carbon-neutral and negative fuels
   - ☐ Ethanol biofuels
   - ☐ Other Biofuels
   - ☐ Geothermal
   - ☐ Hydrogen
   - ☐ Other (Please specify): ____
     ____
     ____
     ____
   - ☐ N/A – My organisation is not involved and has never been involved in technology transfer initiatives for climate change mitigation.

2. There are many technology transfer funding agencies, which organisations have funded your projects before. Please mark all that apply.
   - ☐ Global Environment facility
   - ☐ Clean Development Mechanism
   - ☐ Own government
   - ☐ UNDP

- UNEP
- JICA
- Other (Please specify):

____

- N/A – My organisation is not involved and has never been funded in technology transfer initiatives for climate change mitigation

3. Approximately what per cent in terms of projects that your institution is running are on technology transfer in the area of climate change mitigation?

0% 1-20% 21-40% 41-60% 61-80% 81-100%

4. Approximately how long have your organisation participated in technology transfer initiatives in energy for climate change mitigation.

0 Years <1 Year 1-3 Years 4-6 Years 7-9 Years 10+

5. Please rate the importance of each of the following factors in terms of your organisation's decisions whether or not to participate in technology transfer initiatives .In other words, to what extent would each of these factors inhibit your participation in technology transfer initiatives in the area of sustainable energy with other different stake holders? For each item below, please place a checkmark in the box that best describes your view.

	Unimportant	Of little Importance	Moderately important	Important	Very Important
Scientific knowledge					
Technology design					
Process					
Physical technology					
Know how					
Maintenance costs					
Intellectual Property					
Licences					
Organisational design					
Political constraints					
Geographic location					
Resources					
TRIPS/UNFCCC provisions					

6. **Please give your level of agreement or disagreement with each of the following statements. For each statement below please place a checkmark in the box that best describes your view.**

Key: Strongly Disagree = SD Disagree=D Neutral= N Agree =A Strongly Agree= SA

	SD	D	N	A	SA
In my experience the part that initiated the idea, contributes financially has due influence on the success of technology transfer initiatives					
The cost to bring the technology on the market has a due influence on the success of the technology transfer initiative					
The ability of the product supplier to fund the transfer initiative will enhance the success of the technology transfer initiative.					
In general Government IPR Policy Framework: S & T, Innovation Legal and Regulatory Framework: National, Institutional arrangements play a pivotal role in the success of success of the technology transfer initiative					
In general, product for a small part of a technology market, that is designed with narrow applicability make it difficult for technology transfer initiatives to succeed					
The distance between the technology supplier and recipient makes technology transfer initiative difficulty to achieve.					
The fact that an organisation is profit oriented, non-profit oriented, job creation oriented etc. have an effect on successful transfer of technologies between two entities					
The fact that the 2 parties the recipient and transferring agent have the same organisational design enhances the chances of success in any technology transfer initiatives.					
If an organisation has an environment that facilitates the formation of start-ups and spin off the success rate of the technology transfer initiative will be high					
Pre-negotiation visits to the plants of the institutions by the recipient and transfer agent to exchange notes on their capabilities makes technology transfer initiatives chances of success to be higher.					
Personnel exchange between all the stakeholders in the technology transfer initiatives through visits enhances the chances of success in the technology transfer initiative.					
Demonstration of the technology by the supplier at the destination will enhance the chances of success of the technology transfer initiative					

	SD	D	N	A	SA
Knowledge of intellectual property rights related issues among the parties involved in the technology transfer initiative is important for the success of the technology transfer initiative.					
For the initiative I participated in I was aware of all the aspect of IP related to the products being transferred					
Since IP rights are territorial in nature we made it a point that the necessary IP related rights were secured before the commencement of the technology transfer initiative.					
When negotiating for technology transfer project I would prefer an exclusive license as compared to a non-exclusive license as latter tends to crowd out other participants thereby hindering technology diffusion process.					
In my experience in climate change projects I participated in the transferred products were demonstrated at the site of receiving					
In My experience in the climate change projects all the material specifications and training manuals were included in the package					
In My experience in the climate change projects All the material specifications and training manuals were included in the package					
In My experience in technology transfer the climate change projects All the quality control aspects were given in the package including the necessary research and development aspects were included in the in the package					
In my experience in the technology transfer initiatives in climate change projects All the operations process parameters were given in the package					
In my experience in the technology transfer initiatives in climate change projects all the design parameters where given in the package					
Understanding product life cycle is essential in technology management. Especially considering the nature of technologies as many times failure to take heed to technological advances have led to closure of business. In this regard in the technology transfer initiative we took our time to understand the technology market and settled to the transferred technology.					
The initiative that I participated in for technology transfer in climate change was for humanitarian and charity reasons.					
The initiative that I participated in for technology transfer in climate change was for profit sales					

	SD	D	N	A	SA
The initiative that I participated in for technology transfer in climate change was for cost, cost plus, no profit no loss for all installations.					
The cost to bring the products it to market including the Shipping cost of the components and other materials needs to be agreed upon before rolling out the initiative.					
The market price of the technology, cost of the product as compared to the previous products has bearing on the success of technology transfer initiatives					
In all the technology transfer initiatives that I participated in we planned in a way such that it was possible to replace the transferred product with another new product without altering the function, in a view to minimise vendor lock in					
In my experience in technology transfer initiatives in the climate change area, I have discovered that most companies that failed to participate in the programed were inexperienced in manufacturing. Those companies that had an experience in manufacturing and were just adding a new product on the line performed well as compared to their counterpart that had just started manufacturing based on the project.					
In all the initiatives that I participated in, the companies and institutions that had the necessary resource in terms of finance and human skills to develop the technology in house were better positioned to successfully act as recipients of technology?					
In all the initiatives that I participated in helped companies to introduce the product faster if they had manufacturing capacity and similar product lines.					

7. **In your opinion, has iinduced demand, or latent demand, (phenomenon that after supply increases; more of a good is consumed). Helped in the technology transfer initiatives that you have participated in. Yes/No**
8. **Please provide the following information:**

   a. Organisation name(Optional)____
   b. Organisation type Government Private Company Other______
   c. Number employed in your organisation: Full-time_________ Part-time_________

d. Population served by your organisation:____________________________________
e. Approximate total operating budget of your organisation: $__________________
f. Your Title: ____
g. Number of years/months employed by your department
   Years_____ Months_______
h. Number of years/months employed in your current position
   Years____ Months________
i. Your gender: Male Female
j. Your age group: 20-30 31-40 41-40 51-60 61+
k. Highest level of education you have attained:
   High SchoolBachelor's Master's Doctorate
   Other______

Thank you for your cooperation in completing this survey instrument. If you feel that there are any points of particular interest to your organisation concerning technology transfer in climate change mitigation that this survey has failed to address please feel free to elaborate below.