ADOPTION OF ADAPTED TECHNOLOGY BY MICRO AND SMALL ENTERPRISES IN THE INFORMAL SECTOR IN KENYA

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C82/7040/2003

A Thesis Submitted to the School of Humanities and Social Sciences in Partial Fulfillment of the Requirements of the Degree of Doctor of Philosophy in Economics of Kenyatta University

OCTOBER 2015
DECLARATION

This thesis is my original work and has not been presented for award of a degree in any university or for any other award.

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DEDICATION

I would like to dedicate this PhD research study to my children, Erika, Irene, Nathan, Helen, Susan, Stanley and Faith, and grand children Alvin, Adrian, Shaka, Tana, Allison and Imani.
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OPERATIONAL DEFINITION OF TERMS

**Adaptation**: This is a situation where an innovation or technology is modified or changed before or during the process of adoption in order to accommodate the user’s intended needs, cultural mores, practices and experiences without losing much of the essential original properties for which the technology was sought.

**Adapted technology**: This is an idea, technique, cultural value or object (machine or tool), which is a modification of an imported substitute, but is designed and developed within a society using modern scientific methods with the aim of maximizing the use of local resources to develop local capacity and improve productivity.

**Adopter**: An adopter is a person, group of persons or organization/firm that makes a decision to acquire an idea, innovation or technology.

**Adoption**: Adoption is a decision to acquire and use an existing idea, innovation or technology as the preferred course of improving performance.

**Boda boda**: A bicycle or motor cycle, which has been licensed to carry passengers or luggage.

**Change agent**: An individual/firm who/which sets out to influence potential clients' adoption decisions in the direction desired by the individual or firm.

**Diffusion**: This is a change in a social system brought about by the assimilation of a new idea, practice or object through a process by which that idea, practice or object is communicated through certain channels over time among members of a particular social system.
**Diffusion of innovation**: This is a social process in which information about a new idea, practice or object is communicated, embraced and becomes entrenched in a social system.

**Elderly age**: For purposes of this study, elderly age applies to members of society aged above 55 years of age.

**Employment**: In the informal sector, employment means people working for a living and not necessarily for wages. Much of the employment in this sector is in subsistence production.

**Growth of micro and small enterprise**: This refers to an increase in the number of employees of a unit of activity. The use of this phrase is in line with Government of Kenya definition, where “growth of MSE” is defined in terms of changes in the number of employees of a unit of enterprise (Republic of Kenya, 1999b)

**Jua Kali**: This is a *Swahili* phrase, which is slang for artisans who toil under the blazing sun.

**Labour productivity**: This refers to the amount of goods or services that a worker produces in a given amount of time, usually one day, week or month.

**Large scale enterprise**: Large-scale enterprises are firms that employ over 100 workers.

**Low income earner**: For purposes of this study, a low income earner is any one whose monthly gross income from labour, investment or service is less than Ksh 20,000 (US$ 233).
Indigenous or traditional technology: This is an idea, technique, cultural value or object (equipment or tool) that has existed in a particular society over a long period of time, one generation inheriting it from another. Shadoofs and dykes in Egypt, handlooms in India and spear-making and bark-cloth making in East Africa being examples of indigenous technology.

Informal Sector: This is a sector of the economy whose economic activities are unregistered and unregulated, and the entrepreneurs of the economic activities in this sector do not pay tax on the incomes accruing from those economic activities.

Innovation: An idea (knowledge), practice (technique), an object (tool, equipment, machine) or cultural value, which is unique to a particular society, and is used as a new way of solving problems. Innovation is also defined as the commercialization of an invention. Both definitions are used in the text where appropriate.

Matatu: A privately owned and operated min-van, which has been licensed and whose interior has been modified or configured to carry 14 paying passenger

Medium size enterprise: These are firms that employ 51-100 workers.

Micro enterprise: These are units of economic activity that employ up to ten (10) workers.

Middle age: For purposes of this study, middle age applies to members of society aged between 36 and 55 years of age.

National poverty index: The number of poor people in a country expressed as a percentage of the total number of poor people in the country (see Republic of Kenya, 2014).
Non-adapted imported technology: This is an idea (knowledge), practice (technique), object (tool, equipment, machine) or cultural value, which has been imported from another society and used in its original form in a new environment of the importing society.

Performance gap: This is the difference between the entrepreneur’s, firm’s or organization’s expectations of performance and the actual performance of the enterprise.

Productivity: This refers to the ratio of output (goods/services or total sales) to inputs (labour, capital, raw materials etc) for an enterprise or firm, a sector or the whole economy.

Productivity paradox of information technology: This is the discrepancy between measures of investment in information technology and measures of output at national level.

Small enterprise: These are units of economic activity that employ 11-50 workers.

Social system: This is a set of inter-related human units that co-exist and are engaged in joint problem solving to accomplish a common goal.

Technology: This refers to hardware (tools, equipment, and machines), software (knowledge, skills, procedures and/or principles, blue-prints) and live-ware (people, animals, plants/algae) as well as the organisation of production and marketing. This definition is adapted from the Andean Pact Technology Policies (IDRC – 060e, 1976).
**Technological capability:** This refers to the resources needed to generate and manage technical change, including skills, knowledge and experience, and institutional structures and linkages. This definition is an adaptation from Bell and Pavitt (1993).

**Technological capability in industry:** This refers to the information and skills — technical, organisational and institutional — that allows productive enterprises to utilise equipment and information efficiently. This is definition is adopted from Lall (1995).

**Technology practice:** This refers to the application of scientific and other knowledge to practical tasks by ordered systems that involve people and organisations, other living things and machines.

**Total factor productivity:** Total factor productivity, also known as multi-factor productivity, refers to a variable that accounts for effects of total output not caused by traditionally measured inputs of labour and capital. It is a measure of the efficiency of all inputs to the production process. Increases in TFP result usually from technological innovations or improvements.

**Tuk Tuk:** Three-wheeled motor scooter, which has been licensed to carry passengers or luggage.

**Youth age:** Youth age applies to members of society aged between 18 and 35 years of age.
ABBREVIATIONS AND ACRONYMS

DATO - District (now Sub-county) Applied Technology Officer
DOI - Diffusion of Innovation
IDRC - International Development Research Centre (of Canada)
ILO - International Labour Organization
IPC - International Poverty Centre (of UNDP based in Brasilia, Brazil)
ITDG - Intermediate Technology Development Group
ITU - International Telecommunication Union
KEBS - Kenya Bureau of Standards
KIPi - Kenya Industrial Property Institute
KIRDI - Kenya Industrial Research and Development Institute
KNFJKA - Kenya National Federation of Jua Kali Associations
MSE - Micro and small enterprise
MDGs - Millennium Development Goals
NBS - National Baseline Survey
NGO - Non-governmental organization
OLS - Ordinary Least Square
PERT - Programme Evaluation and Review Technique
R&D - Research and Development
TAM - Technology Acceptance Model
TOE - Technology, Organisation and Environment (TOE) framework
TPB - Theory of Planned Behaviour
TRA - Theory of Reasoned Action
UNDP - United Nations Development Programme
UNITU - United Nations International Telecommunication Union
UTAUT - Unified Theory of Acceptance and Use of Technology
YEDF - Youth Enterprise Development Fund
4Ks - Stands for the four institutions: Kenya Industrial Research and Development Institute (KIRDI), Kenya Bureau of Standards (KEBS), Kenya Industrial Property Institute, (KIPI), and Kenya National Federation of Jua Kali Associations (KNFJKA).
ABSTRACT

The government of Kenya, assisted by donor agencies, has since the 1980s, sought to enhance workers’ productivity in the informal sector. To achieve this objective, the strategy adopted was to replace the use of archaic indigenous and inappropriate imported technologies with locally designed and produced adapted technology. Although since its inception in 1979, KIRDI has been adapting imported technology for use by entrepreneurs in the informal sector, the rate of adoption has been low. The main objective of this study was to investigate factors that influence adoption of adapted technology in Kenya’s informal sector. The study adopted a logistic model, which, with the help of descriptive statistics, was used to analyze data collected from 320 respondents from six districts, two each from the Nairobi, Kisumu and Nyeri counties. The study’s descriptive statistics showed that perceived usefulness of the technology, perceived ease of use of the technology, perceived reliability of the technology to the adopter, and the perceived suitability of the technology to the Jua Kali environment factors were important influences on the decision to adopt adapted technology. The results also showed that the overwhelming majority of adopters of adapted technology got information about the adapted technology through the interpersonal contact communication channel. The regression on the 13 predictor variables was done to get marginal effects. The regression results showed that six out of seven technology-specific variables in the logit model were important in explaining the decision to adopt adapted technology. These were: cost of machine; machine’s maintenance cost; number of workers needed to operate the machine; wage bill of the workers operating the machine; cost of energy; and perceived conferment of higher social status (in the local community) to the owner. The regression results also showed that three out of five human factor variables, individually, made a significant difference in the decision to adopt adapted technology. These were: age of adopter; level of education; and marital status of the adopter. These regression results implied that government institutions and donor agencies involved in designing and producing adapted technology should ensure that the adapted products were cheaper and easier-to-use than their non-adapted imported substitutes; required low servicing and maintenance cost; and should not be labour intensive, but be perceived to be attractive to the adopters who wished to be self-employed. The results also showed that high wages of workers were a disincentive to adoption. This implied that the government should avoid extending the mandatory minimum wage requirement to entrepreneurs in the informal sector. In addition, the results implied that the government and donor agencies should target the youth and women groups when promoting adoption of adapted technology; and that special emphasis on standardized quality products during skills training in vocational and other tertiary institutions should be prioritized. Finally, for information access, the policy implication was that government should resurrect the programme of building infrastructural facilities, such as construction of industrial sheds to be rented by jua kali artisans, as per government policy enunciated in Sessional Paper No. 2 of 1992. These sheds could double as information dissemination centres for potential adopters.
CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Since the late 1960s, the government of Kenya, with the assistance of donor agencies and non-government organizations (NGOs), has established vocational training institutions with the objective of equipping the growing large number of unemployed school leavers with technical skills to use modern technology (tools and equipment) to be self employed, improve their productivity and produce quality products (Oketch, 1995). Since the late 1980s, the government of Kenya, together with donor agencies, has gone further to promote the economic activities of micro and small enterprises by launching a series of policy initiatives aimed at promoting the economic activities of micro and small enterprises (MSEs) with a view of increasing their productivity, generating jobs and enhancing income distribution (Republic of Kenya, 1986, 1989, 1992). The overall objective of these policy initiatives was to address the problems of unemployment and perverse poverty in sections of society in the country.

Since 2000, one of the Government of Kenya‘s long term development goals has been to reduce poverty by promote wealth creation and income distribution. Kenya’s poverty data, computed based on Republic of Kenya (2007a) estimates of 2005/2006, showed that, although the country’s poverty levels had dropped from 52.3 per cent in 1997 to 45.9 per cent in 2006, the actual number of the poor in Kenya had increased from 13.4
million in 1997 to 16.5 million in 2006. According to a study by Cilliers, Turner and Hughes (2015), commissioned by the Cape Town-based Institute of Security Studies, Kenya is one of the ten Sub-Saharan African countries with the largest number of extremely poor people. Using a revised poverty line benchmark of US $ 1.75 per day, the study put the number of people living under the poverty line in Kenya at 18 million (Cilliers, et al., 2015).

According to the Republic of Kenya (2013a), although the national poverty level was put at 3.7 million households or 46 per cent of Kenyans living below the poverty line, there were very wide disparities of poverty levels between the country’s 47 counties, with the Turkana County at the bottom of the ten poorest counties and the Kajiado County at the top of the ten richest counties. The report showed that Turkana County’s poor people live 67.5 per cent below the World Bank determined poverty line of US $ 1.25 per day (Republic of Kenya, 2013a, 2013b and 2014).

What Kenya’s poverty data implied was that, taking into cognizance the perverse dominance of the subsistence mode of production and distribution in the rural areas and the perverse squalid conditions prevalent in the shanties of the peri-urban and the ghettos of urban areas, the need to address the problem of perverse poverty as per the UN’s number one MDGs was of paramount urgency in these areas.
From the late 1960s, Kenya has faced the escalating problem of unemployment, which in 2012 was estimated at 40 percent of the working population of approximately 23 million people aged between 15 and 64 years (World Bank, 2012a). According to the World Bank (2012a), around 800,000 young Kenyans join the job market annually, when only an average of 500,000 jobs are created annually by both the formal and informal sectors of the economy. As of 2009 census, 14.3 million Kenyans were working, with 6.5 million in family small-scale farming, 2.7 million in non-farm self-employment, and 5.1 million in wage employment. Small-scale family farming, which is dominated by subsistence production, although in decline, remains the main source of livelihood to 46 per cent of working Kenyans. Among those with wage jobs, approximately 2 million people were working in jobs considered to be in the modern or formal sector (World Bank, 2012a). It is the improvement in productivity of the family small-scale farmers and non-farm self-employed in the informal sector that the policy makers and donor agencies are keen to promote with the introduction of adapted technology.

According to the Republic of Kenya (2012), in 2010 Kenya’s labour force of 21.4 million supported the country’s population of 39.6 million – a dependency ratio of 54.0 per cent. According to the World Bank, the unemployment problem in Kenya is “a ticking time bomb that requires urgent attention”. It argues that with so many youths joining the job market annually (estimated by the World Bank at 800,000 per annum) and chronic unemployment continuing to be a serious source of worry, without the right
policies in place, the bulk of Kenyan youths will be stuck in poorly paid self-employment and low-end wage jobs. Therefore, the task of planning for the creation of good self-employment and wage jobs deserved a seat at the high table of policy makers (World Bank, 2012a).

The realization in the early 1970s by Kenya’s policy makers that market-led economic activities of the modern sector lacked the capacity to address the problems of poverty, the unemployed youth and low productivity prompted the government and the donor community to promote the economic activities of MSEs in the informal sector, with the twin objective of creating jobs and acting as an entrepreneurial seed bed from which local entrepreneurs could emerge (Kilby, 1971). This partly explains the government’s continued interest, since the 1970s, in the type of technology that is used in the productive activities of MSEs in the informal sector.

One way of addressing the problems of unemployment and poverty in rural and peri-urban areas is to tackle the problem of perverse low productivity and limited exchange, by introducing modern technology in the production and marketing of MSEs’ products in the informal sector in the rural and peri-urban areas. As has been highlighted in a number of economic growth literature, technology is the universally acknowledged variable responsible for increasing total factor productivity in a country’s development process (Solow, 1957; Rostow, 1960, 1990; David, 1990; Brynjolfsson, 1993; Krugman, 1994).
When the Heads of State Summit of the United Nations General Assembly launched the Millennium Development Goals (MDGs) in 2000, they set a common development agenda for all developing countries to achieve the eight MDGs by 2015. This agenda was adopted by member countries of the UN, including Kenya. Top on the list of the eight MDGs was to halve the proportion of the population living in extreme poverty and hunger by 2015. However, individual countries were accorded a degree of freedom to formulate policies, devise strategies and set targets that would lead to the achievement of the first of the UN’s eight MDGs. One area of the Government of Kenya policy, which aims at tackling the problem of poverty as per the first of the UN’s MDGs, was the search for and acquisition of technology that met the needs, and could enhance productivity growth, of micro and small enterprises (MSEs) in the informal sector.

1.1.1 The Importance and Effects of Technology

According to Rogers (2003), technology consists of two components, a hardware aspect, composed of the tool or machine that embodies the technology as a material or physical object, and a software aspect, consisting of the information base for the tool or machine. Rogers further pointed out that many technology adopters require good software knowledge of a particular technology before they make a decision to adopt it.

The importance of technology is embedded in its capacity to make work easier, increase labour productivity and improve product quality. As an instrument, technology can be used for good or ill intentions (Buchanan, 1965). When used for good intentions, its
positive effects facilitate greater wealth creation, increase labour productivity and improve the living conditions of members of society. In most cases, a particular technology brings about these positive effects after it has been assimilated by being widely adopted by individuals, firms and institutions in a particular society. By implication, the overall effect of any technology on a sector of an economy depends on the degree of diffusion whereby there is widespread use of the technology by members of society in that sector (Coombs, Saviotti, & Walsh, 1987).

Specifically, there are two important effects of technology. First, technology facilitates production, distribution and consumption of new products, makes existing products cheaper through improved efficiency in the production process, and facilitates abundance by increasing output. In short, technology facilitates productivity growth. Productivity growth is the single most important economic indicator of performance. The Ministry of Agriculture officials involved in promoting agricultural good practices during the annual Agricultural Show of Kenya exhibitions do not tire to highlight the differential living standards of peasant smallholder agricultural producers in the rural counties of Kajiado, Kirinyaga, Muranga, parts of Meru, Nyeri and Kisii, compared to their counterparts in most of the other parts of rural Kenya. The reason for this, they point out during these shows, is because many of the peasant farmers in these relatively well-off counties make use of some form of technology that makes their smallholding farms more productive. This enables them to “export” their surplus production to the large urban centres of Nairobi and Kisumu cities for monetary reward. As a result, not
only have the poverty levels of these counties been significantly reduced, but so have their subsistence levels of production (Republic of Kenya, 2014, 2013a, 2007a).

The second effect of technology is its influence on the country’s skills level and quantity of labour required in the production process. This effect has important implications on employment, to the extent that when a new technology is introduced in an environment, its short-term effect is either to create or lose jobs, with the latter’s adverse effect (job loss) being mitigated by the increase in productivity and/or improvement in the quality of output.

Whichever of the two effects is the case, a new technology’s appeal is enhanced when its products acquire economic weight to match or out-perform its competitor(s), either in the production process or in the job creation arena. In a social setting where, as is the case in Kenya, chronic unemployment is a serious problem needing policy attention, the new technology’s appeal is further enhanced if, in addition to its technical and operational attributes, it facilitates jobs creation and income distribution. If the demand for the new technology’s products in a particular social setting is high, then the technology’s economic effects on firms, national output, employment, inter-industry linkages and commerce will be greater (Cameron and Metcalfe, 1987).

In general, a new technology should be able to contribute towards attaining a set of development goals in a particular social environment. Much as a lot of technologies
have universal applicability, the technology that suits a particular social environment is not only of primary importance to the achievement of the development goals set by policy makers, but also on the adoption decisions by potential users of the technology. Thus, the need to adapt imported technology to suits a particular social environment.

1.1.2 Micro and Small Enterprises in the Informal Sector in Kenya

Kenya’s income-earning activities outside primary agriculture, animal husbandry, fishing, hunting, gathering, forestry and crude mineral extraction are classified into micro, small, medium and large-scale enterprises. The economic activities of the majority of micro and small enterprises (MSEs) are to be found in the informal sector, which in Kenya is known as the Jua Kali sector (Republic of Kenya, 1992; 1999; 2005).

The Jua Kali sector economic activities are undertaken mostly by the youth, the middle-aged poor and the lower level social status retirees from both the private and public sectors. Most members of these three groups were originally from rural settings, whose parental roots were the marginalized members of society, a sizeable portion of who still survived on subsistence income from family small-scale farming. Those whose roots were not from rural settings, and whose parents were not involved in small-scale farming, trace their origins in urban slums, where their parents were engaged in non-agricultural self-employment, or in wage employment, mostly created by Jua Kali economic activities, and low level employment in the modern sector.
In the informal sector, *employment* means people working for a living and not necessarily for wage payment (Republic of Kenya, 1999, 2005). Home-based enterprises are included so long as at least half of the output is marketed (McPherson, 1994). For example, a peasant farmer or his/her employee who sells raw maize cobs in the market, or sells roasted or steamed maize (a form of processing) on the roadside is operating an MSE. Non-marketed production is excluded (Republic of Kenya, 1999). Most of the MSEs in the informal sector are unregistered, unregulated and, due to the nature of their economic activities, do not pay taxes. According to Parker and Torres (1993) 98.6 per cent of all micro and small enterprises in Kenya fall within the “micro enterprise” size category of 1 – 10 workers.

Micro and small enterprises are categorized into three sub-sectors. The largest (60.6 per cent) is the commercial subsector, comprising butcheries, mobile and fixed food *kiosks*, mobile and fixed merchandise vendors, and vendors of other consumer skills-based handiworks. Second (26.9 per cent), is the manufacturing sub-sector, comprising metalworking, woodworking, tailoring and others. Third (12.5 per cent), is the service sub-sector comprising ICT services (mobile phone and air time vendor kiosks), transport (*matatu* mini-buses, taxis, *boda boda* bicycles or motorized cycles and motorized three-wheeled *Tuk Tuks*) and other services such as those provided by masons, maintenance service providers (like electricians and plumbers) and others (Parker & Torres, 1993; Republic of Kenya, 1999; 2005).
Partly due to the promotional activities of government, donor agencies and non-government organizations (NGOs), the MSEs’ numbers and their economic activities in the informal sector have grown so rapidly that by 2006, the sector contributed 18 percent of gross national product (Republic of Kenya, 2007a). In 2013, the informal sector’s 626,800 new jobs accounted for 84.4 per cent of the country’s total employment of 742,800 new jobs created in the economy. By contrast, the formal or modern sector created only 15.6 percent or 116,000 jobs, 26,300 of which were contributed by the government, in the same year (Republic of Kenya, 2014).

Two national baseline surveys (NBSs) have shown that the number of MSEs in the informal sector have grown from 900,000 enterprises employing 1.3 million workers in 1993 (Parker & Torres, 1993) to 1.3 million enterprises employing 2.36 million workers in 1999 (Republic of Kenya, 1999). A 2007 study report commissioned by the Brasilia-based International Poverty Centre (IPC) of the UNDP estimated that for the year 2006, the number of MSEs had increased to 1.9 million micro and small enterprises employing 4.4 million workers (Pollin, Heintz, & Mwangi, 2007). According to the two national baseline surveys (Parker & Torres, 1993; Republic of Kenya, 1999) and Mwaura (1994), at least one third of the MSE start-ups do not survive the third birthday. Therefore, the current population of MSEs includes only MSE survivors and mergers as well as MSE new start-ups. It is significant to note that during the 13 years period during which data was collected (1993-2006), the informal sector created jobs at a much
faster rate (18.34 per cent average per annum increase) than it was able to add new enterprises (8.55 per cent average annual increase).

While a casual glance at the above-cited statistics on micro and small enterprises gives the impression that the informal sector has performed a laudable function of attracting investment and creating jobs, it is pertinent to point out that these are very low-level capital investments attracting very low-level wage jobs. Most of the employees in this sector earn below the World Bank determined poverty-line wage of less than US$ 1.25 per day (World Bank, 2008). To compound the problem, many studies have shown that, despite the intervention of government and numerous NGOs, the growth potential of individual MSEs is limited (King & Abuodha, 1991; McCormick, 1992; Parker & Torres, 1993; Dondo, 1997).

Studies by Mwaura (1994) and Nelson & Mwaura (1997) showed that more than half of the MSE start-ups in the informal sector collapsed within the first five years of their establishment. What this meant was that whatever jobs had been created by the new start-ups, many of them disappeared together with the collapsed MSEs, unless absorbed by new start-ups or through mergers. These two studies also showed that very few new start-ups, which survived beyond the third year, graduated into medium size enterprises employing over 50 workers. Non-graduation of MSEs into medium enterprises is indicative of MSEs’ failure so far to act as entrepreneurial seedbeds for “serious” entrepreneurs. As a result, there has emerged the so-called “missing middle”
phenomenon, defined as a relative paucity of firms to be found between the MSEs and large enterprises in Kenya (McCormick, 1992; Mwaura, 1994.; Nelson & Mwaura, 1997; Gichira, 1998).

Previous studies on MSEs have indicated that technology-related factors are some of the impediments to growth that informal sector entrepreneurs face. These include the poor quality of MSEs’ products (Steel, 1993; Dondo, 1997; Gichira, 1998) and insufficient demand for their products, partly due to quality concerns (Parker & Torres, 1993). Other problems, such as harassment by officials of local authorities (World Bank, 2012a), although seemingly unrelated to technology, only compound the technology-related factors because they influence the decision to acquire technology and locate the enterprise. In most cases, the informal sector entrepreneur’s goal in using a particular technology in the production process is to improve performance on the job. That is to increase productivity and quality of the product. The question that arises is whether the technology used by MSEs in the informal sector is partly responsible for the massive collapse of MSEs within three years of start-up or for the limited growth potential of individual MSEs, and/or the non-graduation of survivor MSEs into medium size enterprises. In general, the question is whether the technologies used by entrepreneurs in the informal sector made work easier, increased productivity and/or improved the quality of the products they produced. Why did this question arise for this study?

For this study, the question about the type of technology used in the informal sector arose when it was realised that most of the technologies used by MSEs in the informal
sector were either indigenous technology passed on from one generation to another, or modern, but imported technology. For various reasons, most of the indigenous technologies produce low quality and non-competitive products, while most modern imported technologies are unsuited to the local environment in the informal sector to which they are introduced.

1.1.3 Adoption of Technology in the Informal Sector in Kenya

Technology adoption theory predicates that, when a new technology is imported into a new environment, it should be adapted to suit the environment of the new social setting (Pacey, 1996; Johnson, Gatz, & Hicks, 1997). The more the new technology is imported, adopted and assimilated or diffused in the new social setting, the more market signals are sent to the importers to out-source more of the imported technology to meet the domestic demand. However, few imported technologies from the developed economies have diffused in the new social systems in developing economies due to the dissimilar environment. What this means is that the imported technologies’ operations are not internalized to become part of the norms, practices and experiences of users of the new technology in the new environment (Pacey, 1996).

In a developed economy with an insignificant subsistence sector, the decision to adopt technology depends largely on a firm’s expectations about the benefits and costs of the technology (Au, Kauffman, & Riggins, 2006). This is because most of the investment decisions are driven by the profit maximization motive. However, in a developing
country, with a large informal sector dominated by subsistence production, utility maximization is the main driving motivation for technology adoption. For this study, the question that arose was what influenced potential adopters in the informal sector to acquire a new technology, and how the new technology’s design characteristics influenced the potential adopters to acquire it.

In Kenya, most of the MSE entrepreneurs in the informal sector have either been using indigenous technology or non-adapted imported technology (Republic of Kenya, 1992). Most indigenous technologies produce low quality and non-competitive products (Republic of Kenya, 2007c). Non-adapted imported technology, on the other hand, is inappropriate to the local environment as it is either too costly to be afforded by most potential adopters in the informal sector or requires infrastructure that is standard where it is imported from, but such infrastructure (like the electric power grid or clean piped water) is either non-existent or inaccessible to MSE entrepreneurs in Kenya’s informal sector (Schumachar, 1973; Fisher, 1992). In many cases, non-adapted imported technology requires imported inputs, including spare parts, and its operation requires maintenance routine, which is either unfamiliar or too complicated for the operators in the informal sector to cope with (Pacey, 1996). Therefore, there is a need for imported technology to be adapted to suit the MSE entrepreneurs’ environment in the informal sector.
One of the constraints faced by MSE entrepreneurs in the informal sector is the lack of training in skills and knowledge to modify or adapt imported technology to suit their requirements. That is why government and donor agencies through NGOs, have taken up the task of adapting imported technology to suit the requirements of MSE entrepreneurs.

If indigenous technology and imported non-adapted technology are not effective in performing the tasks for which they are deployed in Kenya’s informal sector, what alternatives are available? Schumacher and the Intermediate Technology Development Group (ITDG) suggested a solution: the development of intermediate technology, which is a cross-breed between the indigenous technology and the modern technology. The ITDG, which Schumacher and George McRobie founded in 1965, argued that the intermediate technology had to be appropriate to the local environment of developing societies. The idea behind the development of intermediate technology was to make the technology small, simple, cheap and non-violent to the environment, so that sophisticated manufacturing skills, organizational structures and finance would be unnecessary (Smillie, 2000). The problem with the ITDG proffered solution was that, before the NGOs and the government intervened, entrepreneurs in the informal sector in Kenya, lacked the technical capability and capacity to develop appropriate intermediate technology.
The original concepts of “appropriate” and “intermediate” technology the ITDG had in mind had to fulfill all or most of the following conditions: “Meet the needs of the majority, not a small minority of a community; Employ natural resources, capital and labour in proportion to their long-term sustainable availability; Ownable, controllable, and maintainable within the community it serves; Enhance the skills and dignity of those employed by it; Non-violent both to the environment and to the people; It had to be socially, economically and environmentally sustainable” (Smillie, 2000 p. 91).

When the ITDG was founded in 1965, the concepts of appropriate and intermediate technology were mere concepts. By 1980, there were thousands of organizations, groups and institutions with an “appropriate or intermediate technology” focus. Many of these groups have become NGOs that, together with government agencies, are currently engaged in modifying or adapting imported technology to make it appropriate to serve the needs of the poor and low income earners in developing countries. Kenya is one of the African countries where NGOs, like KickStart, are actively working in tandem with government agencies to adapt imported technology to suit the needs of potential MSE technology adopters in the informal sector.

1.1.4 Adaptation of Imported Technology

As indicated earlier, the theory of technology adoption and diffusion posits that for imported technology from advanced to less advanced social systems to perform
efficiently, it has to be modified or go through a process of adaptation to fit the new environment (Schumacher, 1973; Pacey, 1996; Johnson et al., 1997; Rogers, 2003). Adaptation should involve design changes that either add new functional capability to the technology or make the technology easier to use in its performance of existing functions in the new environment it has been introduced.

Although the importation of most of the modern technology used by MSE entrepreneurs in Kenya’s informal sector is a result of the aggressive salesmanship of foreign marketing agents and their local sales representatives (Kuuya, 1977; Vaitsos, 1991), a substantial number of the imported technology (such as welding machines for training institutions, water pumps for irrigation, maize mills for grinding grains, building stone shapers for masonry) has been acquired as a result of the deliberate direct interventionist policies of government and donor agencies, with the objective of promoting economic growth and income distribution (Chennery, Ahluwalia, Bell, Duloy, and Jolly, 1994). Like most developing countries, most of the imported technology used in Kenya’s informal sector has not gone through the process of adaptation.

The researcher’s experience in the three East African countries he has worked in, including Kenya, is that when imported technology is introduced in the country, it is first used in government institutions, large farms, large firms or high-income households. This was the case with welding machines (public works departments and
private engineering workshops) and water pumps (for irrigation on large scale farms and water supply to firms and institutions). As the characteristics of some of the imported technologies became familiar to the local population, a few of them were adopted by low-income households and MSEs, most of which operated in the informal sector. However the imported technologies came along into Kenya’s informal sector with constraints such as inaccessible infrastructure, lack of utilities (energy and water sources), transport, secure premises, or unfamiliar maintenance routine, which the designers and producers of the imported technology did not anticipate in their home countries. Adaptation of the imported technology to the local environment in the informal sector was supposed to address some of these constraints so that the technology could be easily adopted and assimilated.

What this implied was that, for imported technology to have a positive impact on income generation, growth and development of micro and small enterprises in the informal sector in Kenya, it had to go through three main stages. First, it had to go through a process of adaptation to suit the users’ environment in Kenya’s informal sector (Pacey, 1996; Johnson, et al, 1997). Second, it had to go through a process of adoption of the adapted technology involving pioneer adopters and those who follow the pioneer adopters(Rogers, 2003). Third, it had to go through a process of diffusion where the adoption of the adapted technology attained a critical mass to become the accepted mode of performing tasks (David, 1990) to enhance productivity growth in Kenya’s informal sector and the economy as a whole. As pointed out earlier, most of
the entrepreneurs of MSEs in the informal sector lack the technical capability to go through the first stage, leave alone the capability to leverage imported technology through the second and third stages highlighted above.

However, not all technology imports used in the informal sector are unsuited to the local environment. A few imported technologies come to Kenya in search of a market when they are already well suited to the local environment in the informal sector. The need for new markets, after saturating their home markets, forces some multinational corporations, like Nokia and Samsung, to adapt their export products to suit the local environment in developing countries. To avoid the long process of adaptation of imported technology, the policy makers in many developing countries, including Kenya, have created the necessary enabling environment, by putting in place business friendly legal and regulatory framework (Alliance for Financial Inclusion, 2010), to facilitate the importation of some of the technologies, such as mobile phones from Europe and Asia and mobile agency banking services from Brazil (Ngang’a and Mwachofi, 2013), that are already well suited to the local environment in the informal sector.

One of the few imported technologies, which has been designed, developed and produced abroad to suit Kenya’s informal sector environment is the IT technology of mobile phones. The Motorola Dyna TAC, the first commercial cell phone, was launched by the Motorola IT Company in the USA in 1973. It stood at 25 cm high,
weighed 790 grammes and cost US$ 3995. The subsequent portable generation of cell phones targeted the elite with no practical application to the development needs of developing countries (Gruber and Verbovev, 2001; Juma, 2011).

The original expensive mobile telephony technology, which was launched in Kenya in 1992, has since been adapted by the numerous brand mobile phone producers (Nokia, Alcatel, Huawei, Samsung, and Lucky Goldstar - LG) to suit the pockets, needs and working environment of low income earners. By coincidence rather than by design, the cheap-to-buy, easy-to-use and convenient to carry mobile phone has fitted in the African culture of providing easy access to, and passing idle time chatting to relatives, friends and acquaintances. The once very expensive cell phone was in 2015 costing as low as Ksh 1649/= (US $ 19) for the NOKIA 105 model. To facilitate access to internet, brand cell phone producers came up with 3G smart phones that are affordable to low income Kenyans with tight budgets, such as the Android-powered Samsung’s Erica and Huawei’s U5130, each costing only Ksh 2,999 (US$ 35). These cheap and easy to use mobile phones have diffused in Kenya’s society so rapidly that they are everywhere. Overall, one important positive outcome of the diffusion of mobile phone technology has been to facilitate access to information and lead to a variety of innovations in the informal and formal sectors of the economy.

The key phrases here are “the diffusion of mobile phone technology” and the effects of such adoption in “facilitating access to information” and promoting “set development
goals”. First, mobile phone adoption provides a platform for dissemination of information about adapted technology. Second, one of the most outstanding contributions of cell phone adoption, to the government policy goal of halving poverty by 2015, has been to inculcate the culture of saving among low-income Kenyans by allowing the private sector to provide a money transfer platform that increased financial inclusion. This was made possible by the Central Bank of Kenya’s “Letter of No Objection” of February 2007 that enabled Safaricom Kenya LTD to launch a mobile money transfer service, M-Pesa, in March 2007 (Alliance for Financial Inclusion, 2010).

Safaricom K LTD followed the pioneering M-Pesa product with the launch, in November 2012, of a virtual banking platform, M-Shwari. By September 2013, M-Shwari had recorded 2 million subscribers, who had deposited Ksh 20 billion (US$ 235.3 million) in their M-Shwari accounts (Communication Commission of Kenya, 2013). Once the culture of saving has been embedded among low-income members of society, the task of promoting and encouraging them to take risks to invest in technology is made easier. This is particularly so now that, thanks to the Central Bank of Kenya’s policy-drive for financial inclusion, most low-income Kenyans, who own mobile phones, and are potential adopters of adapted technology, can now use them to access credit, make saving deposits and pay bills. This is a contribution that adapted technology of cell phones has made to Kenya’s informal sector despite the fact that the adaptation process took place in the multinational corporations’ home countries.
Not only is the cell phone technology creating jobs, increasing the incomes and encouraging and promoting a savings culture among the poor, but it is making work in the health and education sectors easier. Although there is no study that has come up with definitive findings as yet, the researcher is of the view that the massive adoption of mobile phones by entrepreneurs in the informal sector will soon, if it has not started already, be contributing to increased growth in productivity of the workers / entrepreneurs of MSEs in the informal sector. The moral of the mobile phone story is that there are technologies out there that are already suited to the local environment that the private sector can import and popularize without going through the hustles of domestic adaptation. The government can use its institutions and limited resources to identify and facilitate the private sector to make them available on the Kenya market.

Mas (2010) observed that as a result of the diffusion of mobile phone technology, a financial revolution is in progress and is happening, not in New York, London, Beijing or Mumbai, but in the slums of Nairobi and the markets of Kisumu. Evidence of the rapid diffusion of adapted mobile phone technology in Kenya can be seen from the fact that the number of mobile phone subscribers has increased from 15,000 high income subscribers in 1999 (United Nations ITU, 2009) to 20.1 million in June 2010, 22.3 million in September 2010, 24.97 million in December 2010, and 30.7 million in December 2014 (Communication Commission of Kenya, 2015). Kenya’s experience with adapted mobile phones suggests that not all imported technology is unsuited to the local environment in the informal sector.
However, while the widespread availability of this cheap-to-buy, easy-to-use, and convenient to carry imported cell phone technology has facilitated very rapid adoption and diffusion in the informal sector and the country as a whole, this technology’s technical attributes are necessary but not sufficient conditions for the fast adoption of imported technology in a developing economy, leave alone the informal sector. The successful adoption and diffusion of cell phones in the informal sector cannot be explained away only by the technology’s positive attributes highlighted above.

By contrast, the cheap-to-buy, easy-to-use, and convenient to carry time-keeping technology of clocks and wrist watches has been in Kenya since the beginning of the 20th century, yet the use of these time-keeping items of technology in Kenya for over 100 years has not only remained elitist, but has not diffused among Kenya’s indigenous society. In this regard, adoption of time-keeping technology devices has hardly contributed to the enhancement of productivity growth or improvement of the job performance through observing punctuality by indigenous Kenyans. Thus, in Kenya, the time keeping technology is one example of those technologies that have been adversely affected by under-utilisation, which is partly blamed for some adopted technologies’ failure to contribute to increased total factor productivity (Roach, 1991; Venkatesh & Goyal, 2010; Venkatesh & Morris, 2000).

One of the effects of underutilization of adopted technology is the frequent collapse or non-growth of MSEs. This is partly blamed on the MSEs entrepreneurs’ habit of
rushing to locate their start-ups where similar enterprises are located. In Kenya’s informal sector, it is common to find adopters of a particular technology congested in one location at the expense of other areas in need of the services of the same technology. This is partly due to the dominant prevalence of Garret Hardin’s “tragedy of the commons” phenomenon (Hardin, 1968) where low-income technology adopters seem to be influenced more by the rational herding behavior theory (Bikchanani, Hirshleifer, & Welch, 1998) than by the rational expectations theory of Au and Kauffman (2005) and Au, Kauffman and Riggins (2006).

The “tragedy of the commons” phenomenon ((Hardin, 1968) in the informal sector is a situation brought about by cultural practice, where too many individual MSE entrepreneurs make “rational” decisions to launch start-ups on the basis of the success of those who have preceded them, without taking into account the fact that their entry will flood the market and obliterate entire lines of business they are involved in. In such situations, an MSE entrepreneur’s technology adoption decision is influenced less by realistic calculations of benefits and costs of the technology, as is the case with technology adopters in advanced economies. In such a situation, it would be futile to expect MSEs in the informal sector attain the50 per cent critical mass of technology adoptions in the informal sector, which is a necessary condition to facilitate growth, as economic theory postulates (David, 1990). It is for this reason that one would have expected the government and donor agencies to intervene, not only to facilitate adaptation of imported technology, but to also ‘nudge’ potential adopters into adoption
of the adapted technology. If this was done it would stem the high rate of collapse due to over-crowding and over-supplying the products and services of adapted technology.

It is, however, worth noting that research studies elsewhere have indicated that technology adoption alone is not enough to contribute to productivity growth. The adopted technology has to be appropriately and frequently used for it to make a measurable contribution to productivity growth (Devaraj & Kohli, 2003; Au et al., 2006).

What do the two contrasting examples of cell phones and watches technology adoption, and the collapse and non-growth of MSEs due to their overcrowded locations suggest? What these contrasting examples suggest is that, in addition to technology-specific attributes that attract potential adopters, there are some cultural aspects of technology associated with human characteristics, which policy makers and donor agencies have to take into consideration when adapting imported technology to a new environment (Kuuya, 1977).

1.1.5 Government Policy on Technology Adaptation in the Informal Sector

Governments all over the world are actively involved in formulating policies on technology acquisition, transfer and diffusion. In fact, one of the many pre-occupations of proactive governments all over the world is to hire agents to carry out industrial espionage, where all sorts of means at the disposal of government agents are deployed
to acquire technology from other countries. The Kenya government policy on technology transfer lacks the sophistication of other countries, which have been in the game of industrial espionage for as long as modern economic history.

Since the 1970s, the policy makers in government and other stakeholders in the informal sector have been aware that most indigenous technology is antiquated and uses crude production techniques, which produce low quality/uncompetitive products (Republic of Kenya, 2007c). The policy makers and donor agencies have also been aware that most of the imported technology is from the developed countries where it was designed to suit different social and economic environments (Fisher, 1992). In an effort to address the problems posed by antiquated indigenous technology and inappropriate imported technology, the government has devised polices and put in place institutions to remedy the situation.

The Government of Kenya’s first attempt at policy formulation on technology transfer was contained in Sessional Paper No. 10 of 1965, when import substitution as a strategy of industrial development was formulated to facilitate technology transfer to Kenya (Republic of Kenya, 1965). The next important milestone in government policy on technology transfer, particularly to be used in the informal sector was triggered by the ILO Report on Unemployment (ILO, 1972), which recommended that the Kenya government should provide the MSEs in the informal sector with technical aid, including research and development (R&D). Through the Sessional Paper on

It was in pursuit of the ILO recommendations that the government, under the Science and Technology Act, Cap 250, established in 1979 the Kenya Industrial Research and Development Institute (KIRDI), with a broad long-term objective of providing “…scientific and technological knowledge and service for the attainment of a level of self-reliance in technology and for creating self-sustaining industrial development” (Republic of Kenya, 1979, p. 1).

The next important policy document was Sessional Paper No 2 of 1992, which together with Sessional Paper No 2 of 2005 and the 4K MSE 2030 Initiative framework of 2007, are the most comprehensive government policy documents on MSEs. Sessional Paper No 2 of 1992, outlined the policies to be pursued by government to facilitate acquisition of technology by the MSE in the informal sector. In this document, KIRDI was assigned the task of importing technology and adapting it for use in the MSE sector. It is this policy document, which mandated KIRDI to collaborate with universities and other relevant institutions to identify technology-related research needs that were to be addressed in the MSE sector (Republic of Kenya, 1992). Sessional Paper No 2 of 2005 was basically an upgrade of Sessional Paper No 2 of 1992.
Just before the launch of Vision 2030 (Republic of Kenya, 2007), a new policy initiative on technology used in the informal sector was devised. In November 2007 the government, in anticipation of the First Medium Term Plan (2008 – 2012) of Vision 2030 (Republic of Kenya, 2008), launched the 4K MSE 2030 Initiative, which was mandated to address the issues responsible for low competitiveness of MSE products and services (Republic of Kenya, 2007c). The institutions that constitute the 4K MSE 2030 Initiative are the Kenya Industrial Research and Development Institute (KIRDI), the Kenya Bureau of Standards (KEBS), the Kenya Industrial Property Institute (KIPI), and the Kenya National Federation of Jua Kali Associations (KNFJKA).

The strategic objective of 4K MSE 2030 Initiative was to create and maintain a platform for mass production of quality industrial products by MSEs. The specific objectives were to: Upgrade the MSE products; Build capacity for MSEs to manufacture upgraded products; Promote innovation and technology transfer; Instill a culture of quality and standardization; Promote use of intellectual property as a tool of trade and business (Republic of Kenya, 2007c). The 4K MSE 2030 Initiative, policy document mandated the 4K institutions to “Upgrade MSE products”.

The tasks involved in upgrading MSE products included adapting imported technology to suit the local environment, as exemplified by the 4K institutions’ work on the AWEMAK-160 and AWEMAK-210 proto-type welding machine, which until 2012 were undergoing test runs. In 2013, the AWEMAK-210 got the Kenya Bureau of Standards
mark of quality in readiness for commercialization. Other than general guidelines given to KIRDI to import technology and adapt it for use in the MSE sector, there is need to establish the factors that guide the adaptation process of adapting imported technology.

Implied in the strategic objective of the 4K MSE 2030 Initiative is the government’s desire to make technology available to Kenya’s informal sector. Such technology should conform to the ideals of the ITDG highlighted earlier, and should be instrumental in achieving the first goal of the UN’s Millennium Development Goals (MDGs) of halving poverty by the year 2015 in particular, and contributing to the attainment of Vision 2030 in general. Also implied in the government’s decision of November 2007 to set up an institutional framework under the 4K MSE 2030 Initiative, is the desire to provide a solution to the problem of antiquated and inappropriate technology used by the MSEs in the informal sector.

Thus, when technology designers and developers of government agencies (like KIRDI) and their donor agency counterparts (like KickStart) set out to modify or adapt imported technology to suit the informal sector environment, the technology design characteristics they should concentrate on should be those that enhance the adoption of the adapted technology. This requires the technology designers to have set of guidelines on the design characteristics of technology that are suited to, and the human factors that conform to the social norms in the informal sector environment.
1.1.6 Link between technology adaptation and adoption process

Since its inception in 1979, KIRDI, through its mandate of research and development (R&D), has built some infrastructure and acquired a certain level of capacity to design, adapt/upgrade, develop and produce some technologies, which are relevant to the MSE sector. KIRDI, for example, has designed and produced an efficient firewood and charcoal-saving stoves aimed at reducing the rate at which trees are cut down for firewood. In addition, KIRDI in collaboration with KEBS, KIPI and KNFJKA had modified the imported air-cooled welding machine, leading to the local production of two proto-type welding machines, AWEMAK-160 and AWEMAK-210, which have undergone test trials, for appropriateness to the environment of the informal sector.

The AWEMAK-series welders are an improvement of the waste engine-oil cooled adapted welding machine, which is fabricated by Jua Kali artisans in engineering workshops. Although this Jua Kali engineered and produced welding machine is currently widely adopted in the informal sector, its producers are blamed for the current widespread vandalizing of the Kenya Power and Lighting Co LTD’s electricity transformers to drain the oil coolant for use in the Jua Kali made welding machines as the transformer oil is a superior cooling agent to the waste oil they normally use. The success of the AWEMAK-series welders in replacing the Jua Kali made welding machines will, therefore, kill two birds using one stone: It will provide the informal sector with an appropriate technology and save the Kenya Power and Lighting Co LTD
the millions of foreign exchange currency spent replacing vandalized costly transformers on power transmission lines.

In its other endeavour to modify imported technology, KIRDI has been assisted by NGOs, such as ApproTech (now renamed KickStart), which is involved in designing, developing and supervising the production and marketing of tools and equipment considered appropriate to local MSEs in both the formal and informal sectors. Many of the tools and equipment produced by KIRDI and NGOs like KickStart are modifications or adaptations of imported technology. These include a manually operated block press used to make stabilized soil-blocks in place of expensive imported machines used to make clay bricks or cement blocks; manually operated micro irrigation water pump (Money Maker) in place of the expensive imported electric and petroleum fuel powered water pumps; manually operated oil-seed press in place of expensive and difficult to operate imported cooking oil processing press; and a charcoal fired baking/meat-roasting oven in place of imported electric or gas ovens, to mention but a few (Fisher, 1992; Havers, 1998; Kihia, 2001). The extent to which the local modification of imported technology has enhanced the chances of adoption of some of these adapted technologies is yet to be determined.

By 2011, quite a number of the adapted technologies had been adopted all over the country. Two good examples of widely adopted and diffused adapted technologies are the waste engine-oil cooled welding machine, which is locally designed for the Jua Kali
artisan and KickStart’s manually operated micro irrigation water pump *(Money Maker)*. Virtually every trading centre in Kenya with a *Jua Kali* metal-working shed has a number of the locally adapted welding machines fabricated by Jua Kali artisans – thanks to the booming construction sector’s high demand for metal-framed windows and doors. On the other hand, according to KickStart, which designed, developed and supervised the production and marketing of the micro manual irrigation pump, the adoption of the *Money Maker* by small-holder farmers (mostly women) in rural and peri-urban areas has increased from zero at the time of its launch in 1998 to 14,000 in 2001, 34,350 in 2003 and 72,300 by June 2011 (KickStart Annual Reports of 2000 - 2012). Before the launch of the *Money Maker*, only entrepreneurs of medium sized farms operated imported electric and/or fossil fuel powered water pumps for irrigating their farms. Today thousands of smallholder farmers have acquired the *Money Maker*, which enables them to produce crops throughout the year so long as there is a source of water to facilitate irrigation.

The rapid adoption and country-wide spread of ownership of the cheap-to-buy adapted waste oil-cooled welding machine and the *Money Maker* have been attributed to the fact that the two machines have been locally modified to suit the informal sector environment. Not only are they cheaper to buy and easier to operate than their imported substitutes, but they are tailored to suit the local environment. What did the adaptation of these two technologies involve in order to make the local substitutes suited to the local environment?
The waste oil-cooled welding machine, for example, has been designed to withstand the harsh open-air weather conditions the Jua Kali artisans operate under. Their imported substitutes are air-cooled and easily overheat when operated continuously in the hot open-air conditions the Jua Kali artisans work under. On the other hand, the Money Maker is given credit for the fact that, despite being manually operated, it can pump water from a depth of seven meters (22.75 feet) from a river, lake, swamp or dam, up to a height of fourteen meters (45.5 feet), and can irrigate two acres of land in six hours. Both machines require minimal maintenance. By contrast, their imported substitutes are expensive to buy, require regular and complicated maintenance regimes, with the irrigation water pump requiring expensive and difficult to access spare parts and petroleum products or electricity as its power source(s).

The problem is that much as KIRDI and NGOs like KickStart have adapted quite a number of imported technologies to suit Kenya’s environment, the rate of adoption of these adapted technologies has been relatively low, when compared to the rate of adoption of the IT technology of mobile phones in Kenya. Part of the problem could be that much as many items of technology required by MSEs in Kenya’s informal sector have been produced by KIRDI and NGOs like KickStart, not much promotional and information dissemination activities have been undertaken in the informal sector to market the locally adapted technologies. This may partly explain why, compared to the imported IT technology of mobile phones in Kenya, the rate of adoption of adapted technologies in Kenya’s informal sector is relatively low. As a result, most of the MSE
entrepreneurs still use indigenous/traditional technology or non-adapted imported technology when the adapted substitutes exist.

Previous studies have established that potential adopters need information about the existence, and operational characteristics, of the adapted technology. Therefore accessing information about adapted technology could be one of the bottlenecks to adoption. Potential adopters also need to have easy access/availability of the new technology. Should the technology be unfamiliar to operators, potential adopters also need to acquire the skills to use the new technology (Mols, Bukh, & Nielsen, 1999). Could the problem of low rate of adoption of adapted technology in Kenya’s informal sector be caused by lack of information about the existence of the adapted technology? If this is the case, what communication channels are best suited to pass information about adapted technology to potential adopters?

While the Nganga and Mwachofí (2013) study has done a fairly good job in highlighting the internal and external challenges faced by MSE adopters, it falls short of identifying specific factors that influence technology adoption by MSE entrepreneurs, particularly those who adopt adapted technology. Since the government policy, as enunciated in Sessional Paper No 2 of 1992, Sessional Paper No 2 of 2005 and the 4K MSE 2030 Initiative framework of 2007, on technology adoption in the informal sector, includes measures to adapt imported technology to suit the local environment, there is a
need for a study to determine the factors that influence adoption of adapted technology
the informal sector environment.

1.2 Statement of the Problem

According to two national baseline surveys (Parker & Torres, 1993; Republic of Kenya, 1999), at least one third of the MSE start-ups do not survive to their third birthday. Out of those that survive into the fifth year, only a few graduate into medium enterprises (Mwaura, 1994; Nelson & Mwaura, 1997). Although the causes of the collapse and non-graduation of MSE start-ups are many, some studies predicate that the problem is partly to be found in the adoption of inappropriate imported technologies (Fisher, 1992; Havers, 1998; Kihia, 2001)

Producers of goods and services are driven to invest in technology by many factors. They adopt technology if they believe that doing so leads to positive outcomes. The positive outcomes include cutting costs, increasing output without increasing inputs, improving quality of products, to mention but a few (Pikkarainen, Karjaluoto, & Pahnila, 2004). The 4K government institutions [Kenya Industrial Research and Development Institute (KIRDI), the Kenya Bureau of Standards (KEBS), the Kenya Industrial Property Institute (KIPI), and the Kenya National Federation of Jua Kali Associations (KNFJKA)] and some NGOs like KickStart have been involved in the process of adaptation of imported technology to make it appropriate to suit the needs and environment of low-income investors in the informal sector. The problem is that
much as KIRDI and NGOs like KickStart have adapted quite a number of imported technologies to suit Kenya’s environment, the rate of adoption of these adapted technologies has been relatively low.

Further, the factors that influence MSE entrepreneurs in the informal sector to adopt adapted technology are yet to be clearly stated. Knowledge of such factors would enable those involved in the process of designing and producing adapted technology to come up with appropriate designs and products for the informal sector.

Furthermore, there was a need for a study to be undertaken to establish why potential adopters in the informal sector in Kenya embraced a new technology, and how the new technology’s design characteristics, human characteristics or other factors, like communication channels used to access information, influenced the potential adopters to adopt technology.

1.3 Research Questions

The need for a study to be undertaken to establish why potential adopters in the informal sector in Kenya have been slow to embrace adapted technology triggered this study. The study set out to determine the factors that influence adoption of adapted technology by entrepreneurs of micro and small enterprises in Kenya’s informal sector. The questions that the study intended to answer were:
1. What are the technology-specific factors that influence adoption of adapted technology used by entrepreneurs of micro and small enterprises in the informal sector in Kenya?

2. What are the human characteristics that influence the adoption of the adapted technology by entrepreneurs of micro and small enterprises in the informal sector in Kenya?

3. What are the communication channels used to acquire information about adapted technology, by entrepreneurs of micro and small enterprises in the informal sector in Kenya?

1.4 Objectives of the study

The general objective of this study was to investigate the factors that influence adoption of adapted technology used by micro and small enterprises in Kenya’s informal sector.

The specific objectives were to:

1. Determine technology-specific factors that influence adoption of adapted technology used by micro and small enterprises in the informal sector

2. Determine human characteristics, which influence adoption of adapted technology used by micro and small enterprises in the informal sector

3. Determine the communication channels used to acquire information about adapted technology used by micro and small enterprises in the informal sector
1.5 Significance of the Study

Government policy is clear about the need to adapt imported technology to suit the local environment. The study findings are expected to help government institutions like KIRDI and donor agencies like KickStart, which are involved in designing and developing appropriate technology for the informal sector, to come up with guidelines that can facilitate the production of appropriate designs of adapted technology suited to the informal sector environment. The study finding should also come up with guidelines on how the government can come up with policies and strategies that promote the adoption of adapted technology.

1.6 Scope of the Study

Most of the activities of technology adaptation for the informal sector undertaken by government agencies like KIRDI and NGOs have been undertaken in the agricultural, food processing and manufacturing sub-sectors. This provided the justification for the scope of this study, which focused on the adapted technology used in these sub-sectors. Dominant in numbers on the list of adapted machines in the study were the manual irrigation pump (*Money Maker*) in the agricultural sub-sector, the petrol or diesel powered maize grinding mill and the charcoal fired meat roasting machines in the food processing sub-sector, and the locally designed and produced waste oil-cooled welding machines in the manufacturing sub-sector. The study’s target population was the informal sector entrepreneurs in the administrative wards of the urban sub-counties of
the Nairobi and Kisumu counties, and the locations in the rural sub-counties of Nyeri North (Kieni) and Nyeri South (Othaya) of Nyeri County. Information from the Ministry of Labour showed that these were the sub-counties with the highest concentration of adapted technology in the informal sector. Only MSEs that had adopted technology after the launch of the Millennium Development Goals (MDGs) in the year 2000 were included in the study sample. This had been necessitated by the need to avoid over-stretching the recall capabilities of respondents, since few of them kept written records of operations.

1.7 Organization of the Study

The study is organized in five chapters. Chapter One gives the background to the study as a prelude to the principle objectives of the study. Chapter Two reviews both theoretical and empirical literature that provided the basis for the theoretical framework. Chapter Three presented the research design and methodology. Chapter Four presents and discusses the empirical results. Finally, Chapter Five gives a summary of the study findings, before making conclusions and policy recommendations.
CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section reviews both theoretical and empirical literature on adoption of technology. However, because most of the technology used in developing economies is imported, a conceptual review of technology transfer will set the stage for the review.

2.2 Theoretical Literature

2.2.1 Conceptualising Technology Transfer

Many models have been developed for use in analyzing technology transfer. Most of these models have been used in studies whose results stress the need for the end-user and the user’s environment to be the main consideration in the development or modification of technology to meet a perceived need. However, producers of most of the imported technology used by micro and small enterprises (MSEs) in the informal sector in Kenya do not take into consideration the local MSE end user and the user’s environment due to the market structure (Jensen, 1982) and due to real or perceived market demand limitations.

In their study, Ruttan and Hayami (1973) developed a set of technology transfer models, which distinguished three phases of international technology transfer, namely, the
material transfer model, the design transfer model and the capacity transfer model. This set of three phase models of technology transfer recognized the principle that, in its basic form, technology transfer involved the developer of the technology, the item or technology to be transferred, the channels used to effect the transfer, and the technology recipient or end user (Market, 1993).

In their study, Johnson, Gatz, & Hicks (1997) observed that many early studies on the subject of technology focused on technology transfer between the developed and developing countries, with emphasis being placed on the economic, political and cultural differences between the developer/exporter of technology, on one hand, and the recipient/end-user on the other. Most of those studies established that technology transfer involved three stages. The first stage involved the development from invention up to the commercialization of the technology. The second stage involved the processes and channels used to effect the technology transfer. The final stage involved the recipient or end-user of the technology making use of the technology. The studies also established that a successful technology transfer involved more than the simple act of movement of technology from one environment to another (Johnson et al., 1997).

Conceptually, Johnson et al.(1997) argued, technology transfer should be traced from the activities that led to the development of new technology or modification (adaptation) of an existing one, up to the activities of the end user. These activities occurred within a social, economic and cultural context, where individuals, groups or
firms combined knowledge, thinking and creative ingenuity, to produce and use the technology. Johnson *et al.* (1997) further argued that without the sensitivity for the needs of end-user and the environment in which the technology would ultimately be used, the process of technology transfer may not easily reach its logical conclusion. Their contention that the end user and the user’s environment should be the main consideration in the development and transfer of technology was in support of the Ruttan & Hayami (1973) models.

The conclusion one draws from the Johnson *et al.* (1997) and Ruttan and Hayami (1973) studies is that if technology is imported from a different social setting to be adopted by the micro and small enterprises in the informal sector in Kenya, it should be adapted to suit the social, economic and psychological setting of the end users in Kenya’s informal sector. However, while most technology imports into Kenya can be identified with the Ruttan and Hayami’s first phase of material transfer model, international patents protection restricts design transfer (second phase), while business competition concerns impede capacity transfer (third phase). Recent developments and economic trends that have made intermediate and final products outsourcing from developing countries popular is likely to increase design and capacity transfers from developed economies, with Kenya using its regional hub position and regional economic dominance to benefit most from technology transfers resulting from outsourcing.
2.2.2 Conceptualizing Technology Adoption

According to Bass (1969), some individuals or firms adopted an innovation or technology independently of other individuals in a social system. Bass called these first adopters “innovators”. The innovators or pioneer adopters influenced other adopters to follow. The follower adopters were called “imitators”. If the experience of pioneer adopters was that the technology being adopted was easy to use, the imitators would have an easy ride in the adoption process. However, according to Larsen and Agarwala-Rogers (1977), technologies that were relatively more complex and difficult to understand were more likely to be re-invented, defined as the degree to which an innovation was changed or modified by a user in the process of adoption and implementation.

Rogers (2003) defined innovators as the first 2.5 percent of the adopters. According to Rogers, among the factors that influenced the rate of adoption were compatibility and complexity of an innovation. Compatibility and complexity were partly dependent on the environment in which the technology has been introduced. Pacey (1996) argued that, although on the technical side the operating principles behind the functioning of a particular technology could be universal, when it comes to the application of that technology in a different social setting, the technology had to be modified or adapted to suit the material and social conditions of the new environment in which it would operate (Pacey, 1996).
The problem faced by entrepreneurs of MSEs in the informal sector in Kenya is that not only do most of them use non-adapted imported technology, but they lack the technical capability to modify the imported technology to suit their working environment.

2.2.3 Technology Adoption Theory

There are many theories of technology adoption, particularly on the adoption of information technology. The most used theories of technology adoption include: the technology acceptance model (TAM) (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989), the technology, organization and environment (TOE) framework (Tomatzky and Fleischer, 1990), the theory of planned behavior (TPB) (Ajzen, 1991), the unified theory of acceptance and use of technology (UTAUT) (Venkatesh, Morris, Gordon & Davis, 2003), the diffusion of innovation (DOI) theory (Rogers, 2003). Of these, the DOI and TOE framework are used to analyse technology adoption at a firm level, while the TAM, the TPB and the UTAUT theories are used to analyse technology adoption at the individual level (Oliveira and Martins, 2011).

However, while most of these widely used theories of technology adoption have been specific to the study of information technology adoption, due to the overwhelming dominance of the information technology revolution since the early 1970s, they were preceded by other technology adoption theories, which made important contributions to
the theory of technology adoption. A review of some of these, and a few on information technology adoption, which are relevant to this study follows.

Bass (1969) made one of the most important contributions to the theory of technology adoption and diffusion when in 1969 he came up with a model that provided the impetus underlying diffusion research in marketing. The model’s basic assumption was that the timing of the initial purchase of a new product was related to the number of previous buyers. According to the model, the probability that an initial adoption would be made at time $t$, given that no previous adoption had taken place, was a linear function of the number of previous adopters (Bass, 1969). Thus,

$$P(t) = \rho + \frac{q}{m}Y(t)$$

where:

- $P(t)$ = probability that an initial adoption will be made at time $t$
- $\rho$ and $q/m$ are constants
- $\rho$ = coefficient of mass media influence
- $q$ = coefficient of interpersonal influence, and
- $m$ = an index of market potential
- $Y(t)$ = the number of previous buyers

Since $Y(0) = 0$, the constant $P$ is the probability of an initial adoption at $t = 0$, with its magnitude reflecting the importance of innovator/pioneer adopters in the social system. According to the Bass (1969) model, adoptions of the technology grew to a peak and then leveled off at some magnitude lower than the peak.
The first important contributions of the Bass model was that it was a *predictive* model that sought to forecast how many adoptions of a new product would occur at future time periods. The key elements in the Bass model were two types of communication channels: the mass media channel, and the interpersonal contact or word-of-mouth channel. The Bass model assumed that individual pioneer adopters (innovators) were exclusively externally influenced to adopt technology by mass media throughout the diffusion period. On the other hand, individual follower adopters (imitators) were influenced by inter-personal contact (or word-of-mouth) communication.

The second important contribution of the Bass model was that it provided a mathematical formula for predicting the rate of adoption using three parameters: a coefficient of mass media influence ($\rho$), a coefficient of interpersonal contact influence ($q$), and an index of market potential ($m$), which was estimated by data from the first few time periods of market penetration (or diffusion) of a new product.

Mahajan, Muller, and Bass (1990) reviewed a number of studies that had used the revised Bass (1969) model in their studies to get estimates of the adoption process. They pointed out that the Bass (1969) model is derived from a hazard function (i.e., the probability that an adoption will occur at time $t$ given that it has not yet occurred). In the Bass (1969) model, the probability that an adoption would occur at time $t$, given that no earlier adoption had occurred, was given by:

$$
\frac{f(t)}{[1 - F(t)]} = P(t) = \rho + q/mY(t) = \rho + qF(t) \quad \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots (2.2)
$$
where:

\(f(t)\) was the likelihood of adoption at time \(t\) or the probability function of time to adoption

\(F(t)\) was the cumulative fraction of adopters at time \(t\)

\(P(t)\) was the probability that an initial adoption would be made at time \(t\)

\(Y(t)\) was the number of previous (\(Y_{t-1}\)) adopters

\(\rho\) was the coefficient of mass media influence

\(q\) was the coefficient of interpersonal influence

\(m\) was the total number of adoptations during the period for which the probability to adopt function was constructed.

According to Mahajan et al. (1990) the density (probability to adopt) function of time to adoption is given by \(f(t)\) and the cumulative fraction of adopters at time \(t\) is given by \(F(t)\). The basic premise of the Bass (1969) model states that the conditional probability at time \(t\) (the fraction of population that will adopt at time \(t\)) is increasing on the fraction of the population that has already adopted. Therefore, the basic premise stated that part of the adoption influence depended on imitation or “learning” and part of it did not. The parameter \(q\) in the Bass (1969) model reflected the influence of imitation, while parameter \(\rho\) reflected an influence that was independent of previous adoptations. If \(q\) was equal to zero (0), \(f(t)\) would follow the negative exponential distribution. If \(m\) was the potential number of ultimate adopters, the number of adopters at time \(t\) would be \(mf(t) = n(t)\); and the cumulative number of adopters at time \(t\) would be \(MF(t) = N(t)\).
The basic premise of the Bass model could be manipulated along with the definitions just provided to yield the following equation:

\[ n(t) = \frac{\partial N(t)}{\partial t} = \rho [m - N(t)] + \frac{q}{m} N(t)[m - N(t)] \]  

\[ \ldots \ldots \ldots \ldots \ldots \ldots \ldots (2.3) \]

where:

- \( n(t) \) was the non-cumulative number of adopters at time \( t \)
- \( N(t) \) was the cumulative number of adopters at time \( t \)
- \( \rho [m – N(t)] \) represented innovators – those adopters who were not influenced by others
- \( q / m N(t)[m – N(t)] \) represented imitators – adopters who were influenced by innovators

Time \( t = 0; \quad n(0) = \rho m \)

Equation 2.3 of the Bass (1969) model was a first order differential equation, which could be integrated to yield the S-shaped cumulative adopter distribution, \( N(t) \). Once \( N(t) \) was known, further differentiation yielded expressions for the non-cumulative number of adopters, \( n(t) \), and the time (\( T^* \)) and magnitude (\( n(t^*) \) and \( N(t^*) \)) of the peak of the adoption curve (Mahajan et al., 1990)

Mahajan, Muller and Srivastava (1990) argued that adopters termed as innovators in the Bass (1969) model should not be called innovators because they are not necessarily the first adopters of an innovation as defined by Rogers (1962), now in its fifth edition (Rogers, 2003). Following Lekvall and Wahlbin (1973) Mahajan, Muller and Srivastava (1990) suggested that because the Bass (1969) model captured the spread of innovation due to mass media and interpersonal communication channels, the model’s coefficients
\( \rho \) and \( q \) should be referred to as the coefficients of external influence and internal influence, respectively.

Mahajan, Muller and Srivastava (1990) further suggested that because one standard deviation away from the mean of the normal distribution represents its point of inflection as suggested by Rogers (2003) in the earlier edition, the same analytical logic could be used to develop adopter categorization for the Bass (1969) model. This scheme, like that of Rogers (2003), would also yield five adopter categories, with the number of adopters \((\rho m)\) who initiate adoption being defined in the Bass model as innovators.

In their review of the different uses of the Bass (1969) model to analyse adoption decisions, Mahajan, Muller and Bass (1990) observed that the use of the Bass (1969) model forecasting the diffusion of innovations required the estimation of three parameters: the coefficient of external influence \((\rho)\), the coefficient of internal influence \((q)\) and the market potential \((m)\). They observed that although the estimates for the market potential \((m)\) of a new product could be derived from the diffusion time-series data, other application of diffusion models (Teotia and Raju, 1986; Oliver, 1987) obtained better forecasting results by using exogenous sources of information (such as market surveys, secondary data, management judgments or other analytical models) for estimating \(m\).
Mahajan, Muller and Bass (1990) observed that because the Bass (1969) model contained three parameters ($\rho$, $q$ and $m$), adoption data for a minimum of three periods was required to estimate these parameters. However, other empirical studies (Tigert and Farivar, 1981; Srinivasan and Mason, 1986), which have documented estimates of these parameters, pointed out the short-coming that adoption forecasts are sensitive to the number of data points used to estimate them. These concerns led to the development of estimate procedures that update parameter estimates as additional data become available after the initiation of the diffusion process (Mahajan, et al., 1990).

In the 1980s, the most dominant model, which was widely applied in research on the subject of technology adoption and diffusion, was the epidemic model. This model, which marked a slight departure from the Bass model, was so called because, in an epidemic, a disease was spread to healthy individuals by contact with infected ones. As the disease spread, the number of carriers of the disease increased and so did the rate of transmission until the number of healthy individuals who were uninfected became so small that the rate of transmission had to decrease. In the case of technological innovations, what spread and diffused was information about the technology itself (Coombs, Saviotti, & Walsh, 1987).

According to the original epidemic model, the process of adoption and diffusion of technology could be represented by a simple mathematical model (Coombs et al., 1987). If $x(t)$ represented the proportion of potential adopters who had already adopted
at time $t$, then the rate of diffusion was given as $\frac{\partial x(t)}{\partial t}$. The balance of potential adopters was $[1 - x(t)]$. This implied that the rate of diffusion could be expected to be proportional, both to the fraction of adopters $x(t)$ and the fraction of potential adopters left $[1 - x(t)]$, such that:

$$\frac{\partial x(t)}{\partial t} = \beta x(t) \cdot [1 - x(t)] \quad \text{.......................(2.4)}$$

where $\beta$ was a constant.

The differential of equation (2.4) had the following solution:

$$x(t) = \frac{1}{[1 + \exp^{-\beta t}]} \quad \text{.......................... (2.5)}$$

Equation 2.5 is a logistic time curve equation, which is sigmoid or S-shaped such that the rate of adoption and diffusion first increased until a point of inflexion and then decreased as in Figure 2.1.
Cumulative number of adopters who have adopted an innovation $x(t)$

**Figure 2.1 Logistic diffusion curve**

**Source:** Coombs, Saviotti, and Walsh, 1987 p. 122)

In the graphic representation of the logistic curve in Figure 2.1, $a$ is the point at which the diffusion curve begins to rise and $\beta$ is the slope at which the curve rises. When adoption and diffusion data is collected about the times at which each individual or firm in the industry (or sub-sector) has adopted a particular technology, a graph of the Y-axis, $x(t)$, versus time $t$ of the X-axis is constructed. By fitting the logistic equation (2.5) to this data, the best values of $a$ and $\beta$ are found. The meaning of $a$ and $\beta$ can be understood by reference to Figure 2.2, with curves 1, 2 and 3, such that $a$ determines the
Cumulative number of adopters who have adopted an innovation $x(t)$

**Figure 2.2** Effects of an earlier start ($a$) and a faster rate of diffusion ($\beta$) on the shape of the logistic curve.

**Source:** Coombs, Saviotti, and Walsh, 1987, p. 123.

In Figure 2.2, *curve 1* for the first innovation has higher values of both $a$ and $\beta$ than the values of *curves 2* and *3* for the second and third innovations, respectively. When values of $a$ and $\beta$ are determined for different populations of firms, they can be compared and their differences interpreted on the basis of the different characteristics of their populations (Coombs *et al.*, 1987).
One of the criticisms labeled at the epidemic model was that its proponents considered only the demand side of technology adoption. It is this criticism that led to the emergence of an improved version of the epidemic model. Metcalfe (1981) and Cameron and Metcalfe (1987) tried to address the demand-side criticism of the original epidemic model by providing a model with two separate equations: one for the rate of growth of demand, and the other for the rate of growth of supply of the technology. According to Metcalfe (1981) the appearance of a new technology created an adjustment gap, defined by the differences between the equilibrium market demand \( n(p_n, a) \) – that is, the demand that will be reached after the adopting environment had been saturated – and the actual demand at a particular time during the diffusion process \( x_n(t) \). In the Metcalfe (1981) model, the rate of growth of demand for the technology \( t \) was proportional to the adjustment gap, such that:

\[
g_{d}(t) = b[n(p_n, a) - x_n(t)] \tag{2.6}
\]

where:

- \( g_{d}(t) \) was the growth of demand at a particular time during the diffusion process
- \( b \) was the diffusion rate constant
- \( p_n \) was the price of the technology
- \( a \) was the performance level of technology
- \( n(p_n, a) \) was the equilibrium market demand
- \( x_n(t) \) was the actual demand at a particular time during the diffusion process.
One important feature of this model was that the equilibrium market demand \( n(p_n, a) \) depended on both the price \( p_n \) of the technology and, on the performance level of the technology, represented by \( a \) in equation 2.6. This performance level \( a \) represented the advantage the new technology offered over the old one, such that if both product and process technology led to a decrease in \( p_n \) and an increase in \( a \), this should lead to an increase in the equilibrium market demand \( n(p_n, a) \). Post adoption improvements on the technology (such as adaptation of imported technology) had explicitly been introduced into this model.

On the other hand, the rate of growth of supply \( g_s(t) \) was assumed to be proportional to the profitability of the technology for the supplier. This profitability would increase when the price of the technology \( p_n \) increased, but would be negatively affected by increasing costs of all inputs used in the production of the technology, such that:

\[
g_s(t) = \frac{p_n(t) - h_0 - h_1X_n(t)}{k} \quad \text{…………………………(2.7)}
\]

where:

- \( p_n(t) \) was the price of the new technology
- \( h_0, h_1 \) and \( k \) are constants, with \( k \) reflecting the supply of capital funds and investment requirements.

In this model, the price of technology \( p_n \) had opposite effects on demand and supply of the technology. A decrease in \( p_n \) would lead to an increase in the rate of demand of the
technology and its market penetration (diffusion) but the same (decrease in \( p_n \)) would influence negatively the rate of growth of supply of the technology. It was assumed that the rate of growth of demand and supply of the technology would tend to be equal at each point of the diffusion process, thus defining a balanced diffusion path.

When the rate of growth of demand was equated with the rate of growth of supply of the technology, the resultant equation was:

\[ g(t) = B [C_n - X_n(t)] \]  

\[ \text{……………………………….}(2.8) \]

where:

\( g(t) \) was the rate of diffusion

\( B_n \) and \( C_n \) were the parameters formally resembling the diffusion rate constant \( \beta \) and saturation constant \( k \) in the epidemic model

\( X_n(t) \) represented the demand for the technology at time \( t \).

In the Metcalfe (1981) model, parameters \( B_n \) and \( C_n \) were jointly determined by the dynamics of demand and supply, and both could change during the diffusion process, since they were influenced by the performance of the technology. In the same model, the temporary monopoly, which motivated an innovator (pioneer adopter) to introduce a new technology into the market, was represented by the adjustment gap:

\[ C_n - X_n(0) \]

where:

\( X_n(0) \) was the demand for the new technology at the beginning of the diffusion process.
This adjustment gap would have its maximum value for the first innovator (pioneer adopter) and would gradually decrease as more imitators (early adopters who follow the pioneer) entered the market. A decreasing adjustment gap was reflected in a decreasing proportional rate of growth of demand.

In the Metcalfe (1981) model, both in theory and in practice, production costs of an innovation could decrease during the course of diffusion, if there were post-innovation improvements (adaptations), which led to decreasing prices of the technology and to performance improvements. This would be reflected in an increase in the value of $C_n$, the supply of capital funds and investment requirements.

In their study Larker and Lessing (1980) improved on the Bass model’s contribution to the adoption theory by highlighting two distinct factors or dimensions, which influenced the decisions to adopt technology. These were, first, perceived importance, defined as the quality that caused a particular technology to acquire relevance to a decision to adopt; and second, perceived usableness, defined as the degree to which a technology was unambiguous, clear or readable. Further improvements on the Bass model led researchers to develop the technology acceptance model (TAM), which used two key factors (usefulness of technology and ease of use of technology) to explain and determine the user acceptance of a new technology (Davis, 1989)
The technology acceptance model (TAM) provided a framework for identifying factors, which affect user acceptance of technology. TAM’s framework, which had a behavioural analytical bent, traced how exogenous factors influenced belief, attitude and intention to adopt and use a technology. The TAM predicated that when potential technology adopters were presented with a new technology, the main factors that influenced their decision to adopt and use the new technology were *perceived usefulness* (PU) and *perceived ease of use* (PEU) of the new technology.

In the study, Davis (1989) defined perceived usefulness as the degree to which a person believed that using a particular technology enhanced his/her job performance; while perceived ease of use was defined as the degree to which a person believed that using a particular technology would be free from effort (Davis, 1989). The TAM has been continuously studied and upgraded, culminating in the two major upgrades. One of the upgrades was TAM 2, which added *social norms* (SN) to TAM 1’s PU and PEU (Venkatesh & Davis, 2000).

The other upgrade is TAM 3, which, as the sequel improvement of TAM 2, added *facilitating conditions* (FC) to PU, PEU and SN (Cabral, Lucas, & Gordon, 2009; Venkatesh & Bala, 2008). In another study, Venkatesh, Morris, Gordon and Davis (2003) combined multiple models of behaviour adoption, namely, the theory of reasoned action (TRA), the theory of planned behaviour (TPB), and the diffusion of innovation (DOI) theory with TAM 1 and TAM 2, to come up with a unified theory of
acceptance and use of technology (UTAUT) theory (Venkatesh, et al., 2003). Figure 2.3 shows a typical presentation of a technology acceptance model (TAM) as originally presented by (Davis, 1989, 1993).

In Figure 2.3, the TAM hypothesized that a potential adopter’s attitude towards using a technology was a major determinant of the decision to adopt technology. The attitude towards using a technology was in turn a function of two beliefs: perceived usefulness and perceived ease of use. Perceived ease of use had a causal effect on perceived usefulness, and therefore, the two are closely related. The technology design features directly influenced the two beliefs: perceived usefulness and perceived ease of use. It was through the two beliefs that technology design features had indirect effects on the attitude towards using and the actual use behavior of an adopter. In the original
technology acceptance model, ‘attitude towards using a technology’ was defined as the degree of evaluative effects that an individual associates with using a target technology in her/his job (Davis, 1993).

The successful use of TAM encouraged subsequent models of technology adoption to build on theories of behavioural change in their attempt to understand what motivated and influenced the adoption of new technologies (Cabral et al., 2009). As a result, technology literature suggested that the key influences of technology adoption were: perceived usefulness (PU) of the technology; ease of use (EU); social influences, including social norms; moderating influences, such as gender and age; and facilitating conditions, such as resource availability (Cabral et al., 2009). In these studies, a social norm was defined as action that an individual perceived that most people who were important to him/her would support or agree with (Cabral et al., 2009; Venkatesh and Davis, 2000).

While TAM provides a good framework to analyse technology adoption at the individual adopter’s level, the diffusion of innovation (DOI) theory, whose chief proponent is Everett Rogers, is used to analyse technology adoption at both individual and firm adopters’ levels (Oliveira and Martins, 2011). Rogers (2003), in his theory of diffusion of innovation (DOI), sees technology as being communicated through certain channels over time and within a particular social system. In Roger’s model, individual adopters are seen as possessing different degrees of willingness to adopt technology,
and the portion of population adopting technology is approximately normally distributed over time.

Rogers defines technology adoption as the decision to acquire and use an idea, innovation or technology as the preferred course of improving performance. Noting that the rate of technology adoption usually starts low and then accelerates until 50 per cent of potential adopters have adopted and then decelerates, he arbitrarily used two basic parameters of the normal distribution (the mean and the standard deviation) to classify adopters into five categories, namely: innovators, early adopters, early majority, late majority and laggards. Rogers’ classification is presented in Figure 2.4. The rationale behind this classification, Rogers argued, was that one standard deviation away from the mean of the normal distribution represented its point of inflection (Rogers, 2003).

Figure 2.4 Adopter categorisation on the basis of innovativeness

Source: Rogers (2003)

Rogers breaks this normal distribution into segments leading to the apportioning of individual adopters into the following categories (see Fig. 2.4): Innovators – this is a
category of adopters who are technology enthusiasts, venturesome, educated and with multiple information sources; *Early adopters* – this is a category of adopters who are visionary, social leaders, and are normally popular and educated; *Early majority* – this is a category of adopters who are pragmatists, take deliberate decision to adopt, and have many informal social contacts; *Late majority* – this category would normally comprise conservatives or traditionalists, and are of lower social economic status; and finally, the last category of adopters is that of the *laggards*, which comprises adopters who are not only skeptics and depend on neighbours and friends as the main source of information, but they are also fearful of debt (Rogers, 2003).

Rogers’ classification in Figure 2.4 shows a classic adoption curve indicating a small number of individuals adopting the technology early (innovators) constituting the left tail, followed by the imitators who are the majority of adopters. Those who adopt the technology last (laggards) form the right tail (Rogers, 2003).

Finally, in their review of literature on information technology adoption models, Oliveira & Martins (2011) highlighted the technology, organization and environment (TOE) framework, which was a product of a study by Tormatzky and Fleischer that identifies three contexts of an enterprise, which influence the process of technology adoption (Tormatzky & Fleischer, 1990). These are: technological context, organizational context and environmental context. Oliveira & Martins, (2011) were of the view that the TOE framework by Tormatzky and Fleischer provided a better basis
for analyzing technology adoption at a firm level. They argued that unlike Rogers’s DOI, the TOE framework included the environmental context. On the other hand, Davis’s TAM and Venkatesh, Morris, Gordon, & Davis’ UTAUT model provided good frameworks for analyzing technology adoption at individual adopters’ level (Oliveira & Martins, 2011).

2.3 Empirical Literature Review

Early intellectual research tradition on adoption and diffusion of technology was initiated in the late 1920s to early 1940s by anthropologists and sociologists, with a view to understand social change. Studies by Bowers (1937) and (1938) were the first publications of the early sociology tradition to use primary data from respondents, plus secondary data from government records. Bowers set out to determine what factors or influences led to the adoption of ham-radios. To undertake this task, Bowers mailed structured questionnaires to 312 radio owners in the United States. This was the first study to establish that interpersonal contact channels were more important for later adopters than mass media channels, which were more important in influencing the decisions of early adopters (Bowers, 1938; Rogers, 2003)

However, it is the study by Ryan and Gross (1943) of the diffusion of hybrid corn in the USA, more than any other study on adoption of technology, which influenced the methodology, theoretical framework and result interpretations of later researchers. The Ryan and Gross (1943) study was undertaken from 1941 in the Iowa State, with the
objective of establishing what influenced the adoption and diffusion of hybrid corn seed that was introduced to the farmers of Iowa State in 1928. In their findings, all but two farmers in the State had adopted hybrid corn between 1928 and 1941. When plotted cumulatively on a year-by-year basis, the adoption rate formed an S-shaped curve over time. After the first five years (1928 - 1933), only 10 per cent of farmers of the two Iowa communities under the study had adopted hybrid corn. In the next three years (by 1936), the adoption curve “took-off” with the adoption rate increasing to 40 per cent. Thereafter, the rate leveled off as fewer farmers remained to adopt the new innovation.

Despite the fact that, compared to the open-pollinated corn, the hybrid corn was higher yielding, more resistant to drought and better suited to mechanical harvesting, the typical Iowa State farmer moved slowly from awareness-knowledge of the innovation to adoption. The period it took from first awareness to adoption averaged about 9 years for all respondents. The respondents took on average 3-4 years of trial planting on small plots, before deciding to plant 100 per cent of the acreage with hybrid corn varieties.

The study also established that communication channels played different roles at various stages in the adoption process. The typical farmer first heard of hybrid corn from sales agents. This made salesmen the most important channel of communication for early adopters. Neighbours (interpersonal contacts), on the other hand, were the more important channel of communication for later adopters (imitators). Thus, the Ryan and Gross (1943) study findings corroborated the Bowers (1938) study finding, which
showed that interpersonal networks played an important role in the diffusion process. The question that arises is whether the Ryan and Gross (1943) study findings could be of relevance to Kenya today, since the level of mass media penetration in the USA at the time of the study in the 1930s could be comparable to Kenya’s before the later part of the 2010 decade when the cell phone ‘bug’ became infectious? This study’s results should shed some light on the question of the role of the mass media communication channels in the adoption process.

From the 1970s, the marketing diffusion paradigm popularized by the Bass (1969) model, highlighted in earlier in Section 2.2.3, took centre stage. The Bass model and its revised forms were used as a forecast tool of innovation adoption and diffusion in retail service, industrial technology, agricultural, educational, pharmaceutical and consumer durable products markets.

To estimate the diffusion parameters of his model, Bass (1969) suggested the use of the ordinary least squares (OLS) to estimate the diffusion parameters of $\rho$, $q$ and $m$. Mahajan, et al., (1990) pointed out that this procedure involves estimation of parameters by taking the discrete or regression analog of the differential equation formulation of the model in equation 2.3 above, which was:

$$n(t) = \frac{\partial N(t)}{\partial t} = \rho \left[ m - N(t) \right] + \frac{q}{m} \frac{1}{N(t)} \left[ m - N(t) \right]$$
By rearranging the above equation, it yields:

\[
N(t + 1) - N(t) = pm + (q - p)N(t) - \frac{q}{m} N^2(t)n(t + 1)
\]

\[
= \alpha_1 + \alpha_2 N(t) + \alpha_3 N^2(t)
\]

where:

\[
\alpha_1 = pm
\]

\[
\alpha_2 = q - p
\]

\[
\alpha_3 = -\frac{q}{m}
\]

With the equation 2.9, it was possible to use the OLS procedure to estimate \(\alpha_1, \alpha_2, \text{ and } \alpha_3\). Once the \(\alpha\)’s were known, \(p, q\) and \(m\) could be estimated.

However, the Mahajan *et al.* (1990) study put a caveat on the use of the OLS procedure. The study pointed out that the OLS procedure had three shortcomings, which were first highlighted by Schmittlein and Mahajan (1982). These were: First, they argued that because of the likelihood of multicollinearity between independent variables \(N(t)\) and \(N^2(t)\) in equation 2.4, the procedure could yield parameter estimates that were unstable or had wrong signs. Second, the procedure did not directly provide standard errors for the estimated parameters \(p, q\) and \(m\), and hence, the statistical significance of these estimates could not be assessed. Third, there was a time-interval bias because discrete time-series data were used for estimating a continuous model. To overcome these shortcomings, Schmittlein and Mahajan (1982) suggested the use of the maximum
likelihood estimation procedure to estimate the parameters directly from the solution of
the differential equation

While the Mahajan et al. (1990) study supported the use of the maximum
likelihood estimation procedure to estimate the parameters directly from the solution of
the differential equation as suggested by Schmittlein and Mahajan (1982), in their
review they, Mahajan et al. (1990), pointed out that parameter estimation for diffusion
models was primarily of historical interest, since their estimates could not be relied on
to predict the future diffusion process as the Bass (1969) model had claimed to do.

Lawrence and Lawton (1981) studied parameter estimates of the Bass model and found
that \( p + q \) ranged from 0.3 to 0.7 over several innovations. They noted that the first year
sales, \( S_1 \), could be expressed as:

\[
\left\{ \frac{m(1 - e^{-(p+q)})}{1+ (q / p) - e^{-(p+q)}} \right\} \quad \text{...................... 2.10}
\]

and hence, \( q / p \) could be expressed as:

\[
\left\{ \frac{[m(1 - e^{-(p+q)}) - S_1]}{S_1 e^{-(p+q)}} \right\} \quad \text{.............................. 2.11}
\]

Noting that the mean time of adoptions, \( T^* \), was given by\ organa(1 / (p + q)] \ln(q / p)}\,
Lawrence & Lawton (1981)argued that because \( p + q \) varied over a relatively narrow
range and had a mode of 0.5, guesses of \( p + q \), \( m \) and \( S_1 \) could provide good estimates
of \( T^* \), the mean time of adoption.

Notwithstanding the reservations on the shortcomings of using the OLS procedure in
the Bass (1969) model, in their review of several diffusion studies, Mahajan et al.
(1990) observed that in their study Lawrence and Lawton (1981) reported good results using this method. Other researchers applying fifteen different uses of the Bass model had established that the average mass media influence coefficient (p) was 0.03 and the average interpersonal contact influence coefficient (q) was 0.38 (Sultan, Farley, & Lehmann, 1990). However, according to Mark and Poltrock (2001) no one channel of communication is sufficient to facilitate widespread adoption of an innovation. In the USA, a sizeable number of large companies used the Bass model as a market forecast tool. These included Eastman Kodak, RCA, Sears, and AT&T (Mahajan et al., 1990). According to Rogers, the greater influence attached to word-of-mouth communication in the Bass model was consistent with universal research findings in diffusion research studies which show that innovation diffusion was essentially a social process occurring through interpersonal networks (Rogers, 2003).

During the 1970s and 1980s, studies of technology adoption using the epidemic model, also highlighted in Section 2.2.3, took centre stage. According to Coombs, et al. (1987), a number of epidemic model studies (Metcalf, 1970; Nabsenth & Ray, 1974) had established the following common observations. First, in general, technology adoption and diffusion curves were S-shaped, and that a logistic curve would best explain the spread of innovations. Second, the variables influencing the rate of adoption were divided into those related to the adopters and those related to the innovations/technologies. Third, among the variables related to the adopter, firm size was often the most important, with the rate of growth of the industry and quality of
management also influencing the rate of adoption and diffusion. Fourth, among the variables on the technology side, level of output (profitability) and the cost of the technology were the most important in influencing the rate of diffusion (Coombs et al., 1987).

Critics of the epidemic model pointed out deficiencies in the original epidemic model. For example, they point out that the model assumed that the adopters’ environment was homogeneous, distributed among pioneers, early imitators, early majority, late majority and laggards in deterministic proportions as envisaged by Rogers (2003) [see Fig. 2.4 in Section 2.2.3 above]. This, critics pointed out, was a very unrealistic assumption. The other criticism labeled at the epidemic model was that its proponents only considered the demand side of technology adoption. It is the second criticism that led to the emergence of an improvement of the original epidemic model by Metcalfe (1981) and Cameron and Metcalfe (1987) as highlighted in Section 2.2.3.

In the modified epidemic model Metcalfe (1981) took care, both in theory and in practice, of the possibility of the production costs of an innovation decreasing during the course of diffusion, if there were post-innovation improvements (adaptations), which led to decreasing prices of the technology and to performance improvements. These post-innovation improvements would be reflected in an increase in the supply of capital funds and investment requirements for increased production the technology.
Most of the research studies based on the modified epidemic model, supported earlier diffusion studies’ (Ryan & Gross, 1943; Griliches, 1957; Rogers, 1958; Mansfield, 1969) findings that, in general, diffusion curves were S-shaped and that a logistic curve would best explain the spread of innovations.

An alternative approach was used by Rahm and Huffman (1984) to study technology adoption in agriculture. Rahm and Huffman (1984) adopted the random utility model. The Rahm and Huffman (1984) model assumed that the decision by the farmers to acquire new technology was guided by the objective of maximising utility. In the Rahm and Huffman model (1984), the technology index was represented by $t$, where $t$ was equal to 1 for old technology and 2 for new or other technology. The utility function that ranked the $i^{th}$ firm’s preference for the technology in use was represented by $U(R_{it}, A_{it})$. In this representation, utility depended on a vector $R_t$ of moments that described the distribution of net returns for technology $t$, including the cost of adoption. The vector $A_t$ represented other attributes associated with technology.

According to Rahm and Huffman (1984), the variables $R_{it}$ and $A_{it}$ were not observable and unavailable, but a linear relationship was postulated for the $i^{th}$ enterprise between the utility derived from the $t^{th}$ technology and a vector of observed technology-specific characteristics $X_i$ and a zero mean disturbance term $e_t$. Thus,

$$ Ut_i = X_i \alpha_t + e_{it} \quad \text{................................................................. (2.12)} $$

where $t = 1, 2; \quad i = 1\ldots, n.$
In the Rahm and Huffman (1984) model, farm operators were assumed to choose from the technology that gave them the largest utility, such that the $i^{th}$ firm adopted the new technology if $U_{2i} > U_{1i}.$

The other model to be massively used to analyse adoption and use of information technology is the technology acceptance model (TAM), whose chief proponent is Davis (1989). Davis (1989) borrowed tools from Fishbein and Ajzen (1975) attitude theory of psychology to come up with the TAM that provided an analytical framework for identifying factors that influenced user acceptance of new technology. In Davis’s framework, attitude theory from psychology provided a rationale for the flow of the causality from technology features through perceptions to attitude and finally to usage (Davis, 1989). In his study Davis (1989) had used TAM in two studies (one field and the other laboratory) to establish the relationship between perceived usefulness and perceived ease-to-use variables in user acceptance (adoption and use) of information technology. The impact of perceived usefulness on technology utilization had been suggested by earlier studies, including that of Robey (1979).

In both field and lab studies, Davis (1989) established that both variables were important determinants of user acceptance, but that the usefulness of a technology variable was more strongly linked to user acceptance than the ease of use variable. Noting that some users were often willing to cope with some difficulty of use in a technology that provided critically needed functionality, the Davis (1989) study’s major
conclusion was that perceived ease of use and perceived usefulness were strong correlates of user acceptance and should not be ignored by those attempting to design or implement successful technology systems. Follow up studies by Davis, Bagozzi, and Warshaw (1989); Davis (1993); Venkatesh and Davis (2000); and Meso, Musa, and Mbarika (2005); Park (2009) got similar results that corroborated those of Davis (1993).

For future research on information systems and information technology usage, Davis (1989) recommended that researchers should address other variables, which affect usefulness, ease of use and user acceptance, which this study attempted to do, with specific reference to the informal sector in Kenya.

A meta analysis of 88 studies found TAM to be a valid and robust model (Cabral et al., 2009). TAM1’s two measures (perceived usefulness and perceived ease of use) were found to correlate strongly with behavioural intentions, although this varied with circumstances. In TAM2, social influences, like voluntariness and self-image, were found to have influences on the adopter’s attitude towards the perceived usefulness and ease of use of a technology. In addition, facilitating conditions, such as locally available resources, directly influences user behavior (Cabral et al., 2009). However, a number of studies (Caviglia, 2001; Munnukka, 2007) focused on human characteristics (such as age, gender and education) as the determinants of the decision to adopt technology.

Rogers (2003), who is the acknowledged father of diffusion of innovation (DOI) theory from the 1950s (Rogers, 1958), sees technology as being communicated through certain
channels over time and within a particular social system. Rogers (2003) identified five characteristics by which a technology could be described and showed how individuals’ perception of these characteristics was used to predict the rate of adoption of technology. Rogers defined rate of adoption as the relative speed with which members of a social system adopted a technology. This rate of adoption was generally measured as the number of individuals (or firms) who adopt a new idea/technology in a specific period. According to Rogers, 47-87 per cent of the variance in the rate of adoption was explained by five attributes, namely: Relative advantage – the degree to which a technology was perceived as being better than the one it sought to supplant; Compatibility – the degree to which an innovation or technology was perceived as consistent with the existing values, past experiences and needs of potential adopters; Complexity – the degree to which technology was perceived as relatively difficult to understand and use; Trialability – the degree to which technology was available and could be experimented with on limited basis; Observability – the degree to which the results of the use of a technology were visible to others.

Further, according to Rogers (2003) the rest of the variance (51-23 per cent) that could not be explained by the five attributes of technology highlighted in the previous paragraph, could be explained by four other variables that also influenced the decision to adopt technology. First, was the type of technology-decision – that is, whether the decision to adopt was an individual adopter’s decision, or whether it was a collective decision, such as that of a cooperative society, or a local authority decision, or a central
government agency decision. Rogers observed that individuals made decisions to adopt faster than groups or organisations. Thus, the greater the number of persons involved in making a technology adoption decision, the slower the rate of adoption would be. Second, was the communication channels used to acquire information about the technology, which also influenced the rate of adoption. Two communication channels, mass media and interpersonal contacts, were considered the most commonly used to get information or create awareness–knowledge, which influences the rate of adoption of technology. Third, was the nature of the social system such as societal norms (cultural practices), degree of network interconnectedness and so forth, which also influenced the rate of adoption of technology. Finally, the extent of change agents’ promotional efforts, such as the activities of sales/marketing operatives to popularise the technology, would influence the rate of adoption (Rogers, 2003).

Other studies such as that of Caviglia & Kahn (2001) used diffusion of innovation theory (DOI) to study technology diffusion for sustainable agriculture in the Brazilian tropical rain forest. They used discrete choice analysis to provide evidence to support Rogers’ contention that availability of information to adopters, and the level of education and experience of prospective adopters, were better determinants of adoption of new technology/practices than income.

Diffusion of innovation (DOI) theory is also used by Pickett-Baker (2011) as a theoretical framework to explore the drivers and barriers to the domestic adoption of
renewable heat and energy technologies in the United Kingdom (UK). Pickett-Baker observed that renewable energy technologies, suitable for domestic adoption, had existed for many years, but had not yet moved beyond the innovators and early adopters in the UK. Adoption had been confined to environmentally active consumer groups (Pickett-Baker, 2011). Pickett-Baker’s study found that the influence of environmental attitudes of potential adopters could cause adoption behavior, which is inconsistent with indicators of innovations. Pickett-Baker’s study, therefore, concluded that the calculated formation of a pertinent felt need, or problem, in potential adopters, who do not have an environmentalist predisposition, is necessary to drive the adoption of renewable energy. This is where external pressure in form of government activism is necessary to ‘nudge’ in potential adopters to adopt (Pickett-Baker, 2011).

In their literature review of information technology, Oliveira and Martins (2011) highlighted the Tornitzky and Fleischer (1990) study, which used the technology, organization and environment (TOE) framework to identify three aspects that influence technology adoption, namely: the technological aspect, organizational aspect and environmental aspect. It is the environmental aspect of influence that brings out the marked difference between Rogers’s DOI and the TOE framework when used to analyse the main factors that influenced technology adoption by firms.

In their study of the electronic billing industry in developed economies, Au, Kauffman and Riggins (2006) used the rational expectation theory of technology adoption to
conclude that in cases of cluster adoption, firms, due to network externalities, would be influenced by their geographical location, their reach of consumer bases, their industry sector associations and their consensus choices of the technology vendor.

A number of studies (Caviglia & Kahn, 2001; Munnukka, 2007) focused on human characteristics as the determinants of the decision to adopt technology. In their studies, the level of education was found to be an important factor in the decision to adopt technology. A number of other studies showed that education, especially at higher levels of formal education, was associated with the increase in the probability to adopt and use technology (Rogers and Shoemaker, 1971; Mullen and Lyle, 1994; Akwara, 1996; Kohler, Behrman and Watkison, 2001; Meso, Musa and Mbarika, 2005).

Other studies also showed that the age of a potential adopter influenced the decision to adopt (Appelbaum, 1990; Agarwal and Karahanna, 2000; Munnukka, 2007). Learning theory posits that younger people are more willing and eager to acquire and learn new ways/methods of performing tasks than older people (Appelbaum, 1990; Agarwal and Karahanna, 2000). According to learning theory, the expectation is that more individuals of the youth age group are more likely to adopt new technology, which involves learning new ways/methods of performing tasks, than the individuals in the elderly age group (Appelbaum, 1990; Munnukka, 2007).
Technology adoption studies elsewhere have also indicated that gender was a factor of influence on technology adoption. In their study of IT technology adoption and use in the work place, Venkatesh & Morris (2000b) used the theory of planned behavior (TPB) to arrive at the conclusion that when compared to women decisions, men decisions were more strongly influenced by their attitude towards using new IT technology. By contrast the women were more strongly influenced by subjective norm and behavioural control. According to their study, these findings were robust across income, organization position, education and computer self-efficacy levels. Other studies (Venkatesh and Morris, 2000; Munnukka, 2007), supported the proposition that the sex of an adopter influence the decision to adopt and use technology.

Rogers (2003) showed that one’s social status in society influenced the decision to adopt technology. According to Rogers, opinion leadership is earned and maintained by the individual’s technical competence, social accessibility and conformity to the social norms of society. Rogers defined social norms as established behavior patterns for members of society (Rogers, 2003). According to Rogers, established behaviour, for opinion leaders, should in most cases include taking the lead to adopt new technology. Thereafter, interpersonal contacts take-over to influence technology adoption.

Other studies showed that perceived conferment of higher social status to the adopter was a technology-specific characteristic that influence technology adoption (Rogers, 2003; Fine, 2001; Mohan and Mohan, 2002; Molony, 2006). This variable was
supposed to take care of several types of adopters. First, were the adopters who got the idea to adopt technology because their predecessors had acquired higher status due to the income earned from the technology they adopted. These were imitator adopters who sought to acquire similar social status by adopting the technology (Rogers, 2003). Second, were the adopters who were previously unemployed, but were now identified with ownership of an income generating asset (Molony, 2006). Third, were adopters whose names were associated with the naming of the area where the technology was located. Thus, adoption of technology was suppose to confer social capital to the owner, particularly so in the informal sector (Fine, 2001; Mohan and Mohan, 2002; Molony, 2006).

Some of the latest empirical studies on technology adoption have shifted attention from technology adoption to the problem of technology under-utilization (Morris & Venkatesh, 2010; Venkatesh and Goyal, 2010). Low level use of technology that has been adopted has been suggested as one of the causes of the so-called “productivity paradox” of information technology. The productivity paradox (also known as the Solow computer paradox) was first highlighted by Solow (1987) and popularized by Brynjolfsson (1993). The productivity paradox is defined as the discrepancy between measures of investment in information technology and measures of output at national level (Wetherbe, Turban, Leidner and McLean, 2007).
The failure of massive investments in information technology to boost productivity growth during the period between 1970 and 1995 has become known as the productivity paradox. Until the advent and widespread use of information technology, it was widely believed that office automation boosted labour productivity or total factor productivity (TFP). However, over a quarter of a century from early 1970s to mid-1990s, during which period there was very rapid growth of computer adoption and usage, there was a massive slowdown in the productivity growth in the USA and other developed economies. This led Robert Solow, a Nobel Laureate in Economics, to observe that “you can see the computer age everywhere but in the productivity statistics” (Solow, 1987 p. 36). Solow’s quotation generated a flurry of research studies on productivity of information technology in the USA.

A study by Loveman (1988) showed that while firms were demonstrating a voracious appetite for a rapidly-improving IT, measured productivity gains were insignificant. The study by Barua, Kriebel and Mukhopadhyay (1991) traced the causal chain a step back by looking at the IT’s effect on intermediate variables, such as capacity utilization, inventory turn-over, quality, relative price and new products introduction. The study found that IT was positively related to three of these five intermediate measures of performance, although the magnitude of the effect was generally too small to measurably affect the return on assets or market shares (Barua et al., 1991).
According to Roach (1989) and (1991), before 1970, the service sector productivity growth was comparable with that in manufacturing, but after 1970, the two trends diverged significantly. Roach pointed out that, notwithstanding the massive investment in IT during the period between 1970 and 1986, output per factory blue-collar production worker grew by 16.9 per cent, while output per information technology (white-collar) worker decreased by 6.6 per cent, during the same period. Roach further pointed out that IT was an effectively used substitute for labour in most manufacturing industries, but had paradoxically been associated with bloating white-collar employment in services, especially so in the financial services (Roach, 1989, 1991).

It would appear that the time lag between the introduction of a new technology and the attainment of a critical mass of 50 per cent penetration (diffusion) rate of IT is partly to explain for the low levels of productivity growth in the USA up to 1995 (Franke, 1987; David, 1990; Brynjolfsson, 1993). The consensus view is that the USA computer use reached 50 per cent penetration around 2000 (Baily and Lawrence, 2001; Brynjolfsson and Hitt, 2003). This view is supported by the fact that productivity growth in the USA increased from an annual average of 1.4 per cent during the 1975 – 1995 period, to 2.9 per cent per annum in 1996, and by 2000, the rate of increase had reached an average of 5.2 per cent per annum (Brynjolfsson and Hitt, 2003). The USA’s experience of lack of IT productivity growth during the period 1970 - 1995, just as was the case with the introduction of electricity from 1880s to 1920s, should be a pointer to what to expect of
the adoption of new technology in Kenya’s informal sector – the need to attain a critical mass of diffusion of a new technology before its effects can be felt in the economy.

Simillie (2000), citing Schumacher (1973), argued that technology from developed countries has evolved over several generations along with a vast array of support services like modern transport, accountancy, marketing and so forth, which are lacking in most parts of the developing countries. Schumacher (1973), further pointed out that technology from developed economies was designed primarily for the purpose of saving labour, and therefore, is inappropriate for use in developing countries with chronic unemployment. Schumacher’s arguments are very relevant to technology imports used in Kenya’s informal sector.

Most empirical studies in Africa on technology adoption using econometric models often related the decision to adopt technology to households and technological characteristics. Many of these studies have established that the constraints imposed by household characteristics (factors used to profile individuals in a household) and technology-specific characteristics are some of the factors that impede technology adoption (Umali and and L. Schwartz, 1994). Studies by agricultural economists in West African countries established that adoption of new technology was heavily influenced by subjective preferences. A study by Adenisa (1995), for example, found that adoption of imported sorghum varieties in Burkina Faso was influenced by perception of quality for making a local porridge, while in Guinea, improved sorghum
varieties were adopted by the perception of ease of cooking. Another study in Eastern Africa by Benin, Pender and Ehui, (2003) showed that the household and technological characteristics influenced awareness of potential adopters, management practices, and availability, costs, benefits and risks associated with different technologies.

In Kenya, earlier studies on technology adoption concentrated on issues pertaining to technology transfer only without assessing the effects of local modifications of imported technology on the adoption and assimilation process of adapted technology in Kenya’s economic and cultural environment (Kaplinsky, 1977; Conghlin and Ikiara, 1988; Juma and Kirima, 1993). Many studies have highlighted a number of major constraints to sustainable growth of MSEs in Kenya (Parker & Torres, 1993; Mwaura, 1994; Nelson and Mwaura, 1997; Dondo, 1997), but only a few have highlighted technology-in-use as one of the bottlenecks to growth of MSEs. One of the studies by Fisher (1998) highlighted improper use and inappropriateness of technology as a major factor limiting growth of MSEs. Other studies, which highlighted technology related constraints, include Kaplinsky (1977, Conghlin and Ikiara, (1988), King and Abuodha (1991), Juma and Kirima (1993) and Havers (1998). However, none of these studies has examined the effects of adaptation of imported technology on the adoption of technology used by entrepreneurs of micro and small enterprises in the informal sector.

A number of the studies on technology adoption in Kenya highlighted technology specific factors and human characteristics as playing a key role in the technology
adoption of mobile ICT (Meso et al., 2005), technology adoption in agriculture (Mburu, Wakhungu and Gitu, 2007) and technology adoption of mobile and agency banking services (Ngang’a & Mwachofi, 2013). However, none of these studies had examined how the technology specific factors and human characteristics influence the adoption of adapted imported technology by entrepreneurs of micro and small enterprises in the informal sector.

A number of studies in Kenya show that peer effects on technology adoption are sometimes cited as the rationale for temporary subsidy that could generate long-term effects on adoption (Miguel and Kremer, 2004; Kremer and Miguel, 2006). This would entail providing a subsidy to a small number of pioneer adopters, whom others (imitators) would learn from to ensure wide-spread long-run adoption of technology (Kremer and Miguel, 2006).

Another study in Kenya by Nyangena (2004) used a learning model incorporating social capital as a fixed input, to establish that learning effects from other farmers (interpersonal contacts) significantly influenced adoption behaviour. Another study by Meso et al. (2005) of mobile ICT in Nigeria and Kenya used TAM to show that some of the factors used to profile individuals (such as education level, age, gender, cultural influences and technology characteristics) were important factors of technology adoption. Another study done in Kenya by Mburu et al. (2007) to establish determinants
of smallholder dairy farmers’ decisions to adopt certain marketing channels corroborated the Benin et al. (2003) and Meso et al. (2005) studies’ findings.

This literature review would be incomplete if it did not take into consideration Pacey’s (1996) caution. Pacey (1996) took a deem view of intellectuals who, when discussing technology adoption and diffusion, concentrated only on the technical aspects of technology (knowledge, skills and techniques; tools, machines, chemicals and live-ware; resources, products and waste). Pacey contended that technology adoption and diffusion were heavily influenced by cultural aspects (societal goals, values, ethical codes, beliefs; awareness and creativity; users’ and consumers’ activities; and trade union activity). For example, employee attitudes towards, and acceptance of new technology had long been recognised as major factors in new technology’s successful adoption and diffusion. The more receptive employees were towards a new technology, the more willing they were to change their long standing practices and integrate new ones in their day-to-day work activities (Pacey, 1996). In their studies, Krugman (1994) and Succi and Walter (1999) concurred with Pacey on the influence of cultural and intangible factors (such as organisational aspects) on adoption and diffusion of technology.

In line with Pacey’s caution, Ng’ang’a and Mwachofi (2013) undertook a study that looked at the problem faced by promoters of mobile and agency banking technology when promoting its adoption and diffusion in the Karatina and Likuyani districts of
Kenya. Their study integrated TAM’s *perceived usefulness* and *perceived ease of use* variables with four additional variables (resource-based factors; training; skills and knowledge; attitude and *culture*) to investigate adoption of technology in mobile and agency banking. The study found that although a variety of mobile and agency banking services were on offer, only a very small portion of customers, who access them, actually used them. The study established that the main challenges to adoption of mobile and agency banking technology in Karatina and Likuyani districts were caused by internal and external factors to micro and small enterprises (MSEs) potential adopters. The factors were cost related, compatibility, lack of institutional pressure, competition between adopters, *culture* related, inadequate resources, inadequate relevant training, skills, knowledge and attitudinal factors. The study recommended that internal factors to MSEs should be addressed through awareness creation, training, improving MSE capability, while for external factors, the study recommended that they should be addressed through policy framework, improved IT and telecommunication infrastructure, integrated and persistent institutional pressure and availing requisite human and financial capital and other resources that would support early MSE adopters. Much as the study included *culture* as one of the four added variables, the study findings did not indicate how culture related factors influence adoption by MSE entrepreneurs.

The conclusion one can draw from Pacey’s caution, is that technology imported from one social setting into a completely different one would lack the cultural base, and
organisational structures, institutions and activities that are necessary to enhance the rate of adoption and diffusion of the imported technology into a new social setting. Adaptation of technology from a different social setting is meant to facilitate faster adoption. For example, the agency banking model, which was imported from Brazil into Kenya by the Equity Bank of Kenya, lacked an equivalent unique Brazilian cultural background in Kenya. There was, therefore, a need to adapt the imported mobile and agency banking technology to suit the local environment of Kenya’s MSEs. This should not be that difficult with the current relatively high level of mobile phone technology adoption in Kenya.

This study embraced the caution in Pacey’s (1996) study and followed the lead of the Ngang’a and Mwachofi (2013) study of integrating TAM’s two variables with other variables, which are relevant to Kenya’s informal sector.

2.4 Overview of Literature

Much as the Bass(1969) model was popular for its predictive capabilities, its relevance to this study is questionable. It is not the intention of this study to resurrect the old perennial debate on the Problem of Induction, which was first highlighted by David Hume in the eighteenth century, and with the introduction of the study of Econometrics in the first half of the 20th century, debated vigorously as to whether inductive evidence can go beyond the available evidence in order to predict future events (Hume, 1975;
Keynes, 1921, 1939). Not only does such a debate raise the question of relevance of the model and reliability of results, but it puts into question the wisdom of collecting empirical data and inductively using the Bass-type model to predict the number of future adoptions of a new technology (Pheby, 1988). According to Au et al. (2006), based on the rational expectations theory of technology adoption, decision makers should not base their decisions of adoption on the results of the past beyond the point where past information serves as an input for forming expectations about the future. Despite modern advances in the use of econometric tools of analysis for prediction, econometric models still cannot really tell us what is going to happen in the future. However, econometric models can use the available information to make the best (others say the most scientific) guess possible, by giving an estimate. Even then, an estimate is still a guess (Halcoussis, 2005).

For this study, the Bass model was considered less likely to produce satisfactory results when applied to the informal sector in Kenya where access to the mass media communication channel, so critical to the Bass model’s pioneer adopters, is either difficult or at best rudimentary. The Bass model also relies on the OLS regression as the procedure of estimation, which has since the 1960s been replaced by the logistic regression when dealing with dichotomous outcomes such as those of this study.

Further, given that the decision to adopt technology in the informal sector is individual-specific in terms of access to information, all potential adopters do not have the same
probability of adopting the technology in a given time period. In any case, given the heterogeneity of individual characteristics among potential adopters in the informal sector (in terms of their income, education levels, information access and the motivation behind adopting the technology at any one time), it would be very challenging, if not impossible, to develop the adoption curve at the aggregate market level.

In addition to some of the Bass model shortcomings, which were highlighted by the Mahajan, Muller and Bass (1990) study (for example, the unsuitability of using the OLS regression procedure), without radically modifying the Bass model assumptions, it would be difficult to apply the Bass model to Kenya’s informal sector, where the need to incorporate informal sector specific elements (such as the low income base of potential adopters and their incapacity to access formal financial markets) in the model would mean there is a likelihood of the regression model incorporating more discrete than continuous independent variables. In any case, such modification of assumptions would in turn raise the usual vexed questions about the validity of measurement tools.

Finally, as Mahajan, et al. (1990) pointed out, because the Bass model contains three parameters ($\rho$ – coefficient of mass media influence, $q$ – coefficient of interpersonal influence and $m$ – an index of market potential), adoption data for a minimum of three time periods are required to estimate the three parameters. This study used one-time period cross-section data. It would, therefore, be inappropriate to apply the Bass model to this study’s data set.
However, it is necessary to put a caveat on the critique of the Bass model on the basis of scanty data or the limited access of mass media and interpersonal contact communication channels in the informal sector. The introduction and rapid diffusion of mobile phones has dramatically increased their use as mass media and interpersonal contact communication channels in the informal sector to the extent that mobile phones use will, over time, most likely play the leading role in accessing information and improvement in interpersonal contact communications in the future technology adoption decisions in the informal sector. This should facilitate data collection for future studies.

When it comes to the epidemic model, on the other hand, criticism is leveled at two of the assumptions of the model: profit maximisation as the investment motivation and the prevalence of perfect free market conditions. For example, in the informal sector in Kenya, not only do the adopters differ in the motivations for investing (profit maximization is only one of the factors that motivates technology adoption, and not necessarily the most important), but also the varying unfavourable environment in which the entrepreneurs operate the technology affects profitability. It should be pointed out that profit maximization as an incentive has yet to be fully grounded in the informal sector culture of production, distribution and consumption in Kenya’s informal sector. This is due to the fact that the subsistence mode of production and distribution, to a large extent, still inspires and guides the informal sector’s production, distribution and consumption relations.
Second, the epidemic model is static, as it assumes that the population of potential adopters and diffusing technologies are the same at the beginning as at the end of the diffusion period. However, in Kenya, with the frequent collapse of MSEs, potential adopters change and some technologies undergo modifications (adaptations) to suit the adopters’ environment during the diffusion process. Third, even when the modified epidemic models of Metcalfe (1981) and Cameron and Metcalfe (1987) took into account the supply side of technology, the assumption was that market forces were fully at play in both the demand and supply markets of technology. In Kenya’s informal sector, market determinism is limited by the interventionist activities of the government and donor agencies when it comes to availability of easy access to and cost of the adapted technology.

The other problem with the Metcalfe (1981) model when applied to this study is that it assumed one large supplier of the technology, which was being adopted. It is very difficult to extend this assumption to the Jua Kali sector suppliers of technology in the informal sector in Kenya, since they are so numerous and produce non-standard technology serving the same purpose for the MSE adopters. As a result, the rate of diffusion $g_s(t)$ in Metcalfe’s model could not be assumed to be proportional to the profitability of the technology to the supplier(s).
While the earlier rural sociology studies on technology adoption Griliches (1957) and Mansfield (1963) placed primary emphasis on *profitability* in explaining different rates of adoption, later studies emphasized the role played by opinion leaders (Katz, Levin, and Hamilton, 1963), education and information (Rogers and Shoemaker, 1971). Other studies, Davis (1989), (1993) and Rogers (2003) have emphasized subjective factors such as potential adopter’s attitude as well as utility maximization (Rahm and Huffman, 1984) and the entrepreneurs’ desire to enhance social status in society, especially opinion leaders who seek role model status (Rogers, 2003). This study is partial to some of the latter’s (Rahm and Huffman, 1984; Davis, 1989; Rogers, 2003) approaches.

The technology acceptance model (TAM) and its hybrids are the latest models to be massively used to analyse adoption, particularly, of information technology. These models emphasise two variables: perceived usefulness and perceived ease of use of technology. However when put to the test during this study’s pilot testing of the questionnaire as to what their influence was in the choice between the two technologies $t_1$ (non-adapted) and $t_2$ (adapted), the two variables were equally unanimously supported as important in influencing the decision to adopt both types of technologies. Thus, on their own, the two variables could not be relied on by this study to provide the difference necessary for a choice between the adapted and non-adapted technologies. The Ngang’a and Mwachofi (2013) study had to add four other variables to TAM in order for them to analyse factors that impede MSE adopters’ use of mobile and agency banking technology.
While in agriculture numerous studies have supported the hypothesis that investments in education and extension services enhanced allocative skills, including the choice of which technology to adopt (Huffman, 1977; Rahm and Huffman, 1984) it would appear that the findings of these studies have put less emphasis on *profitability* as the primary motivation for adoption of new innovations. In their analysis, these studies have relied on micro data information about adoption behaviour at the enterprise level to come up with their findings. Information about individual entrepreneur characteristics (sex, age, marital status of adopter), human capital (level of education, experience, health) and other entrepreneur motivations (desire to enhance social status in society, and one’s social responsibility of providing a service to society – like a leader setting up a maize mill in a village whose enterprise location becomes a locus for giving direction to strangers) have been found to be important variables in influencing the decision to adopt a new innovation.

A good example of the studies that de-emphasize profitability as the prime motivation for technology adoption is the Rahm and Huffman (1984) study, which assumed that innovation adoption decisions by farmers are based on the objective of maximizing utility. This approach is relevant to informal sector economic activities in Kenya, where the profit motivation is less emphasized, partly due to the dominance of subsistence production and consumption and due to the environment, particularly, cultural norms.
2.5 Conceptual Framework

2.5.1 Introduction

This section presents the conceptual framework of the study, which is based on the utility maximization theory of the adopter, as per the Rahm and Huffman (1984) model.

2.5.2 The Technology Adoption Process

The study assumed that the decision by the entrepreneur to adopt and use technology had already been made. Therefore, the study’s focus was on the adoption choice between two types of technology: imported non-adapted technology and locally produced adapted technology. Specifically, the study’s focus was on the prediction of a dichotomous choice by the entrepreneur in Kenya’s informal sector between the adoption of imported non-adapted technology $t_1$, and the adoption of locally produced adapted technology $t_2$. The choice between the two was guided by the entrepreneur’s characteristics and his or her motivation. The choice of technology would also depend on perceived attributes of technology that influence the entrepreneur’s decision to adopt the technology.

Both economic theory and the theory of micro and small enterprises and research findings from earlier studies informed this study to come up with the a priori identified technology-specific attributes, human attributes and communication channels as the factors that were postulated as having influence on the decision to adopt technology.
The technology-specific factors were: perceived usefulness of the technology (PUT), perceived ease of use of the technology (PEUT), perceived reliability of machine (PRM) and the cost of machine (CM). Others were machine’s servicing and maintenance cost (MMC); machine’s average production/output capacity (MAPO); number of employees required to operate the machine (L); cost of labour employed to operate the machine – wage bill (W); cost of energy used to operate the machine (CE); machine’s perceived suitability to the local environment (MPSLE); perceived conferment of higher social status (in the local community) to the owner (PCHSSO).

Studies, such as Caviglia and Kahn (2001), and Munnukka (2007) suggested that age, gender and education were some of the human characteristics that are good predictors of adoption. Human characteristics were expected to increase the probability of entrepreneurs making the decisions to adopt technology, since some of them, such as the level of education and or training, helped adopters to use the technology they adopted efficiently. Therefore, the study’s a priori identified human characteristics that were postulated as having influence on the decision to adopt technology were: age (A), sex (S), level of education (LEd), marital status of the entrepreneur/adopter (MSE), perceived gender-related cultural practices (PGCP) that influence decision to adopt, and the entrepreneur’s social status in the local community (ESSLC).

According to Mark and Poltrock (2001) no one channel of communication is sufficient to facilitate widespread adoption of an innovation. They argued that potential adopters
may hear about an innovation through the mass media channel, but pursue it only after being introduced or familiarized to it through interpersonal contacts with acquaintances. Thus, the other major factor that this study postulated as having influence on the decision to adopt technology was the communication channel (COCH) used to disseminate information about the technology. The most important variants of communication channels that influence the decision to adopt technology were: mass media communication channel (MMCC), interpersonal contact communication channel (ICCC) and the promotional activities of sales agents (PASA) channel.
CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter deals with the research design, model specification and estimation, definition and specification of variables, cross-section data properties and data analysis techniques.

3.2 Research Design

The study adopted the cross-section design. Both quantitative and qualitative data were collected and analysed. Cross-section data was collected from the administrative wards of the urban sub-counties of Nairobi and Kisumu counties, and the locations in the rural sub-counties of Nyeri North (Kieni) and Nyeri South (Othaya). To avoid overstretched the recall capabilities of respondents (since few, if any, kept records), only entrepreneurs who had adopted technology after the launch of the MDGs in 2000 were included in the sample.

The study made use of two of the most important technology adoption determinants in the TAM model: the perceived usefulness and perceived ease of use of the technology factors (Davis, 1989, 1993; Park, 2009; Venkatesh and Davis, 2000). From the Bass (1969) model and Rogers (2003) studies, the study borrowed the communication factor variables. From Meso et al. (2005) the study picked the reliability of the technology
factor. From the epidemic model (Metcalfe, 1970; Ray, 1979), the study borrowed *cost of technology* and technology’s *level of output* factors. Finally, using the economic theory of micro and small enterprises, the study incorporated technology adoption factors that were considered specific to the informal sector.

3.3 Model Specification

As a basis for the study’s theoretical framework, the random utility model adopted by Rahm and Huffman (1984) was modified to fit the purpose of this study. In this study, it was assumed that the decision to adopt technology by an MSE entrepreneur in the informal sector was guided by a utility maximization objective, such that the utility derived from adoption of locally produced adapted technology, $t_2$, was greater than the utility derived from adoption of imported non-adapted technology, $t_1$. Thus

$$U_{t_2i} > U_{t_1i}$$

As was the case in the Rahm and Huffman (1984) model, the utility function ranking the $t^{th}$ entrepreneur’s preference to available technology is presented as

$$U(R_{tj}; A_{tji})$$

where

- $U =$ utility, which depends on a vector $R_{tji}$ of moments that describe the distribution of net returns for technology $t_j$
- $A_{tji} =$ vector of other attributes associated with the technology $t_j$
- $t_j =$ type of technology
- $i =$ the firm which or entrepreneur who adopts technology
Like was the case in the Rahm and Huffman (1984) model, in this study the variables $R_{ti}$ and $A_{ti}$ are not observable and are unavailable, but a linear relationship is postulated for the $i^{th}$ enterprise between the utility derived from the $t_j$ technology and a vector of observed technology-specific characteristics $X_i$, and a zero mean disturbance term $e_t$.

In this study, given the factors that were postulated as having influence on the decision to adopt technology, vector $X_i$ represented the technology-specific characteristics, human characteristics and communication channel(s) that were postulated as having influence on the decision to adopt technology $t_i$, such that if $U_{t2i} > U_{t1i}$, then

$$U_{t2i} = U(X_{t2i}) + e_{t2i}$$

(3.1)

Where: $t_j = 1$ (non adapted), $2$ (adapted); $i = 1, 2, 3, \ldots n$; $e$ = error term

The human characteristics of MSE entrepreneurs highlighted above are assumed to influence the choice of the technology that gives them the highest utility. Therefore the $i^{th}$ enterprise’s owner adopts the locally produced adapted technology if $U_{t2i}$ exceeds $U_{t1i}$. The quantitative variable $Q_i$ indexed the adoption decision, such that:

$$Q_i = 1 \text{ if } U_{t2i} > U_{t1i} \text{; and } Q_i = 0 \text{ if otherwise} \quad \quad \text{ (3.2)}$$

The probability that $Q_i$ was equal to 1(one) could be expressed as a function of firm specific characteristics. Thus,

$$P_i = P_r(Q_i = 1) = P_r(U_{t1} < U_{t2i})$$

$$= P_r(X_i a_1 + e_{t1} < X_i a_2 + e_{t2i})$$
\[
= P_r[e_{1i} - e_{2i} < X_i(a_2 - a_1)]
\]
\[
= P_r(\mu_i < X_i\beta)
\]
\[
= F(X_i\beta) \quad \ldots \quad (3.3)
\]

where:

\( P_r(, ) \) is the probability function

\( \mu_i = e_{1i} - e_{2i} \) is a random disturbance term

\( \beta = a_2 - a_1 \) is a vector of coefficient

\( F(X_i\beta) \) is the cumulative distributive function for \( \mu_i \) evaluated at \( X_i\beta \).

In the function \( F(X_i\beta) \), the probability of the \( i^{th} \) farm adopting the new technology was the probability that the utility of the old technology was less than the utility of the new technology, or the cumulative distribution function of \( F \) evaluated at \( X_i\beta \). Thus, the exact distribution for \( F \) depended on the distribution of the random term \( \mu_i = e_{1i} - e_{2i} \). If \( \mu_i \) was normal, then the \( F \) was a cumulative normal; and if \( \mu_i \) is uniform, then \( F \) was triangular (Rahm & Huffman, 1984).

Therefore, the marginal effect of a variable \( X_j \) on the probability of adopting the new technology was

\[
\frac{\partial P_i}{\partial X_j} = f(X_i\beta)\beta_j \quad \ldots \quad (3.4)
\]

where:
\( F(\cdot) = \) marginal probability density function of \( \mu_i \).

Clearly, the direction of the marginal effect was determined by the sign of \( \beta_j \), but \( \beta_j \) represents coefficient differences \( a_{2j} - a_{1j} \). Thus \( \beta_j \) was expected to be positive (negative, zero) if \( a_{2j} \) was positive and greater than (less than, equal to) \( a_{1j} \) (Rahm and Huffman, 1984).

In this study, the model for the analysis and prediction of a dichotomous outcome is the logit model. The dependent variable is \( \text{Prob}(\text{Adoption} = 1 | X) \) where \( X \) is the set of independent variables. If the probability of adopting the locally produced adapted technology is \( p(Q_i = 1) = p_i \), then

\[
p_i = \frac{1}{1 + e^{-z}} = \frac{e^z}{1 + e^z} \quad \text{.........................................................(3.5)}
\]

where \( z = x\beta + u \)

The probability of not adopting the locally produced adapted technology is:

\[
1 - p_i = \frac{1}{1 + e^z} \quad \text{.................................................................(3.6)}
\]

From equation 3.4, the odds ratio is specified as

\[
\frac{p_i}{1 - p_i} = e^{x\beta + u} \quad \text{.................................................................(3.7)}
\]
Equation 3.7 is the odd ratio, which is the ratio of the probability that the $i^{th}$ enterprise will adopt the locally-produced adapted technology. The odd ratio is converted into a logit equation by obtaining natural logs to obtain the following equation:

$$\text{logit}(Q_i) = \ln \left( \frac{p_i}{1 - p_i} \right) = z = x\beta + u = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + u_i \ldots \ldots \ldots (3.8)$$

Where:

$Q_i$ = the decision by the $i^{th}$ enterprise to adopt the locally produced adapted technology

$p_i$ = probability of adoption of locally produced adapted technology

$\beta_i$ = the regression coefficient of the $i^{th}$ variable

$X_i$ = independent variables which can be discrete or continuous variables

$u_i$ = error term

The method of estimation of the coefficients $\beta_i$ ($i = 1, 2, \ldots, k$) is the maximum likelihood estimation (MLE). Data are entered into the analysis as 0 or 1 for the dichotomous outcome, continuous values for continuous predictors, and dummy coding 0 or 1 for categorical (discrete) predictors (Peng, Lee, & Ingersoll, 2002).
The specified model was developed by modifying equations 3.7 and 3.8 to yield a functional equation of the form:

$$\ln \left( \frac{\rho_i}{1-\rho_i} \right) = (\beta_0 + \beta_1 PUT_i + \beta_2 PEUT_i + \beta_3 PRM_i + \beta_4 CM_i + \beta_5 MMC_i +$$

$$\beta_6 MAPO_i + \beta_7 L_i + \beta_8 W_i + \beta_9 CE_i + \beta_{10} MPSLE_i + \beta_{11} PCHSSO_i + \beta_{12} A_i +$$

$$\beta_{13} S_i + \beta_{14} LED_i + \beta_{15} MSE_i + \beta_{16} PGCP_i + \beta_{17} ESSL_i + \beta_{18} MMCC_i +$$

$$\beta_{19} IPCCC_i + \beta_{20} PASA_i )$$ ................................................................. (3.9)

where:

- \( P_i \) = \( \text{Prob}(P=1|X) \)= probability to adopt adapted technology
- \( PUT_i \) = Perceived usefulness of technology
- \( PEUT_i \) = Perceived ease of use of technology
- \( PRM_i \) = perceived reliability of machine
- \( CM_i \) = Cost of the machine
- \( MMC_i \) = machine’s maintenance cost
- \( MAPO_i \) = machine’s average production/output capacity
- \( L_i \) = number of workers employed by the enterprise
- \( W_i \) = cost of labour employed in the enterprise – the wage bill
- \( CE_i \) = cost of energy used to operate the machine
- \( MPSLE_i \) = machine’s perceived suitability to the local environment
- \( PCHSSO_i \) = machine’s perceived conferment of higher social status to the owner
- \( A_i \) = Age of adopter;
Given that $P_i$ represented the dependent variable – the probability to adopt adapted technology, and $X_i$ the independent variables, composed of technology-specific factors, human factors and communication channels used to get information about adapted technology, a logit model was used where 1 stood for adopters of adapted technology and 0 stood for adopters of non-adapted technology.

For objectives one and two of the study, a two-stage regression was done. The first step regression involving the predictor variables was done to get the log of odd ratios, while the second regression got estimates of marginal effects. It is the results of estimates of marginal effects that were interpreted on the basis of whether:

- The variable increased or reduced the probability to adopt adapted technology
- The findings were in line with theory and/or other empirical study findings
To realise the third objective of the study, descriptive statistical measures of proportion were used.

3.4 Definition and Measurement of Variables

In the study’s logit model, the adoption of adapted technology was the dependent variable $P$ that took the value of one (1) if adapted technology was adopted and zero (0) if otherwise. Table 3.1 shows the study’s definition and measurement of the twenty predictor variables.
Table 3.1 Definition and measurement of variables.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definition and measurement of variables</th>
<th>Directional relationship with decision to adopt adapted technology</th>
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</table>
| Perceived usefulness of technology (PUT) | Defined as the degree to which a person believes that using a particular technology enhances his/her job performance. YES or NO response was solicited to the question: Is the technology useful to the adopter? The degree of adopter attitude towards usefulness of the machine was measured on a likert scale by six items:  
  i) Using the machine improves my skills  
  ii) The machine enables me to accomplish tasks more quickly  
  iii) Using the machine increases my productivity  
  iv) Using the machine reduces number of employees required  
  v) Using the machine improves the quality of the product  
  vi) Overall, I find the machine very useful to my job.  
Each of the six items had a standard (std) seven-point semantic differential rating scales with midpoint labeled “neutral”. | Either there is a relationship or no relationship with dependent variable |
| Perceived ease of use of technology (PEUT) | Defined as the degree to which a person believes that using a particular technology would be free from much effort.  
YES or NO response was solicited to the question: Is the machine easy to use? Like its predecessor, PUT, the degree of attitude towards ease of use of the machine was measured on a likert scale using six items, each with a std seven-point semantic differential rating scales with midpoint labeled “neutral”. | - ditto - |
<table>
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<th>Variable</th>
<th>Description</th>
<th>Sign</th>
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<tbody>
<tr>
<td>Cost of machine (CM)</td>
<td>Defined as off-shelf cost of the machine in Kenya shillings (Ksh). The unit cost was divided into 7 categories, ranging from affordable (less than Ksh 10,000/=) to expensive (more than Ksh 60,000/=) as per perception of low income earner.</td>
<td>Negative</td>
</tr>
<tr>
<td>Machine’s maintenance cost (MMC)</td>
<td>Defined as monthly cost of servicing and maintenance (greasing, replacement of spare parts) necessary to operate the technology efficiently in Kenya shillings (Ksh) per month</td>
<td>Negative</td>
</tr>
<tr>
<td>Perceived reliability of the machine (PRM)</td>
<td>Defined by rate at which the machine malfunctions during operations. YES or NO response was solicited to the question: Is the machine reliable during use? The degree of attitude towards reliability of the machine during use was measured by six items on a likert scale, each with a std 7-point semantic differential rating scales with mid-point labeled “neutral”</td>
<td>Either there is a relationship or no relationship with dependent variable</td>
</tr>
<tr>
<td>Number of workers employed to operate the machine (L1_50)</td>
<td>Defined by number of workers employed by the enterprise, whether paid wages or not. By convention, the number of employees determines the size of the enterprise (whether micro or small). Increase in the number of employees is used as measure growth of the enterprise by the Government of Kenya.</td>
<td>Positive</td>
</tr>
<tr>
<td>Entrepreneur’s (already established) social status in the local community (ESSLC)</td>
<td>Discrete variable defined as the adopter’s social standing/influence in his/her community before adopting technology: 1 if entrepreneur is a local administrator, sales agent, opinion leader or influential elder; 0 otherwise</td>
<td>Either there is a relationship or no relationship with the dependent variable</td>
</tr>
<tr>
<td>Wage bill cost per unit per month (W)</td>
<td>Defined as monthly wage bill paid to workers who operate the machine in Kenya shillings (Ksh) per month.</td>
<td>Negative</td>
</tr>
<tr>
<td>Cost of energy per month (CE)</td>
<td>Defined as monthly cost of electricity, charcoal or fossil fuels (petrol, diesel, paraffin)used to operate the machine in Kenya Shillings (Ksh) per month</td>
<td>Negative</td>
</tr>
<tr>
<td><strong>Machine’s average production/output (MAPO) per month</strong></td>
<td>Defined as volume of output produced using the machine per month in value terms i.e. Quantity of units of output multiplied by unit price in Kenya shillings (Ksh) per month</td>
<td>Positive</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>Perceived conferment of higher social status to the owner (PCHSSO)</strong></td>
<td>Defined by observed change in social status of the owner since acquiring and locating the machine in the area. YES or NO response was solicited. The degree of attitude towards perceived conferment of higher status was measured by the following six items: i) Before acquiring the machine, the owner was unknown beyond the locality (area of enterprise location): YES or NO ii) Owner has since been appointed a chief (an administrator) in the locality: YES or NO iii) Other adopters copied him/her and adopted machine: YES or NO iv) Location known by adopter’s name and is now used as reference point for direction: YES or NO v) Owner is now a role model in the area (consulted by others on issues): YES or NO vi) Overall, owner’s status has been enhanced: YES or NO</td>
<td>Either there is a relationship or no relationship with the dependent variable</td>
</tr>
<tr>
<td><strong>Age of adopter: Three categories (1, 2, 3)</strong></td>
<td>The working age definition of <em>youth</em> by the World Bank is 15 -35 years of age. However, for this study, and for investment purposes in the informal sector, 18yrs of age was adopted as the starting point for the <em>youth</em> category. The government’s Uwezo Fund launched in 2013 also defines membership of the youth group as those of 18 – 35 years of age. Age of adopter/entrepreneur variable (in years) was divided into three categories: Youth 18 – 35 years of age _1 Middle age 36 – 55 years of age _2 Elderly over 55 years of age _3 Youth was the base category for the <em>age</em> variable.</td>
<td>Either there is a relationship or no relationship with the dependent variable</td>
</tr>
<tr>
<td>Sex of adopter</td>
<td>Defined as the sex of the entrepreneur (adopter). Coded as 1 for male (M); 2 for female (F)</td>
<td>Either there is a relationship or no relationship with the dependent variable</td>
</tr>
</tbody>
</table>
| Level of Education of adopter: Five categories (LEd 1,2, 3, 4, 5) | Discrete variable defined as level of formal education or informal training of adopter: 1 = Primary school education: 1 if one completed 7 or 8 years of primary education; 0 otherwise.  
*Note: Primary school education level was the base category for the LEd discrete variable.*  
2 = Secondary school education level: 1 if one completed 4 or 6 years of secondary education; 0 otherwise  
3 = Vocational, polytechnic/technical or college education/training level: 1 if entrepreneur undertook post secondary education/training; 0 otherwise  
4 = University education: 1 if one has a degree from a university; 0 otherwise  
5 = Other forms of informal training: 1 if one has undergone informal training e.g. on-job training/apprenticeship; 0 otherwise | Either there is a relationship or no relationship with the dependent variable |
| Marital status of entrepreneur/adopter (MSE) | Discrete variable defined as one who has left the bachelor’s or spinster’s club: 1 if married; 0 otherwise | Either there is a relationship or no relationship with the dependent variable |
| Perceived gender-related cultural practices (PGCP) that influence decision to adopt | Defined as gender-related cultural or religious beliefs and practices that had negative influence on the decision to own or operate the machine/technology.  
YES or NO response was solicited as to whether cultural practices had negative influence(s).  
The degree of attitude towards perceived gender-related cultural influences was measured by six items, each with a std 7-point semantic differential rating scales with midpoint labeled “neutral” | Either there is a relationship or no relationship with the dependent variable |
| Communicatio n channels (COCH). This variable had | Defined as the means by which the adopter acquired information about the technology.  
Discrete variable: 1 if entrepreneur got information | Either there is a relationship or no relationship with |
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### 3.5 Profile of the Study Area

The study was interested in both urban and rural areas based MSEs. Nairobi and Kisumu cities were selected to provide observation units from the urban areas, while Nyeri County was chosen to provide observation units from the rural area for the study. The administrative division of a sub-county called a *division* was adopted as the

<table>
<thead>
<tr>
<th>Categories: COCH</th>
<th>Description</th>
<th>Relationship with Dependent Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mass media communication channel (MMCC)</td>
<td>about the machine from mass media (radio, TV, newspapers etc); 0 otherwise</td>
<td>Either there is a relationship or no relationship with the dependent variable</td>
</tr>
<tr>
<td>2. Interpersonal contact communication channel (ICCC)</td>
<td>Discrete variable: 1 if the entrepreneur got information about the machine through personal contacts, relationships and networking; 0 otherwise.</td>
<td>Either there is a relationship or no relationship with the dependent variable</td>
</tr>
<tr>
<td>3. Promotional activities of a sales agent (PASA)</td>
<td>Discrete variable: 1 if the entrepreneur got information about the machine through the promotional activities of a technology sales agent; 0 otherwise.</td>
<td>Either there is a relationship or no relationship with the dependent variable</td>
</tr>
<tr>
<td>Machine’s perceived suitability to the local environment (MPSLE)</td>
<td>Defined as technology that is (climatic and social) of being operated under the hostile informal sector conditions. Yes or NO response was solicited. The degree of attitude towards perceived suitability of the machine was measured by six items on a likert-scale, each with a std 7-point semantic differential rating scales with mid-point being labeled “neutral”</td>
<td>Either there is a relationship or no relationship with the dependent variable</td>
</tr>
</tbody>
</table>
sampling unit because a *division* of a sub-county is a large administrative area, large enough to contain a variety of MSEs that the study intended to cover. The administrative divisions were sampled from two urban North and South sub-counties of Nairobi County, two urban Kisumu sub-counties of Kisumu County, and the two rural sub-counties of Kieni and Othaya of Nyeri County.

These six counties were chosen because according to the information received from Kenya Industrial Research and Development Institute (KIRDI) and KickStart officials, they had the highest concentration of a variety MSEs that had adopted adapted technology in Kenya. In both Nairobi and Kisumu cities, there are expansive slum areas, which are classified as low income areas by the Central Bureau of Statistics (CBS) in its demographic surveys. These slum areas happen also to be where there is a large concentration of informal sector MSEs because they produce the types of goods and services that are popular with low income groups. The rural sub-counties of Kieni and Othaya in Nyeri County, on the other hand, have a relatively well developed road network that facilitates access to rural areas where many peasant small-scale farmers have adopted adapted technology in their production activities.

**3.6 Target Population**

Only two national baseline surveys of micro and small enterprises in Kenya have been undertaken ((Parker & Torres, 1993; Republic of Kenya, 1999). The IPC study report (Pollin *et al.*, 2007) estimates of MSE enterprises in Kenya, which constituted the target
population under investigation, were based on the second national baseline survey of 1999. Although the Ministry of Labour compiles a register of MSEs, this register is not regularly updated to take care of MSE deaths and new start-ups. Neither does the register possess information about the type of technology (non-adapted or adapted) adopted by the MSEs. Because of this, the Ministry of Labour register of MSEs, which would have been useful to the sampling process, could not be adopted as a sampling frame.

The study restricted the target population to those MSEs that used locally made adapted machines and their imported substitutes in the following sub-sectors: Agriculture, which comprises of farming and raw materials production, such as the manual irrigation pump; Food processing, which comprises of food processing machines such as baking, meat roasting, chips frying, maize milling, etc; Manufacturing, which comprises of machines for metal welding, carpentry/wood working, etc; Construction, which comprises of machines such as clay brick making, building stone shaping, cement block making, stabilized soil-block making, etc; Services, which comprises of equipment such as battery charging, etc. According to information provided by KIRDI and KickStart officials, the majority of the adapted technologies that were adopted by entrepreneurs in the informal sector, fell in these five sub-sectors.
3.7 Sampling Technique and Sample Size

3.7.1 Sampling Technique

Because of the heterogeneity of MSEs and their uneven dispersal, it was not possible for all the 1.9 million MSEs in the target population to have an equal chance to be selected. The study, therefore, opted for a multi-stage sampling technique with three stages. The first stage was area sampling, which used the judgmental sampling method. On the basis of information provided by KIRDI and KickStart officials about the areas with widespread adoption of adapted technology, convenience was the basis for the judgmental sampling method used to select accessible areas in the two urban North and South sub-counties of Nairobi County, two urban Kisumu sub-counties of Kisumu County and two rural sub-counties of Kieni and Othaya in Nyeri County. The urban sub-counties of Nairobi, Kisumu and Mombasa counties and the rural sub-counties of Nyeri County had been identified by DATO, KIRDI and KickStart officials as the areas with widespread adoption of adapted technology in Kenya.

In the second stage, purposive sampling method was used. With the help of the government officers known as District (now Sub-county) Applied Technology Officers (DATOs) and chiefs in urban sub-counties, and chiefs and elders in rural sub-counties, the purposive sampling method was used to restrict the sample to those MSEs that used machines to enhance performance in the production tasks in the following sub-sectors: farming and raw materials production in agriculture; food and raw materials processing;
manufacturing; construction; and services. The purposive method was again used to identify areas where adapted technology and non-adapted technology were located to ensure that, as much as possible, an area that provided the former (adapted technology) also provided at least one unit of the control group (non-adapted technology), not necessarily of similar function.

Finally, the third stage involved the selection of individual observation units using the simple random sampling method. In this regard, the observation units were not selected on a statistically representative sample as per sub-sector, but one that reflected the diversity of adopters that had adopted adapted technology. This method was used to select individual observational units to reflect the demographic structure of youth age, middle age and elderly age of adopters in the informal sector. Determination of each sub-sector’s quota was informed by the level of successful adoption of adapted technology in the informal sector as per information provided by officials of the pioneering institutions that produced adapted technology, that is, KIRDI and the KickStart NGO. The largest quota of adapted technology went to the manufacturing sub-sector (36%), followed closely by farming and raw materials production (30%) and food and raw materials processing (29%) sub-sectors. The construction (4%) and services (1%) sub-sectors had relatively small quotas due to the relatively fewer adapted technologies to be found in these two sub-sectors.
The logic behind the choice of the data source and sampling technique was to ensure that the observation units selected for inclusion in the sample fitted the Government of Kenya definition of micro and small enterprises: micro enterprises are those employing 1 - 10 workers; small enterprises 11 – 50 workers. Further, since the MSEs in Kenya are heterogeneous and their entrepreneurs came from different social and economic environments, the information collected from the chosen sample would represent many views and experiences from diverse ethnic communities engaged in different MSE economic activities, especially for the urban areas. The selected respondents were those who had operated the technology of interest for at least two years, and not earlier than the year 2000, as the year of adoption.

3.7.2 Sample Size

In order to obtain the sample size, the following statistical formula, borrowed from Watson (2001), was adopted:

\[
n = \left[ \frac{p[1-p]}{\frac{A^2}{Z^2} + \frac{p(1-p)}{N}} \right] R
\]

where:

n = Sample size

N= Target population

P = Proportion of observation units of adapted technology as a decimal
A= Margin of error as a decimal

Z = Level of confidence

R = Estimated response rate, as a decimal.

Given the heterogeneity of MSEs in the informal sector, and the scanty information about the degree of variability of the two types of technologies (adapted and non-adapted), the study opted for the conservative 50 – 50 per cent representation as the estimated variability in the target population. The study also opted for 0.05 or 5 percent as the margin of error for the desired level of precision with which the sample predicts where the true values in the population lie. Further, given the relatively large sample size the study wanted, the study chose a confidence level of 95 per cent. Finally, the study estimated a response rate of 80 per cent of the survey instruments sent to the field. Thus, given that N = 1.9 million; P = 0.5; A = 0.05; Z = 1.96 for 95 percent level of confidence; and R = 0.8, then:

\[
n = \left[ \frac{0.5[1-0.5]}{(0.05)^2} + \frac{0.5[1-0.5]}{(1.96)^2} + \frac{0.5[1-0.5]}{1,900,000} \right] = 384.124
\]

\[
0.8
\]

\[
n = 384
\]

Hence, using this formula, the calculated sample size required for this study was supposed to be around 384 observation units of micro and small enterprises in the informal sector. It should be noted, however, that in Sudman (1976), a vastly cited
publication, it is suggested that for survey research, a minimum of 100 observations of each sub-group (in this case the adapted and non-adapted sub-groups) would be an adequate sample size. In statistics, it is generally accepted that the larger the sample, ceteris paribus, the more likely the estimates of the variables being measured will be representative of the population (Gall, Borg, and Gall, 1996; Sudman, 1976; Watson, 2001).

At the onset, the study targeted a sample of 600 observational units or firms, 300 of which were adapted and 300 non-adapted. Equal proportional sampling was used to allocate the total sample to the three counties of Nairobi, Kisumu and Nyeri. Consequently, each of the counties was allocated a target of 200 observational units to make the targeted total of 600.

3.8 Research Instruments

The study objectives were achieved using both qualitative and quantitative data. The study used a survey questionnaire that sought information about technology characteristics, human factors and communication channel factors, which were important in influencing the decision to adopt technology. Information sought about individual items in the questionnaire – like age, sex of adopter, education, perceived usefulness, perceived ease of use, perceived reliability of machine – were adopted from previously validated instruments used by earlier studies on technology adoption (Davis,
1989, 1993; Meso et al., 2005). The theory of micro and small enterprises was used to generate other questionnaire items that were added to take care of the peculiarities of the informal sector in Kenya.

3.9 Pilot Study

The questionnaire instrument was pilot-tested on ten (10) respondents each for the manual irrigation pump (Money Maker) and the Jua Kali welding machine in the Nairobi slums of Mathare, Kibera and Kawangware. The responses of the twenty (20) respondents were used to refine the questionnaire for final field use (see Appendix I for the questionnaire).

3.10 Data Collection

The research set out to collect cross-section data from MSE entrepreneurs with the help of research assistants. Further assistance was sought from local administration officials known as chiefs, KickStart sales agents and sub-county applied technology officers. A total of 600 questionnaires were sent to the six sub-counties, two sub-counties for each of the three counties of Nairobi, Kisumu and Nyeri. The study set a target sample of at least 40 observational units of locally produced adapted technology and a control sample of a minimum of 40 firms that used imported non-adapted technology to be selected from each of the six identified sub-counties listed in section 3.6 of this Chapter (Three). The focus group for the study was entrepreneurs of micro and small enterprises
in the informal sector. The unit of study was a micro or small enterprise, which had adopted either imported non-adapted technology, \( t_1 \), or locally produced adapted technology \( t_2 \). The entrepreneur to be interviewed was defined as the individual who was the decision maker at the time of adoption of the technology. In case the entrepreneur was not available for the interview, permission was sought to interview an employee with sufficient knowledge of the enterprise as a stand-in. The relative advantage adapted technology was supposed to have over non-adapted technology was measured in terms of cost, utility to the adopter, convenience and ease-to-use functionality to the operator, and the social prestige conferred to the owner, among others.

### 3.11 Data Coding, Cleaning and Refinement

Data was case ID and coded to facilitate the use of the PC Statistical Package for Social Sciences (PC-SPSS) and the STATA programmes. Data cleaning involved cross checking for inconsistencies and missing data. Where necessary, return visits were paid to the respondents to verify some of the information they provided to the research assistants. After verification visits, it was found that information in a sizeable number of questionnaires (51) were either incomplete or glaringly inconsistent. These were excluded. Another 130 questionnaires were excluded from the sample to achieve parity between adapted and non-adapted observation units. Thus, the process of data cleaning and refinements reduced the sample size used in the analysis from 501 to a total of 320
observational units split on a 50 per cent $t_1$ and 50 per cent $t_2$ basis (See section 4.2 on Response Rate). This ensured that the possible choices between adapted and non-adapted technologies are adequately represented in the sample (Halcoussis, 2005).

3.12 Data Analysis

The collected data was analysed on the basis of objectives set in section 1.4 of Chapter One. To achieve objectives one and two, both descriptive and regression analyses were used. The regression analysis involved a logit model in which the binary choice model included both continuous and discrete variables. The third objective was achieved using descriptive statistics. The descriptive statistics analyses were done using the SPSS programme, while the diagnostic tests and logit regression analyses were done using the STATA programme.
CHAPTER FOUR

EMPIRICAL RESULTS AND DISCUSSION

4.1 Introduction

In this chapter the study findings are presented, starting with the response rate, descriptive statistics, followed by the diagnostic tests and finally the regression results. The findings are based on the first, through to the third specific objectives, which were specified in Section 1.4 of Chapter One.

4.2 Response Rate

The study collected primary data from respondents located in six sub-counties, namely, Nairobi North and Nairobi South sub-counties in Nairobi County, two urban sub-counties of Kisumu South and Kisumu North in Kisumu County and two rural sub-counties of Kieni and Othaya in Nyeri County. Out of the 600 questionnaires sent to the field in the six sub-counties, the researcher and research assistants managed to collect data from a total of 542 observational units in the field, a response rate of 90.3 per cent. Of these, 264 observational units were of adapted technology and 278 units were of non-adapted technology. However, based on responses to question 1c of section B of the questionnaire, 41 questionnaires (3 respondents of non-adapted technology and 38 respondents of adapted technology) were excluded due to the fact that the respondents were employees, who although authorized by the owners to be interviewed, had not stayed long enough with the enterprises to be considered reliable sources of
information. The remaining 501 observational units of the sample were considered sufficient to take care of the subsequent possible attrition, including the elimination of those observational units that failed to provide sufficient information required for the analysis.

After the return verification visits to cross-check some information collected by research assistants, it was established that 51 questionnaires (1 non-adapted and 50 adapted) did not have crucial information necessary for data analysis. These were excluded. Since the study required parity, 130 more observational units of non-adapted technology were dropped to achieve parity of 50 per cent adapted and 50 per cent non-adapted technology observational units from each sub-county. The process of data cleaning and refinement reduced the observational units from 501 to 320.

4.3 General Descriptive Statistics of the Sample

4.3.1 Sampled Micro and Small Enterprises

A total of 320 observation units of adopters were used in the analysis. Table 4.1 shows the distribution of the sampled adopters by technology type.
Table 4.1 Distribution of sampled adopters by technology type

<table>
<thead>
<tr>
<th>Type of technology</th>
<th>Number of adopters</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-adapted</td>
<td>160</td>
<td>50%</td>
</tr>
<tr>
<td>Adapted</td>
<td>160</td>
<td>50%</td>
</tr>
<tr>
<td>Total</td>
<td>320</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: Survey Data

Fifty per cent or 160 observation units of adopters were of non-adapted technology ($t_1$) and the remaining 50 per cent was composed of adopters of adapted technology ($t_2$).

4.3.2 Location of Sampled Adopters

Table 4.2 shows the distribution of adopters in the urban districts of Nairobi and Kisumu and in the rural district of Nyeri.

Table 4.2 Distribution of sampled adopters by location

<table>
<thead>
<tr>
<th>Area (1-4)</th>
<th>Number of adopters</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nairobi South</td>
<td>80</td>
<td>25</td>
</tr>
<tr>
<td>Kisumu</td>
<td>79</td>
<td>24.69</td>
</tr>
<tr>
<td>Nyeri</td>
<td>81</td>
<td>25.31</td>
</tr>
<tr>
<td>Nairobi North</td>
<td>80</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>320</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Survey Data
Twenty five per cent or 80 units of the observations of adopters were from Nairobi South, 79 units (24.69 per cent) were from Kisumu, 81 units (25.31 per cent) from Nyeri and 80 units (25 per cent) were from Nairobi North.

### 4.3.3 Distribution of adopters by sub-sector

The study limited its coverage to five sub-sectors. Table 4.3 shows the distribution of the 320 observation units by sub-sectors.

**Table 4.3 Distribution of adopters by sub-sector**

<table>
<thead>
<tr>
<th>Sub-sector (1 – 5)</th>
<th>Number of firms</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farming and raw materials production in agriculture</td>
<td>95</td>
<td>29.69</td>
</tr>
<tr>
<td>Food and raw materials processing</td>
<td>93</td>
<td>29.06</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>114</td>
<td>35.63</td>
</tr>
<tr>
<td>Construction</td>
<td>14</td>
<td>4.38</td>
</tr>
<tr>
<td>Services</td>
<td>4</td>
<td>1.25</td>
</tr>
<tr>
<td>Total</td>
<td>320</td>
<td>100.00</td>
</tr>
</tbody>
</table>

**Source: Survey Data**

The 320 observation units were distributed among the following sub-sectors: 95 units (29.69 percent) were from the farming/agriculture sub-sector, 93 units (29.06 percent) were from the food and raw materials processing sub-sector, 114 units or 35.63 percent
were from the manufacturing sub-sector, 14 units (4.38 percent) were from the construction sub-sector and 4 units or 1.25 percent were from the service sub-sector.

It will be observed that the manufacturing sub-sector had highest percentage of total observation units of adopters, (35.63 per cent), while the service sub-sector’s representation was the lowest (1.25 per cent). This proportional representation is a fair reflection of the reality on the ground and is supported by respondents’ responses to question: “How many enterprises use the same technology in the same location?” (See Appendix I, Section D, question number 33 of the Questionnaire). The responses showed that even in the rural areas the majority of rural markets and trading centres had more than one manufacturing unit of either adapted or non-adapted technology, with a glaring paucity of service enterprises using adapted technology. In the two rural districts of Nyeri, no adapted machines in the service sub-sector were found.

However, what was of more interest for analysis for this study, was the distribution of observation units of the adopters by technology type, as shown in Table 4.4.
Table 4.4 Sub-sector distribution of adopters by technology type

<table>
<thead>
<tr>
<th>Sub-sector</th>
<th>Technology type</th>
<th>No. of adopters that adopted non-adapted technology</th>
<th>Percentage</th>
<th>No. of adopters that adopted adapted technology</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farming and raw material production in agriculture</td>
<td>40</td>
<td>25</td>
<td>55</td>
<td>34.38</td>
<td></td>
</tr>
<tr>
<td>Food and raw materials processing</td>
<td>52</td>
<td>32.5</td>
<td>41</td>
<td>25.63</td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td>64</td>
<td>40</td>
<td>50</td>
<td>31.25</td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>2</td>
<td>1.25</td>
<td>12</td>
<td>7.50</td>
<td></td>
</tr>
<tr>
<td>Services</td>
<td>2</td>
<td>1.25</td>
<td>2</td>
<td>1.25</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>160</td>
<td>100.00</td>
<td>160</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

**Source: Survey Data**

When adopters were separated into those using adapted and non-adapted technology categories, the former (adapted) category had more adopters in the farming/agriculture sub-sector (34.38 per cent), followed by the manufacturing sub-sector (31.25 per cent). These were followed by the raw materials and food processing sub-sector (25.63 per cent), the construction subsector (7.50 per cent) and the services sub-sector (1.25 per cent). Adopters of adapted technology were mainly the youth and middle age groups.

On the other hand, the adapted technology in the farming/agriculture subsector was dominated by KickStart’s *Money Maker* manual irrigation pump, while in the manufacturing subsector the waste oil-cooled welding machine was dominant.
Among the non-adapted technology adopters, who were generally relatively more educated, and had relatively more income, the manufacturing sub-sector was dominant at 40 per cent, followed by the food and raw materials processing sub-sector at 32.5 per cent and farming sub-sector (25 per cent). The construction and services sub-sectors were tied at 1.25 per cent each. In consonance with this regimentation, the non-adapted technology in the manufacturing and food processing sub-sectors (such as the air cooled welding machine and bakery machines) were relatively more expensive, relatively technologically more advanced, and required more care and maintenance regimes. Data from respondents supported the view that non-adapted technology was a first choice for adoption by individuals who were relatively financially better-off, relatively more educated and relatively more mature in age. As Table AIIb in Appendix II shows, among the youth category, only 2 individuals (1.25 per cent) had adopted non-adapted technology.

4.4 Descriptive Statistics of Technology Specific Factors

This section discusses technology specific variables, including those that were dropped in the logit because they had a story to tell. The first specific objective of the study was to determine technology-specific factors that influence the adoption of adapted technology used by entrepreneurs of micro and small enterprises in Kenya’s informal sector.
4.4.1 Cost of Machine

All respondents in the sample said that the cost of technology was an important consideration in their decision to adopt the technology. Table 4.5 shows a summary of cost of technology variable statistics of the sample by technology type.

**Table 4.5 Cost of Machine by technology type**

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Number of firms</th>
<th>Mean cost (in Ksh)</th>
<th>Std deviation (in Ksh)</th>
<th>Min. (in Ksh)</th>
<th>Max. (in Ksh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-adapted</td>
<td>160</td>
<td>200,750</td>
<td>241,558.50</td>
<td>35,000</td>
<td>860,000</td>
</tr>
<tr>
<td>Adapted</td>
<td>160</td>
<td>25,908.06</td>
<td>36,713.31</td>
<td>2,990</td>
<td>250,000</td>
</tr>
</tbody>
</table>

*Data Source: Survey Data*

The mean of the cost of the 160 non-adapted technology observations was Ksh 200,750/=, while the standard deviation was Ksh 241,558.50. By contrast, the mean of the cost of the 160 adapted technology observations was Ksh 25,908.06, while the standard deviation was Ksh 36,713.31. For the adapted technology, the lowest cost machine, the manual irrigation pump (*Money Maker*), cost Ksh 2,990/=, while for the non-adapted technology, the lowest cost machine (an electric irrigation pump) cost almost twelve times more at Ksh 35,000/=. Both the non-adapted and adapted technology observations had a number of outliers (maximum Ksh 860,000/= and 250,000/= for non-adapted and adapted, respectively), which goes to explain why the standard deviations of both were greater than their means. The source of the outliers was due to the fact that even in the informal sector, some adopters acquired high end cost machines like the adapted diesel powered maize grinding mill (Ksh 160,00) and non-adapted brick/block making machine (Ksh 800,000).
However a better picture is presented by Table A9 and A10 in Appendix II. The two tables show the cost of units of adoption of adapted and non-adapted technology by sub-sector. Table A9 shows that the largest number of adopters of adapted technology 55 (34.4 per cent) were in the farming and raw materials production subsector, 50 (31.25 per cent) in the manufacturing sub-sector and 41 (25.6 per cent) in the food and raw materials processing sub-sector. The construction and service sub-sectors were the least represented among the adopters of adapted technology with 12 (7.5 per cent) and 2 (1.25 per cent), respectively. In terms of unit cost structure, 93 (58 per cent) out of 160 adapted units were in the lowest cost range of Ksh 2,990/= - 15,000/=, 43 (26.9 per cent) units in the range of Ksh 16,000/= - 32,000/=, 15 (9.4 per cent) units in the range of Ksh 35,000 – 100,000/=, and 9 (5.6 per cent) units in the range of Ksh 120,000/= - 250,000/=. Thus, while 136 (85 per cent) of the units of adapted machines in the sample cost less than Ksh 33,000/=, well below the cheapest unit of non-adapted machine - the electricity powered irrigation pump, all the 160 units of non-adapted technology cost over Ksh 34,000 each (see Table A10 in Appendix II).

If one compares these statistics with those of Table 4.17 and Table 4.19, it is apparent that the relatively lower price of adapted vis a vis the non-adapted technologies provides the main explanation as to why 95.74 per cent (45 out of 47) adopters in the youth age group and 95.83 per cent (23 out of 24) adopters who had attained only primary school level of education, adopted adapted technology. Although most of the
adopters of adapted technology in the study sample were from the middle age category (65% of total), it would appear that among Kenya’s millions of the unemployed, it is those in the youth age category and those with least education (primary school level) who are currently well disposed towards adoption of adapted technology.

The most plausible explanation for this is that members of these two groups (the young age and primary school level education adopters) are the least able to raise funds for investing in technology. It is potential adopters from members of these two groups who constitute a natural target groups for financial support policy. For institutions and agencies involved in the process of adaptation, this is a pointer to them to ensure that the products of adaptation are less expensive than the non-adapted products they seek to substitute, if the target group for the adapted technology is the millions of unemployed youth and low level educated individuals.

4.4.2 Machine’s Maintenance Cost

All respondents in the sample said that the machine’s maintenance cost was an important consideration in their decision to adopt the technology. Table 4.6 shows a summary of maintenance cost statistics of the sample by technology type.
Table 4.6 Machine’s monthly maintenance cost by technology type

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Number of firms</th>
<th>Mean cost (in Ksh)</th>
<th>Std deviation (in Ksh)</th>
<th>Min. (in Ksh)</th>
<th>Max. (in Ksh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-adapted</td>
<td>160</td>
<td>404.44</td>
<td>141.11</td>
<td>300</td>
<td>1200</td>
</tr>
<tr>
<td>Adapted</td>
<td>160</td>
<td>205.31</td>
<td>134.19</td>
<td>50</td>
<td>700</td>
</tr>
</tbody>
</table>

**Data Source: Survey Data**

The mean of the monthly maintenance cost of the 160 non-adapted technology observations was Ksh 404.44, while the standard deviation was Ksh 141.11. By contrast, the mean of the monthly maintenance cost of the 160 adapted technology observations was Ksh 205.31, while the standard deviation was Ksh 134.15. For the adapted technology, the lowest monthly maintenance cost was also that of the manual irrigation pump (*Money Maker*) at Ksh 50/=, while for the non-adapted technology, the lowest maintenance cost was that of the air cooled electric welding machine, whose maintenance cost was Ksh 300/= or six times more than the lowest maintenance cost of the *Money Maker*.

Table A11 and A12 in Appendix II show monthly maintenance cost per unit of adoption of adapted and non-adapted technology by sub-sector. Table A11 shows that for adapted technology, the maintenance cost of 136 (85 percent) units of adoption was within the lowest monthly maintenance cost range of between Ksh 50/= and 250/>. This is well below the lowest monthly maintenance cost of the non-adapted machine, the air-cooled electric welding machine.
Data analysis showed that the maintenance cost considerations carried more weight among the youth (100%), less educated (100%), the elderly (81.3%) and those with on-job-training (67.2%) categories of adopters. Since the majority of those worried about the maintenance cost (89.6%) were the ones who adopted adapted technology, the result suggests that the institutions and agencies involved in the process of adaptation should have, as a criterion for adaption, the requirement of minimising maintenance cost, if the technology being adapted is targeted at potential adopters from these groups.

4.4.3 Machine’s Production Output

Very few respondents (7.34% of total) in the study sample considered the technology’s output capacity as an important consideration in their decision to adopt the technology. This finding was surprising since, other than production cost and product demand, the quantity of output is one of the three pillars of competitiveness and profitability in any enterprise. As a caveat, the veracity of the data collected from respondents for this variable, though used in the analysis, was considered questionable, since many respondents harboured fears that the information they provided could be used by local authorities to impose taxation. Table 4.7 gives a summary of average output statistics of the sample by technology type.
Table 4.7 Machine’s average monthly value of output in Ksh by technology type

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Number of firms</th>
<th>Mean cost (in Ksh)</th>
<th>Std deviation (in Ksh)</th>
<th>Min. (in Ksh)</th>
<th>Max. (in Ksh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-adapted technology</td>
<td>160</td>
<td>131,155.6</td>
<td>66,112.55</td>
<td>72,000</td>
<td>560,000</td>
</tr>
<tr>
<td>Adapted technology</td>
<td>160</td>
<td>103,654.4</td>
<td>25,395.24</td>
<td>64,000</td>
<td>280,000</td>
</tr>
</tbody>
</table>

Data Source: Survey Data

The mean of the average monthly value of output of the 160 non-adapted technology observations was valued at Ksh 131,155.6, while the standard deviation was Ksh 66,112.55. By contrast, the mean of the average monthly output value of the 160 adapted technology observations was Ksh 103,654.4, while the standard deviation was valued at Ksh 25,395.24. For the adapted technology, the lowest average monthly output was that of the smaller version of the Money Maker irrigation pump, whose output was valued at Ksh 64,000/=, while for the non-adapted technology, the lowest average monthly output was that of a small diesel powered irrigation pump, whose output was valued at Ksh 72,000/=. The small variation in the minimum and maximum values of output between the adapted and non-adapted technology types was surprising. Table A13 and A14 in Appendix II show monthly value of output per unit of adoption of adapted and non-adapted technology by sub-sector.

Tables A13 and A14 in Appendix II show that with the exception of 5 units of non-adapted technology whose values ranged between Ksh 380,000/= and 560,000/=, the output values of the rest of the non-adapted technology units fell within the output values ranges of the adapted technology units in Table A13 in Appendix II. Thus, the
narrow difference in average monthly output between the two technologies was indicative of the fact that there was not much difference in the levels of output between the adapted and non-adapted technologies. Despite to the relatively large differences between the purchase prices of non-adapted and adapted machines (see Tables 9 and A10), output level differences did not seem to have had much influence on the decision to adopt the adapted technology.

The study’s data could not provide information about capacity underutilization of the adopted technology, which is very common in Kenya’s informal sector. Other than deliberate attempts to conceal actual output data on the part of respondents, there are two plausible explanations as to why technology output level was not an important factor in adoption. One, is the limited market demand for informal sector products that makes the need for high output volumes from the adopted technology a non issue. The other is what Hardin (1968) termed the “tragedy of the commons”. This, as earlier explained, is a dilemma arising from a situation in which multiple individuals, acting independently and rationally to serve their individual self-interest, will ultimately deplete a shared limited resource even when it is clear that it is not in anyone’s long-term interest for this to happen. In the case of the informal sector, the dilemma is brought about by the cultural practice, where too many individual MSE entrepreneurs make “rational” decisions to launch and locate start-ups in areas already crowded with similar enterprises with the hope of emulating the success of those who have preceded them, without taking into account the fact that their entry will flood the market and
obliterate entire lines of business. Most MSEs supply products to meet the effective demand within the vicinity of their localities. The few enterprises that supply products for markets outside their vicinity can still do so within the limited production capacities of their machines, without requiring higher levels of output. Since one of the constraints to the growth of MSEs is the limited effective demand for their products (Gichira, 1998; Parker & Torres, 1993) there is hardly any incentive for a start-up entrepreneur in the informal sector to acquire a machine that produces high output for the limited localized market demand.

However, notwithstanding the caveat on the respondents’ information about output and based on the collected data, for the long run, most of adapted technology units’ comparatively good production capability that matches that of non-adapted technology should be a strong point that should be highlighted by promoters of the adapted technologies.

4.4.4 Number of Workers

Most of the non-adapted technology respondents in the sample said that the number of workers required to operate the technology was an important consideration in their decision to adopt technology. However, most of the adopters of adapted technology respondents said that the number of workers required to operate the technology was not an important consideration in their decision to adopt the technology because most of them (86 or 53.75) were self-employed owners without employees and the majority of
the remaining 74 enterprises that employed workers took on close relatives as employees, whom they either paid very low subsistence wages or in kind. Paradoxically, while one of the government’s main objectives in promoting the adoption of adapted technology in the informal sector is to create jobs, individual adopters in the informal sector are unenthusiastic about adopting technologies that are labour intensive, or require employing many workers. Table 4.8 shows a summary of the employment statistics of the sample by technology type.

**Table 4.8 Employment statistics of the enterprises in the sample**

<table>
<thead>
<tr>
<th>Type of technology</th>
<th>Number of firms</th>
<th>Mean of number of workers per firm</th>
<th>Standard deviation</th>
<th>Minimum number of workers per firm</th>
<th>Maximum number of workers per firm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-adapted</td>
<td>160</td>
<td>2.2225</td>
<td>1.667</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>Adapted</td>
<td>160</td>
<td>1.4689</td>
<td>0.513</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

**Data Source: Survey Data**

The mean of the number of employees of the 160 non-adapted technology observations was 2.225, while the standard deviation was 1.667. By contrast the mean of the number of employees of the 160 adapted technology observations was 1.469, while the standard deviation was 0.513. For both the non-adapted and adapted technology in the sample, the minimum number of employees was one, who was in most cases the self employed owner.

Table A15 and A16 in Appendix II show the number of employees per enterprise of adapted and non-adapted technologies by sub-sector. Table A8a shows that for adapted
technology, the farming-agriculture and manufacturing subsectors accounted for 65.63 per cent of employees. On average, the enterprises that adopted non-adapted technology employed more workers than the enterprises that adopted adapted technology. Out of the 160 adopters of adapted technology, 86 or 53.8 per cent units of adoption were self-employed/single employee enterprises, 73 or 45.6 per cent employed 2 workers and only one or 0.6 per cent employed 3 workers. By comparison, out of the 160 adopters of non-adapted technology, only 32 or 20.0 per cent were self-employed/single employee enterprises, 90 or 56.3 per cent employed 2 workers and 38 or 23.75 per cent employed 3 or more workers.

The single largest employer, with 3 workers, among adopters of adapted technology was a middle aged adopter of the locally designed building stone shaper, compared to the 20 employees for non-adapted technology adopter of the imported brick/block making machine. The study found that in general, adapted technology adopters were more likely to be self-employed, but when the need arose for them to hire workers, they employed relatively fewer workers than their counterparts who adopted non-adapted technology. This result suggests that the government’s and NGOs’ policy of introducing vocational training to equip youths with knowledge and skills for self employment (Oketch, 1995) has been best served by adapted technology rather than the imported machines, which are used during training in the vocational training institutions. Thus, although adoption of adapted technology leads to job-creation, it does so through self-employment.
4.4.5 Cost of Energy used in production

All respondents in the sample said that the energy cost required to operate the technology was an important consideration in their decision to adopt the technology. In some adapted machines, like the manual irrigation pump with zero energy cost, adapter agencies had succeeded to surmount the problem of energy source and cost for the adapted technology. For some, like in the case of the welding machine and the maize grinding mill, adaptation of the technology could not avoid the energy cost component. For example, for the electric motor powered maize grinding mill, adaptation involved solving the problem of access to electricity. The adapted substitute was the tractor engine-driven or the diesel engine-powered maize grinding mills, which could be located in remote areas far removed from the national electric power grid. However, these substitute diesel-powered machines were also more expensive to buy than their non-adapted electricity-powered substitutes, with similar maize grinding capacity. For example, the cheapest locally assembled adapted diesel-powered maize grinding mill in the sample was the 10 horse-power maize grinding mill, whose purchase price was Ksh 70,000/=, while cheapest imported electric-powered equivalent of non-adapted maize grinding mill was the 15 KVA electric motor-powered machine, whose purchase price was Ksh 59,000/=.

Despite the constraint presented by this cost of technology difference, the diesel-powered machines were very popular and more numerous than electric ones, especially so in the rural areas where the maize meal is the unrivalled national staple food. In a
number of cases, adoption of these machines in rural areas resulted in positive externalities, like providing the incentive for enterprising businessmen to set up makeshift diesel depots with manually operated pumps to supply fuel to the adopters. Table 4.9 and Tables A17 and A18 in the Appendix II show a summary of average monthly energy cost statistics of the sample by technology type and by sub-sector, respectively.

**Table 4.9 Average monthly energy cost by technology type**

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Number of firms</th>
<th>Mean cost (in Ksh)</th>
<th>Std deviation (in Ksh)</th>
<th>Min. cost (in Ksh)</th>
<th>Max. cost (in Ksh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-adapted</td>
<td>160</td>
<td>4,458.75</td>
<td>2,929.996</td>
<td>400</td>
<td>35,000</td>
</tr>
<tr>
<td>Adapted</td>
<td>160</td>
<td>3,084.375</td>
<td>2,380.728</td>
<td>0</td>
<td>12,000</td>
</tr>
</tbody>
</table>

**Data Source: Survey Data**

It will be observed that the difference in the mean and the difference in the standard deviation are not that great for both sets of the non-adapted and adapted technologies. This could partly be due to the high energy cost of the large number of diesel-powered locally adapted maize mills and the locally fabricated waste oil-cooled welding machines, among the adapted technology respondents in the sample.

Table A17 in Appendix II shows that for the adapted technology, the average monthly cost of energy ranged from zero cost for the smaller size manual irrigation pump to Ksh 12,000/= per month for the waste oil-cooled welding machine. By contrast, for the non-adapted technology, the energy cost ranged from Ksh 3000/= per month for the small
electric powered irrigation pump to the Ksh 35000/= per month for the large diesel engine powered irrigation pump.

The other possible explanation for the popularity of the more expensive adapted maize grinding mill and waste oil cooled welder machines could be that the majority of the adopters were the middle age and elderly adopters, who were in a relatively better position to raise the necessary funding for the high initial purchase cost and attendant high energy running cost.

Therefore, much as cost of energy was a factor to be taken into consideration, other factors, like the usefulness of the technology to provide a service or produce highly demanded goods like the maize flour, over-rote the high purchase price and energy cost considerations in the decision to adopt the adapted technology. This result would suggest that guidelines to institutions and NGOs involved in technology adaptation should be multifaceted and not tunnel-visional, aimed at finding one cure for all barriers to adoption of adapted technology.

4.4.6 Wage Bill of Enterprise

All respondents in the sample said that the wage bill cost of operating the technology was an important consideration in their decision to adopt the technology. In general, a technology that required relatively high cost skilled manpower to operate (like
handloom weaving, carpentry or metal-working machine) was in most cases adopted by individuals who had the necessary formal or informal training in the required skills and wished to be self-employed. Otherwise, most adopters who, either employed workers to operate the technology, or wished to operate the technology themselves, but lacked the skills to do so, adopted easy-to-operate adapted technologies.

Where it was unavoidable for an MSE entrepreneur to employ labour, adopters of adapted technology paid their employees very low monthly wages, ranging from a minimum of Ksh 1,000/= to a maximum of Ksh 6,000/=.

The wages of employees of adapted technology were lower than those of their counterparts employed by adopters of non-adapted technology, whose wages ranged from a minimum of Ksh 1,500/= to a maximum of Ksh 7,500/=.

However, for both non-adapted and adapted technology observations, the mean monthly wages were below the official minimum wage of Ksh 6,450/= in the formal sector. Table 4.10 shows a summary of average monthly wage bill statistics of the sample by technology type.

**Table 4.10 Average monthly wage bill cost per worker by technology type**

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Number of firms</th>
<th>Mean cost (in Ksh)</th>
<th>Std deviation (in Ksh)</th>
<th>Min. cost (in Ksh)</th>
<th>Max. cost (in Ksh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-adapted</td>
<td>160</td>
<td>5113.75</td>
<td>1395.493</td>
<td>1500</td>
<td>7500</td>
</tr>
<tr>
<td>Adapted</td>
<td>160</td>
<td>4363.125</td>
<td>987.8267</td>
<td>1000</td>
<td>6000</td>
</tr>
</tbody>
</table>

Data Source: Survey Data

The study found that the maximum wages of Ksh 6,000/= and Ksh 7,500/= for the adapted and non-adapted technology workers were paid only to skilled artisan
employees in the urban areas. Rural skilled artisan employees were paid much less, even though some had their wages supplemented with subsistence, such as meals and accommodation, provided by their employers. The higher of the two wages (Ksh 7500/=) was about half the starting monthly wage for similar skills in the formal sector. Part of the explanation for the closeness of the mean of the two groups was partly due to the single worker self-employed adapted technology owners, who paid themselves higher wages than they would pay employees.

4.4.7 Perceived Conferment of higher social status to the owner

Perceived conferment of higher social status to the adopter was another variable that was considered specific to the informal sector. This variable was supposed to take care of several types of adopters. First, were the adopters who got the idea to adopt technology because their predecessors had acquired higher status due to the income earned from the technology they adopted. These were imitator adopters who sought to acquire similar social status by adopting the technology (Rogers, 2003). Second, were the adopters who were previously unemployed, but were now identified with ownership of an income generating asset. Third, were adopters whose names were associated with the naming of the area where the technology was located. Thus, adoption of technology was suppose to confer social capital to the owner (Mohan and Mohan, 2002; Molony, 2006). Table 4.11 shows respondents’ responses on the question of perceived conferment of higher social status to the adopter by technology type.
Table 4.11 Responses on perceived conferment of higher social status to the adopter

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Responses on perceived conferment of higher social status to the owner</th>
<th>Total number of adopters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adapted technology does not confer</td>
<td>Adapted technology confers</td>
</tr>
<tr>
<td></td>
<td>Number of adopters</td>
<td>Percentage</td>
</tr>
<tr>
<td>Non-adapted</td>
<td>148</td>
<td>92.50</td>
</tr>
<tr>
<td>Adapted technology</td>
<td>149</td>
<td>93.13</td>
</tr>
<tr>
<td>Total number of adopters</td>
<td>297</td>
<td>23</td>
</tr>
</tbody>
</table>

Data Source: Survey Data

Data collected from respondents for this variable raised doubts about the correctness of the responses. Table 4.11 shows that only 12 (7.50 per cent) of the 160 adopters of non-adapted technology and 11 (6.87 per cent) of adopters of adapted technology said that the adopted technology conferred to them higher social status. Overall, 297 or 92.8 per cent of all respondents said that adopting technology did not confer higher social status to them. However, the same respondents contradicted this assertion in follow-up questions by agreeing that the technology had not only made them and the location of the technology more known than before, but the adopters were economically better-off after adoption. These contradictory responses from respondents made it difficult to interpret meaningfully the data set for this variable.
4.4.8 Usefulness of the Technology (dropped from the logit)

Perceived usefulness of the technology (PUT) variable was adopted from the technology acceptance model (Davis, 1989, 1993). All the 320 respondents in the sample said that perceived usefulness of the technology was the first consideration in their decision to adopt the technology. Table 4.12 shows the statistics for the perceived usefulness of the technology variable by technology type.

Table 4.12 Responses on perceived usefulness of the technology to the owner (dropped from logit model)

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Responses on perceived usefulness of technology to the owner</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not useful</td>
<td>Useful</td>
</tr>
<tr>
<td></td>
<td>Number</td>
<td>Percentage</td>
</tr>
<tr>
<td>Non-adapted</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Adapted technology</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Data Source: Survey Data

The response that the usefulness of the technology was the first consideration was in unison with the responses given during the pilot testing of the questionnaire, where adopters of the two sets of technologies ($t_1$ for non-adapted and $t_2$ for adapted) were equally unanimous in their view that perceived usefulness of the technology was their first consideration in the decision to adopt the technology. Data collected from the field yielded the same results for the two sets of adopters: each of the 320 respondents said perceived usefulness of the technology was the first consideration in their decision to adopt the technology. A follow-up attempt was made to use the likert-scale to measure
the degree of “perceived usefulness”, but the attempt failed to bring out any significant differences between the two sets of responses – the adopters of adapted and adopters of non-adapted technologies. The overwhelming response of the respondents in unison suggests that a typical technology adopter in the informal sector will consider, first and foremost, the usefulness of the technology, irrespective of technology type, before taking into consideration other factors of influence. This finding is supported by most studies that have used the technology acceptance model (Davis, 1989, 1993; Venkatesh and Davis, 2000)

4.4.9 Ease of Use of the Technology (dropped from the logit)

Like the perceived usefulness of the technology variable in section 4.4.8, perceived ease of use of the technology variable was adopted from the technology acceptance model (Davis, 1989, 1993). Table 4.13 shows responses to the perceived ease of use variable by technology type.

Table 4.13 Responses on perceived ease of use of the technology to the adopter

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Responses on perceived ease of use of the technology to the owner</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not easy to use</td>
<td>Easy to use</td>
</tr>
<tr>
<td>Non-adapted</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Adapted technology</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Data Source: Survey Data
Again, like PUT in section 4.4.8, all the 320 respondents in the sample said that perceived ease of use of the technology was an important consideration in their decision to adopt the technology, although a few in the elderly category (2.82% of total) held the view that they could put up with some difficulty in operating the technology so long as its usefulness over-rode the operational difficulties encountered. It should, however, be pointed out that almost all the technologies used in the informal sector are relatively simple to handle technically. In general, though, units of the non-adapted technology were relatively more advanced than units of the adapted technologies. Where skills were required, like in the case of handloom weaving, carpentry and metal-working, there were enough unemployed artisans trained in vocational and polytechnic institutions to be hired at very low wages to take care of the operational difficulties. Like was the case in (h), an attempt to use the likert-scale to measure the degree “ease of use” that could bring out significant differences, between the two adopter sets of responses, failed to yield a positive result.

4.4.10 Perceived reliability of the Technology (dropped from the logit)

Perceived reliability of the technology to the user was one of the variables that were considered specific to the informal sector. One of the problems encountered by adopters of technology in the informal sector is lack of facilities for servicing and skilled manpower to maintain the machines (Fisher, 1998). Adaptation of technology was supposed to reduce the need for frequent or complicated maintenance routines, without
sacrificing reliability. The variable was, therefore, included to establish whether technology reliability was a consideration in the decision to adopt the technology. Table 4.14 shows responses to the perceived reliability of the technology to the adopter variable by technology type.

**Table 4.14 Responses on perceived reliability of the technology to the adopter**

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Responses on perceived reliability of technology to the user</th>
<th>Total number of adopters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not reliable</td>
<td>Reliable</td>
</tr>
<tr>
<td></td>
<td>Number of adopters</td>
<td>Percentage</td>
</tr>
<tr>
<td>Non-adapted technology</td>
<td>67</td>
<td>41.88</td>
</tr>
<tr>
<td>Adapted technology</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Total number of adopters</td>
<td>67</td>
<td>253</td>
</tr>
</tbody>
</table>

**Data Source: Survey Data**

Whereas 67 or 41.88 per cent of the 160 adopters of non-adapted technology held the view that the technology in use was unreliable, not a single respondent among the 160 adopters of adapted technology held that view. Zero response from adopters of adapted technology had implications for the logit model, which partly explains why the variable was dropped from the logit model. Non-adapted technology, particularly electric powered machines, were affected by the frequent power blackouts, just like the adapted ones that used electricity, but the former suffered from some technical defects that emerged during operations, like the overheating of the welding machine when being operated in the open hot sun during the hot season (jua kali). Although some adapted machines, like the waste oil-cooled welding machine, use electricity, they have been modified and do not overheat even when used in the open hot sun.
The majority (73.87%) of adopters of adapted technology said they were not bothered by power blackouts as they used the time to cut and shape the metals in readiness for welding when the power supply returned. However, whatever advantage the adapted technology had over non-adapted technology was seriously eroded by a general lack of seriousness with work on the part of most adopters of adapted technology. Many customers, who got a chance to talk to the interviewers, complained of late deliveries of contracted work, which could not be explained by power blackouts. This finding suggests that while the institutions and agencies involved in the adaptation process have performed well on the score of technology reliability, they have been let down by the work habits and ethos of the adopters. This is a cultural impediment that needs to be addressed during social inter-mediation programmes by NGOs. However, those promoting adapted technology can confidently use operational reliability of the technology as a marketing advantage over the competition.

4.4.11 Perceived suitability of technology to informal sector environment (dropped from the logit)

Perceived suitability of technology to the Jua Kali environment was another variable that was considered specific to the informal sector. Non-adapted technology was designed to suit the needs and environment of advanced economy societies, and therefore inappropriate for use in the the Jua Kali environment (Schumacher, 1973). This variable was supposed to establish whether the adaptation process had succeeded
in reducing the imported technology’s constraints by making it compatible with Kenya’s informal sector environment (Pacey, 1996). Five premises were used to determine a technology’s overall suitability to the *Jua Kali* environment. The five premises were: the technology was footloose and therefore could be located at a place of convenience to the adopter; was portable to different sites; used mostly local materials as inputs; required minimal imported spare parts; did not require permanent or semi-permanent premises to be located for operations. YES or NO responses were solicited from respondents to each of the five premises. Table 4.15 shows responses to the perceived suitability of the technology variable to the *Jua Kali* environment by technology type.

**Table 4.15 Responses on perceived suitability of technology to informal sector environment**

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Responses on Perceived suitability of the technology to the informal sector’s environment</th>
<th>Total number of adopters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not suitable</td>
<td>Suitable</td>
</tr>
<tr>
<td>Non-adapted technology</td>
<td>160</td>
<td>0</td>
</tr>
<tr>
<td>Adapted technology</td>
<td>0</td>
<td>160</td>
</tr>
<tr>
<td>Total number of adopters</td>
<td>160</td>
<td>160</td>
</tr>
</tbody>
</table>

*Data Source: Survey Data*

Responses to the five premises from all the 160 adopters of non-adapted technology were negative, indicating that they perceived their technology as unsuited to the *Jua Kali* environment. By contrast, the responses to the five premises from all the 160
adopters of adapted technology were positive, indicating that they perceived their technology as suited to the Jua Kali environment. Use of the likert-scale method of measuring the degree of perception did not change the result. This result suggests that the adaptation of technology process has done a good job of tailoring the adapted technology to the Jua Kali environment. The responses also suggest that all the non-adapted technology was unsuited to the local environment, which is not surprising since most of them are imported from developed countries.

4.5 Descriptive Statistics of Human Factors

The second objective of the study was to determine the human characteristics that influence the adoption of adapted technology by entrepreneurs of micro and small enterprises in the informal sector. According to technology adoption theory and empirical research studies the three factors that are used to profile individuals and which have influence on technology adoption and usage are: age (Appelbaum, 1990), gender (Gefen and Straub, 1997; Venkatesh and Morris, 2000) and education level (Alavi, 1994). The economic theory of micro and small enterprises influenced the study to add the following factors: marital status of the entrepreneur and the entrepreneur’s social status in the local community.
4.5.1 Age of the entrepreneur (adopter of technology)

The sampled observation units of adopters were categorized into three age groups: youth age category (18-35 years); middle age category (36-55 years) and the elderly age category (over 55 years). Table 4.16 shows the distribution of adopters by age group and technology type.

Table 4.16 Distribution of adopters by age groups and technology type

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Age groups of the adopters of technology</th>
<th>Total number of adopters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Youth age group</td>
<td>Middle age group</td>
</tr>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
</tr>
<tr>
<td>Non-adapted</td>
<td>2</td>
<td>1.25</td>
</tr>
<tr>
<td>Adapted technology</td>
<td>45</td>
<td>28.13</td>
</tr>
<tr>
<td>Total number of adopters</td>
<td>47</td>
<td>248</td>
</tr>
</tbody>
</table>

Source: Survey Data

Out of a total sample of 320, the youth age (ages 18 – 35) category had 47 adopters (14.69 per cent), while the middle age (ages 36 -55) category, which was dominant in the sample, had 248 adopters (77.50 per cent). The elderly age (ages 56 and above) category had the least representation of 25 adopters (7.81 per cent). This proportional distribution of adopters is not a true reflection of Kenya’s pyramid of the working population, which is top-heavy at the lower age. The breakdown into non-adapted and adapted adopters portrays a better picture of the adoption decisions among the age
group categories. Tables A2a and A2b in Appendix II give a breakdown of adopters by sub-sector.

Of the total 47 adopters in the youth group, only 2 (0.625 percent of total of the 320 adopters), who also happen to have been university graduates, had adopted non-adapted technology: imported non-manual irrigation pump and air-cooled welding machine. The two youth age group adopters got information about the technology through the mass media channel. These two university graduate adopters of non-adapted technology also happen to be closely related, one by marriage and the other by blood, to one of the district applied technology officers (DATO) in Nairobi South, one of the research study areas. Since the DATO are government officers with the responsibility of promoting and popularizing adapted technology, one would have expected the interpersonal contacts between him and the two youths to have influenced the two youths to adopt the available adapted technology he was promoting. However, because the two youths’ original idea, which did not come to fruition, was to get funding from the Youth Enterprise Development Fund (YEDF) that was administered through selected commercial banks, these youths could not risk rejection of their proposals on account of opting for adapted technology. It would appear that the risk of rejection and the perception that adapted technology was untested and was the preferred choice of the less educated members of society, were more instrumental in influencing the two graduate youths’ decision to adopt non-adapted technology. The remaining 45 out 47 of the total adopters in the youth group age category had adopted adapted technology.
Table A3 in Appendix II shows that 29 of the 45 individuals in the youth group who had adopted adapted technology did so in the farming-agriculture subsector, 9 (nine) in the manufacturing, 5 in the food and raw material processing, and 2 in the construction sub-sectors. Based on the data sets in Tables A3 and A4 in Appendix II, it would appear that technology-specific attributes of adapted technology, particularly cost of the technology and ease of use, were more appealing to the majority of individuals in the youth group category, given the environment they faced in the informal sector.

On the other hand, out of the total 248 adopters in the middle age category 144 (58 percent) had adopted non-adapted technology, while 104 (42 percent) had adopted adapted technology. Table 4.6 and Tables A3 and A4 in Appendix II show that individuals in the middle age category were the main adopters in both the non-adapted and adapted adopters, with 100 per cent and 86 per cent representation in the service and construction sub-sector, respectively. Proportionately, therefore, a relatively higher proportion of the youth group (45 out of 47 or 95.7 per cent) had adopted adapted technology, than the middle age group.

Finally, out of the sample’s 25 adopters in the elderly category, 14 (4.38 per cent of the total sample) had adopted non-adapted technology and 11 (3.44 percent) had adopted adapted technology. This group of adopters comprised mainly retirees from both the public and private sectors, who sought to invest their small savings and retirement
benefits in income-generating economic activities they could operate on their own or easily supervise. Tables AIIa and AIIb in Appendix II show that all adopters in this category fitted in only two sub-sectors; farming-agriculture and food and raw materials processing sub-sectors.

For the elderly adopters in the sample, the choice of type of technology seemed to have been influenced more by their level of education and work experience. Many of them said their age tended to make them more risk averse and held the view that adapted technology was new innovation and therefore untested. With the exception of the four adopters of the Money Maker irrigation pump (farming) and 7 adopters of the locally assembled diesel-powered maize grinding mill (food processing), the rest of adopters in this age group category adopted non-adapted technology that had a well established clientele of previous adopters. Being relatively more educated and more likely to access mass media (radio, TV and newspapers), one would have expected that potential adopters in this age group category would be more amenable to promotional activities of marketing agents of any technology. The study’s data did not show that it is from this elderly group category that most adopters accessed information about the technology they adopted through either the mass media or promotional activities of sales agents.

Overall, therefore, it is clear that out of the total sample of 320 observations, the overwhelming majority of the youth group adopters preferred adapted technology (45 compared to 2 for non-adapted technology), while proportionately more middle aged
adopters’ preferred choice was non-adapted technology (144 compared to 104 for adapted technology). On the other hand, for the majority of adopters from the elderly aged group (14 out of 25), the adoption of non-adapted technology was the preferred choice.

If policy was aimed at targeting a particular group in society to promote the adoption of adapted technology, the proportionately larger number of adopters in the middle age group would suggest that individuals in this group would be the natural choice for targeting. However, the higher proportion of 95.7 per cent (45 out of 47) of the youth group who had adopted adapted technology would suggest that the individuals in the youth age group were more well disposed towards, and therefore would embrace adapted technology more eagerly, than the other two age groups. If individuals in the youth group had access to information about adapted technology and some of them were facilitated, say through the Youth Enterprise Development Fund (YEDF) or the Uwezo Fund, to adopt adapted technology, those who are facilitated to adopt would, through the peer effects of adoption, provide the lead to the others in the youth group to learn and adopt (Maguel and Kremer, 2004; Kremer and Maguel, 2006).

4.5.2 Sex of the entrepreneur

Despite the fact that the random sampling method was used to select individual observation units to avoid intentional bias, the male sex dominance of the sampled
observations was evidently the result. Table 4.17 shows the distribution of adopters by the sex of adopters and technology type of all sampled firms.

**Table 4.17 Distribution of adopters by sex and technology type**

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Sex of the entrepreneur</th>
<th>Total number of adopters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>percentage</td>
</tr>
<tr>
<td>Non-adapted</td>
<td>116</td>
<td>72.50</td>
</tr>
<tr>
<td>Adapted technology</td>
<td>113</td>
<td>70.63</td>
</tr>
<tr>
<td>Total number of adopters</td>
<td>229</td>
<td>91</td>
</tr>
</tbody>
</table>

**Source: Survey Data**

There were 229 (71.56 per cent) male and 91 (28.44 per cent) female adopters in the sample, which is indicative of the poor proportional sex representation of ownership of MSEs using technology. This is particularly so considering that Kenya’s population is equally split on the basis of gender. Male sex dominance in this randomly selected sample would seem to give credence to the generally held view among gender activists in Kenya that the continued existence of some traditional beliefs and cultural practices, which were oppressive to women, were serious impediments to potential female adopters.

The male sex dominance phenomenon was still prevalent when the adopters were split into those who had adopted adapted and non-adapted technology. Out of the 160 non-adapted technology observation units, 116 (72.50 per cent) adopters were male, while only 44 (27.50 per cent) adopters were female. On the other hand, out of the 160
adapted technology observation units, 113 (70.63 per cent) adopters were male, and only 47 (29.37 per cent) adopters were female. These statistics show that the adopters were almost equally split on the basis of sex between those who had adopted adapted and non-adapted technology. For the males, 116 and 113 adopters adopted non-adapted and adapted technology, respectively, while for the females, 44 and 47 adopters adopted non-adapted and adapted technology, respectively.

The study took a different angle to look at the same issue of the sex of the adopter by sub-sector. When the adopters were categorized into sub-sectors, male dominance was much less pronounced in the farming and food processing sub-sectors than in the manufacturing, construction and service sub-sectors. Table A1 in Appendix II shows that among the adopters of adapted technology, there was almost gender parity (28 male, 27 female) in the farming subsector, while in manufacturing, construction and services sub-sectors male dominance was overwhelming. The same distribution pattern is repeated for adopters of non-adapted technology in Table A2 in Appendix II. Whether this job regimentation on the basis of sex is a result of traditional beliefs and cultural practices or due to investment choice preferences on the part of adopters could not be established from the data.

The apparent overwhelming male sex dominance of adopters was also put into question when the logit regression results (to be presented later) were compiled. Whether the non-equality in the sex split on overall technology adoption, despite the equality in the
national sex demographic, was coincidence or due to other variables not included in the model, is a finding that needs further study since the female adopters in the sample were emphatic in their assertion that whatever obstacles they faced during the adoption process were not gender related. A contrary finding could not be supported by the information provided by respondents on the question: “Do gender related cultural beliefs and practices influence the decision to adopt?” (see question 17(a) in section D of the Questionnaire in Appendix I).

4.5.3 Level of education of the entrepreneur

The 320 adopters were fitted in five levels of education: Primary school level, which acted as the base for the other four education levels in the regression model, secondary school level, tertiary education level, university graduate level, and on-the-job training level. Table 4.18 shows the distribution of adopters by the level of education and technology type.
Table 4.18 Number and percentage of adopters by education level and by technology type

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Education level of entrepreneur</th>
<th>Total number of adopters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Primary level</td>
<td>Secondary</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>%</td>
</tr>
<tr>
<td>Non-adapted technology</td>
<td>1</td>
<td>0.63</td>
</tr>
<tr>
<td>Adapted technology</td>
<td>23</td>
<td>14.37</td>
</tr>
<tr>
<td>Total number of adopters</td>
<td>24</td>
<td>87</td>
</tr>
</tbody>
</table>

Source: Survey Data

Table 4.18 shows that out of the 320 observation units, primary school level had 24 (7.5 per cent), secondary school level had 87 (27.2 per cent), tertiary institutions level had 166 (51.88 percent), university level had 29 (9 per cent) other levels of education had 14 (4.4 per cent). Tables A5 and A6 in Appendix II show that the dominant group of adopters in the sample is that of the graduates of tertiary institutions: vocational, technical and college category of education, which constituted 52 percent of the sample. This could partly be explained by the fact that the formal training acquired by the individual adopters from the relevant post-primary and post-secondary tertiary institutions included courses in business and entrepreneurship. This was in conformity with the recommendations on the need to introduce technical and business courses in Kenya’s education system by the Philip Ndegwa Commission Report (Republic of Kenya, 1970), the Gachathi Committee Report (Republic of Kenya, 1975) and the Mackay Commission Report (Mackay, 1981). Many of these reports’ recommendations
on technical and business education were adopted by the government as part of the education reforms that culminated into the introduction of the 8.4.4 education system (Yambo, 1991; Oketch, 1995). The training in these tertiary institutions not only equipped the graduates with the technical knowledge and skills to use different types of tools and equipment, but also inculcated the necessary drive and desire to acquire technology for self-employment.

Out of the 24 primary school level adopters in the sample, 23 (95.83 per cent) had adopted adapted technology and only one out of the 24 (4.17 per cent), a female respondent, had adopted non-adapted technology. The imported electric motor-powered cake baking oven she adopted was a gift from her former expatriate employer, who, when leaving the country, wanted her to be self-employed. The characteristics of most of the adapted technology adopted by the 23 primary school leavers fulfilled the conditions of intermediate technology, as recommended by Schumacher’s ITDG (Smillie, 2000). They were easy to operate, used local inputs in production, needed minimal maintenance and were relatively cheap to buy. The Money Make and baking-cum-meat-roasting machine dominated the machines they adopted.

As for the 87 adopters, who were secondary school leavers, 38 of the 87 (43.68%) adopted non-adapted technology, while 49 (56.32%) adopted adapted technology. However, when it came to the largest group of adopters in the sample, the 166 graduates of tertiary institutions (51.88% of the sample), the majority of them (97 out of 166 or
58.4%) had adopted non-adapted technology. The remaining 69 (41.6%) adopters in this category had adopted adapted technology. Just as was the case with the group’s dominance in the sample, part of the explanation for the dominance of non-adapted adopters in this group category is their (adopters’) over-exposure to non-adapted technology during their training in the tertiary institutions. Most, if not all, the machines and tools used in the practical training in the tertiary institutions were either imported from abroad by the training institutions or supplied by donor agencies from abroad.

The next category of adopters in the sample, were of university graduates level of education. Out of the 29 (9% of the sample) university graduate adopters, 16 (or 55.1% of graduate adopters) owned non-adapted technology, while 13 (or 44.9% of graduate adopters) owned adapted technology. Most of the adopters in this category adopted technology that was of the relatively higher-end cost technology, which did not have adapted substitutes. These included machines like the stone shaper, bakery equipment and maize grinding mill. In many cases, the machines were adopted not for self-employment as was the case with most of the other adopters in the sample, but as a source of second income. Most of the university graduate adopters were employees in the public and private sectors, who used their savings or were able to use their pay slips to get loans from their saving and credit cooperative organisations (SACCOs) or other financial institutions to invest in the technology. The only two youth age group category university graduates who adopted non-adapted technology were also civil servants.
Finally, 14 (or 4.38% of the sample) adopters were accommodated in the last category of education level – the “Others” education level category, which comprised mainly of individuals who had acquired skills on the use of the technologies they adopted through on-the-job-training and experience. All the 14 respondents in this category said they adopted the technology mainly because they were impressed with the rewards brought by the technology to their former employers. As would be expected, all of them were self-employed adopters, who adopted similar technology to what they operated for their employers when in employment. Eight (or 57.14% of this category) adopted non-adapted technology, while 6 (or 42.86% of this category) adopted adapted technology. Although all the 14 adopters in this category had acquired their skills when operating non-adapted technology of their employers, and most of them would have preferred to adopt the same, the six who adopted adapted technology said they did so because adapted technology was more affordable, in addition to its being less demanding on maintenance and easier to use.

In general, the descriptive statistics show that individuals with lower levels of education, with the exception of the on-job training and experience group of adopters, were more inclined to adopt adapted technology. They also show that the type of technology used in training to acquire skills has influence in forming individual attitudes towards choice preferences in as far as technology adoption is concerned. It should be observed that much as the adapted technology is new to the adopters in the informal sector, it lacked the modern science base and sophistication that appeals to
youthful higher education level adopters as theory and empirical studies suggested in Appelbaum, 1990; Agarwal & Karahanna, 2000; Munnukka, 2007. Studies in Kenya have shown that, even in the rural context, formal education is considered an asset to potential adopter of new technology (Akwara, 1996; Kohler, Behrman and Watkison, 2001).

4.5.4 Marital status of the entrepreneur

Marital status was another human characteristic used in the study. This variable was included due to the results from the piloting of the research instrument, which indicated that, in the informal sector, the marital status of a potential adopter influenced the decision to adopt technology. Figure 4.1 and Tables A7 and A8 in Appendix II show the distribution of adopters by marital status.
Figure 4.1 Three figures showing distribution of adopters by marital status and by technology type

Figure 4.1 shows that out of the total sample of 320, there were more unmarried adopters, 175 (54.69 per cent), than those who were married, 145 (45.31 per cent). Despite the fact that there were more unmarried adopters than married adopters, when adopters were divided into technology type of adapted and non-adapted, the data suggested that the marital status had influenced choice preferences in the technology adopted. Figure 4.1 shows that 71.88 per cent of married individuals preferred non-adapted technology, while the 81.25 per cent of unmarried adopters preferred adapted technology.
Tables A7 and A8 in Appendix II show the marital status of adopters by sub-sector. Table A7 shows that the sub-sector distribution of the unmarried adopters of adapted technology was concentrated in the farming-agriculture (50 adopters or 31.25 per cent), manufacturing (45 adopters or 28.13 per cent) and food and raw materials processing (26 adopters or 16.25 per cent) sub-sectors, while the proportional distribution of the married adopters of adapted technology for the same subsectors was at 5 adopters or 3.1 per cent, 15 adopters or 9.4 per cent, and 5 adopters or 3.1 per cent for the same sub-sectors, respectively. On the other hand, Table A8 in Appendix II shows that more married adopters adopted non-adapted technology, with the distribution of adopters by sub-sector being remarkably similar at 28 adopters or 17.5 per cent, 36 adopters or 22.5 per cent and 49 adopters or 30.6 percent and for farming-agriculture, manufacturing and food and raw materials processing, respectively.

Overall, therefore, the descriptive statistics show that unmarried individuals were more inclined to adopt adapted technology than married ones. This result supports the results of piloting the research instrument, which indicated that the marital status of a potential adopter influenced the decision to adopt technology. The preponderance of choice of non-adapted technology for married adopters suggest that the perception that adapted technology was untested and therefore riskier to adopt was not limited to the elderly category of adopters, but also to the married adopters. It was worth noting that most of the unmarried adopters of adapted technology cited low cost and ease of use of the adapted technology as the main influences on their decision to adopt.
4.5.5 Entrepreneur’s Social Status before Adoption of the Technology

Entrepreneur’s social status before adoption of the technology variable was another variable that was considered specific to the informal sector. It was included to take care of the role of one’s social status (that is, one with role-model responsibilities) in society plays in influencing the decision to adopt technology. In such cases, an elder, government administrator (chief), politician, religious leader or successful business person, who for altruistic or non-profit motive wishes to endear him/herself to members of the community, would adopt technology (such as a maize grinding mill) in order to provide goods or services to the local community. Table 4.19 shows adopters’ responses on the adopter’s social status before adoption of the technology variable by technology type.

Table 4.19 Responses on adopter’s social status before adoption of the technology

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Responses on entrepreneur’s social status before adoption of the technology</th>
<th>Total number of adopters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Had no status before adoption</td>
<td>Had status before adoption</td>
</tr>
<tr>
<td></td>
<td>Number of adopters</td>
<td>percentage</td>
</tr>
<tr>
<td>Non-adapted technology</td>
<td>144</td>
<td>90.00</td>
</tr>
<tr>
<td>Adapted technology</td>
<td>140</td>
<td>87.50</td>
</tr>
<tr>
<td>Total number of adopters</td>
<td>284</td>
<td>36</td>
</tr>
</tbody>
</table>

Data Source: Survey Data

Data collected from respondents for this variable raised doubts about the correctness of the responses. Table 4.16 (in section 4.5.1) showed that there were 25 adopters in the elderly group, who comprised mainly retirees from both the public and private sectors.
Further, Table 4.18 (in section 4.5.3) showed that there were 29 university graduate adopters, in addition to the 166 graduates of tertiary institutions. In Kenya’s informal sector environment, most, if not all of the elderly adopters and most graduates of universities and tertiary institutions should qualify as entrepreneurs who had acquired social status in their communities before adopting the technology. Since the descriptive statistics do not support this view, one is tempted to hazard a guess that the respondents’ fear that the state, county and local authority tax officials, desirous of widening the tax base, could follow the elderly in retirement, or raise queries of public and private sector employees’ income tax declarations, could have motivated the respondents to undervalue their social status as a cover. Thus, the need to put a caveat on the veracity of the information they provided.

The caveat on the veracity of the information respondents provided for this variable, notwithstanding, Table 4.19 shows that 16 out of 160 or 10 per cent of adopters of non-adapted technology and 20 out of 160 or 12.50 per cent adopters of adapted technology had social status in their communities before adoption of technology. Data also showed that while all 16 adopters of non-adapted technology, who had social status before adoption, were motivated solely by the profit motive to acquire the technology, only 4 out of the 20 adopters of adapted technology who had social status before adoption had some altruistic or non-monetary but self-serving motive behind the adoption. Of the 4, three were religious leaders (altruistic motive) and one was a political leader (non-monetary but self-serving motive).
Thus, the descriptive statistics for this variable show that the adopters of adapted technology who had social status before adoption were too few to support one of Roger’s study findings (Rogers, 2003) that society’s role models have influence in technology adoption by taking the lead to adopt. This study finding suggests that, while it might do little harm for policy makers and donor agencies to involve elders, government administrators (chiefs), politicians, religious leaders or successful business persons, in the promotional activities for adoption of adapted technology, this should only be peripheral as the claim of their influence on adoption of adapted technology is unsupported by this study’s data.

4.5.6 Gender-related Cultural Practices (dropped from the logit)

Perceived gender-related cultural practices variable was another variable that was considered specific to the informal sector. This variable was supposed to establish whether gender-related cultural practices were impediments to adoption and use of technology by women, particularly when it came to raising funds for economic ventures (Wawire and Nafukho, 2010). Table 4.20 shows adopters’ responses to the influence of perceived gender-related cultural practices variable on the decision to adopt technology.
Table 4.20 Responses on perceived gender-related cultural beliefs and practices

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Responses on perceived gender-related cultural beliefs that influence decision to adopt technology</th>
<th>Total number of adopters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cultural practices do not influence adoption</td>
<td>Cultural practices influence adoption</td>
</tr>
<tr>
<td></td>
<td>Number</td>
<td>percentage</td>
</tr>
<tr>
<td>Non-adapted</td>
<td>160</td>
<td>100.00</td>
</tr>
<tr>
<td>Adapted technology</td>
<td>160</td>
<td>100.00</td>
</tr>
<tr>
<td>Total number of adopters</td>
<td>320</td>
<td></td>
</tr>
</tbody>
</table>

**Data Source: Survey Data**

All the 320 respondents in the sample said that perceived gender-related cultural practices were neither impediments to adoption nor important in influencing the decision to adopt technology. The female respondents, however, conceded that cultural practices were important factors in the management and use of the technology, as involvement in commercial activities made inroads on women’s time for household responsibilities.

4.6 Descriptive Statistics of Communication Channels Used to Get Information

The third objective was to determine the communication channels used to acquire information about adapted technology. The communication channels had three components in the model: Interpersonal contact communication channel (ICCC), mass media communication channel (MMCC) and promotional activities of sales agents (PASA) channel. Tables 4.21, 4.22 and 4.23 show adopters’ responses on individual communication channels used to get information about technology.
4.6.1 Interpersonal contact communication channel

Tables 4.21, shows adopters who used the interpersonal contact communication channel to get information about the technology they adopted.

Table 4.21 Interpersonal contact communication channel used to get information

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Interpersonal communication contact channel used to get information about technology</th>
<th>Total number of adopters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Channel used to get information</td>
<td>Channel not used to get information</td>
</tr>
<tr>
<td></td>
<td>Number of adopters</td>
<td>percentage</td>
</tr>
<tr>
<td>Non-adapted</td>
<td>149</td>
<td>93.1</td>
</tr>
<tr>
<td>Adapted technology</td>
<td>131</td>
<td>81.88</td>
</tr>
</tbody>
</table>

Source of data: Survey

Table 4.21 shows that there was overwhelming dominance of the interpersonal contact communication channel as the first source of information to all the adopters. When separated into non-adapted and adapted adopters, 131 or 81.88 per cent of the 160 adopters of the adapted technology, got information about the technology they adopted through the interpersonal contact communication channel. This result is supported by a number of studies, which have shown that technology adoption is enhanced through peer effects of adoption as a result of learning from others about the benefits of the technology (Conley and Udry, 2000; Munshi, 2004; Kremer and Miguel, 2006).
4.6.2 Mass media and promotional activities of sales agents

Tables 4.22 and 4.23 show responses to the mass media communication and promotional activities of sales agents channels as sources of information to the adopters, respectively.

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Mass media channel used to get information about technology</th>
<th>Total number of adopters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Channel used to get information</td>
<td>Channel not used to get information</td>
</tr>
<tr>
<td></td>
<td>Number of adopters</td>
<td>Percentage</td>
</tr>
<tr>
<td>Non-adapted</td>
<td>11</td>
<td>6.9</td>
</tr>
<tr>
<td>Adapted technology</td>
<td>31</td>
<td>19.4</td>
</tr>
</tbody>
</table>

Source of data: Survey

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Promotional activities of sales agents channel used to get information</th>
<th>Total number of adopters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Channel used to get information</td>
<td>Channel used to get information</td>
</tr>
<tr>
<td></td>
<td>Number of adopters</td>
<td>Percentage</td>
</tr>
<tr>
<td>Non-adapted</td>
<td>11</td>
<td>6.9</td>
</tr>
<tr>
<td>Adapted technology</td>
<td>35</td>
<td>21.9</td>
</tr>
</tbody>
</table>

Source of data: Survey

Tables 4.22 and 4.23 show that, unlike the interpersonal contact communication channel, the mass media and the promotional activities of sales agents communication.
channels played only minor roles as sources of information for adopters of adapted technology. This is contrary to the empirical study findings based on the Bass (1968) model and Rogers (2003), which showed that these two channels played major roles as sources of information in the adoption process. Table 4.24 shows the distribution of adopters who got information about technology from more than one communication channel.

**Table 4.24 Responses on multiple communication channels used to get information**

<table>
<thead>
<tr>
<th>Communication channel used to get information about the technology</th>
<th>Observations: Technology overall (Both adapted and non-adapted technologies)</th>
<th>Observations: Technology Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percentage</td>
</tr>
<tr>
<td>Interpersonal contact communication channel</td>
<td>274</td>
<td>85.625</td>
</tr>
<tr>
<td>Mass media and sales promotion channels</td>
<td>39</td>
<td>12.1875</td>
</tr>
<tr>
<td>Interpersonal contact and sales promotion communication channels</td>
<td>4</td>
<td>1.25</td>
</tr>
<tr>
<td>Mass media, ICC, and PASA communication channels</td>
<td>3</td>
<td>0.9375</td>
</tr>
<tr>
<td>Total</td>
<td>320</td>
<td>100</td>
</tr>
</tbody>
</table>

**Source of data: Survey**

Out of the total sample of 320 observations, 274 or 86 per cent of all adopters got information about the technology through the interpersonal contact communication channel. This was the only communication channel, which most of the respondents said was the only channel they used to get information about the technology before they adopted. The other two channels were used in combination by adopters either before or after they adopted.
Table 4.2 also shows that out of a total 320 adopters, only 39 or 12.2 per cent got information about the technology they adopted from mass media and the promotional activities of promotional agents. There were 28 adopters for adapted technology, and 11 adopters for non-adapted technology. Even then, in most cases these two communication channels were only used as second sources when the adopters sought more information on the technology after they had got the first information from interpersonal contacts. It was noted that all the 35 adopters of adapted technology got more information through this channel when they visited the Agricultural Society of Kenya (ASK) Shows that are held annually in their respective counties.

Tables A19 and A20 in Appendix II show the distribution of adopters by sub-sector into the communication channels that the adopters used to get information about the technology. The two tables emphasize further the dominance of interpersonal contact communication channel as the source of information for both categories of adopters in different sub-sectors in the study. These figures suggest that, much as adopters of adapted technology were more sensitive to the different types of communication channels than those that adopted non-adapted technology, the mass media communication channel and promotion activities of sales agents communication channel did not play a significant role as sources of information to adopters, even in their combined form, in the informal sector. The most likely explanation for this result
is due to the dearth of promotional agents’ activities and the limited reach of mass media to the participants of economic activities in the informal sector.

As Tables A19 and A20 in Appendix II also show that there was a significant difference between the two data sets only when the interpersonal contact communication channel was not considered, since the overwhelming majority of adopters from both group data sets (adapted and non-adapted) got information from the interpersonal contact communication channel. This study finding corroborated the early research study findings, which contended that during the initial stages of a country’s development, the interpersonal contact channel is the main channel of accessing information about a new technology (Bowers, 1937, 1938).

Thus, in response to the study’s third objective, the results of study’s descriptive statistics make one to safely assert that the communication channel that was overwhelmingly relied on as the source of information to most adopters of adapted technology in the informal sector was the interpersonal contact communication channel (ICCC). In distant second were a combination of the mass media and the promotional activities of sales agents communication channels.
4.7 The Regression Results

4.7.1 Multicollinearity Test Results

The study’s logit model of twenty variables was subjected to a multicollinearity test to determine the level of correlation between the independent variables. To achieve this, a correlation analysis, using a pairwise matrix, was undertaken to determine the degree of correlation between the study’s twenty independent variables. This was done to avoid serious problems of multicollinearity that could undermine the effective use of the model in the analysis. Multicollinearity is a regression illness resulting from a violation of one of the classical linear regression assumptions, namely, that none of the independent variables in the model should be linearly related to another (Halcoussis, 2005). However, economic theory tells us that many factors in the economy affect each other. Therefore, any regression model with more than one independent variable is likely to have some degree of relationship with another independent variable in the same model. Therefore, this study’s concern with the problem of multicollinearity was one of degree (Halcoussis, 2005; Okech, 2010).

One of the signals of multicollinearity is the correlation coefficient $r$, which measures the extent to which two variables move together. The coefficient $r$ takes the values from $-1$ to $+1$. The closer $r$ is to $+1$ or $-1$, the more likely there is a serious problem of multicollinearity. In economics, however, multicollinearity is usually generated by variables with positive correlation coefficients (Halcoussis, 2005). Many researchers
consider a correlation coefficient of 0.80 and above as indicative of the presence of serious multicollinearity, which would result in biased estimates (Halcoussis, 2005).

Two pairwise correlation matrix were carried out on the study’s twenty variables. The first pairwise matrix did not provide any correlation coefficients for three discrete explanatory variables, namely, perceived usefulness of technology, perceived ease of use of technology and perceived gender-related cultural practices. The result of the first pairwise matrix of 20 variables is presented in Table A21 in Appendix II. The degree of correlation between the interpersonal contact communication channel and mass media communication channel variables was – 0.9444. Similarly, the degree of correlation between promotional activities of sales agents and mass media communication channel variables was 0.9486; and the degree of correlation between promotional activities of sales agents channel and interpersonal contact communication channel was – 0.8955.

When all the three variables were included the regression did not yield any results. Since each of the three communication channel variables had a correlation coefficient ranging from - 0.8 to -1 and from + 0.9 to +1, a decision was made to pick promotional activities of sales agents channel to represent the three communication variables and drop the mass media communication channel and the interpersonal contact communication channel from the regression.
Finally, the degree of correlation between the machine’s perceived suitability to the
local environment and the perceived reliability of the machine variables was 0.9876.
Since the inclusion of the two, or either of them, made the regression fail to give a
result, both were also dropped. Therefore, in total the first multicollinearity test resulted
in the dropping of four variables, namely, interpersonal contact communication channel,
mass media communication channel, machine’s perceived suitability to the local
environment and perceived reliability of the machine variables from the regression
model.

After dropping the four independent variables, the following 16 variables were left in
the logit equation for regression analysis: cost of machine in Kenya shillings; machine’s
servicing and maintenance cost in Kenya shillings per month; cost of energy; number of
employees operating the machine; wage bill cost of labour used to operate the machine
in Kenya shillings per month; machine’s average production output valued in Kenya
shillings per month; perceived usefulness of the technology; perceived ease of use of
the technology; machine’s perceived conferment of higher social status (in the local
community) to the owner; Age of adopter; sex of adopter; level of education of adopter;
marital status of the entrepreneur/adopter; perceived gender-related cultural practices
that influence adoption; entrepreneur’s social status in the local community before
technology adoption; and promotional activities of sales agents.
Several regression trial runs were carried out, starting with the regression of the dependent variable on the 16 remaining independent variables. Much as the regression gave a result it (the regression) still exhibited trouble with very long durations of iterations and relatively low values of the Pseudo $R^2$. Already, the first pairwise correlation matrix used to determine the degree of correlation had not provided any correlation coefficients for three variables: perceived usefulness of the technology; perceived ease of use of the technology and perceived gender-related cultural practices that influence adoption. Furthermore, the Davis (1989) study had indicated that two variables, perceived ease of use of technology and perceived usefulness of technology were very strong correlates when it came to the technology user acceptance process. Therefore, the presence of these two variables in the study’s model gave an early hint of the continued presence serious multicollinearity.

A second pairwise matrix was estimated to determine the degree of correlation between the remaining 16 variables of the model, since it was apparent that a number of the 16 variables were in some way related to each other. When the second pairwise correlation matrix was obtained, three discrete explanatory variables (perceived usefulness of technology, perceived ease of use of technology and perceived gender-related cultural practices that influence adoption), which were omitted by the first pairwise correlation matrix, were omitted again. These three variables were, therefore, also dropped from the logit model. It will be noted that all the seven variables that were dropped were discrete variables.
The study’s logit model was left with thirteen (excluding category) predictor variables in the logit model. Two of these - age of adopter and level of education of adopter - were categorised. This brought to seventeen the number of predictor variables in the logit model. A third and final pairwise correlation matrix was estimated. Table A22 in Appendix II shows a correlation matrix resulting from the third pairwise correlation matrix for multicollinearity on the remaining thirteen main explanatory variables in the logit model of the study. The third and final pairwise correlation matrix yielded a correlation matrix with all the variables’ correlation coefficients that were below the target range of -0.6 to +0.6, a range This range was considered acceptable for the study’s requirements because it was below the -0.8 to +0.8 range considered to be serious level of multicollinearity. It is the logit model, with the seventeen variables (including categories of age and level of education), which was subjected to the regression estimation.

4.7.2 Logit Model Estimates

The regression of the independent variables was carried out in two steps. The first step regression was to get estimates of log of odd ratios of the explanatory variables in the model. Table 4.25 shows the first step regression estimates of log of odd ratios of the explanatory variables in the model.
Table 4.25 Logit model estimates of adoption of technology

<table>
<thead>
<tr>
<th>Predictor Variables</th>
<th>Coefficient</th>
<th>Std Error</th>
<th>Z</th>
<th>P &gt;</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of machine (Ksh)</td>
<td>-0.0000129*</td>
<td>0.000</td>
<td>-1.91</td>
<td>0.056</td>
<td></td>
</tr>
<tr>
<td>Age of adopter 123_2</td>
<td>-1.612075</td>
<td>1.015</td>
<td>-1.59</td>
<td>0.112</td>
<td></td>
</tr>
<tr>
<td>Age of adopter 123_3</td>
<td>-2.986652**</td>
<td>1.513</td>
<td>-1.97</td>
<td>0.048</td>
<td></td>
</tr>
<tr>
<td>Sex of adopter</td>
<td>-0.0498985</td>
<td>.493</td>
<td>-0.10</td>
<td>0.919</td>
<td></td>
</tr>
<tr>
<td>Machine’s maintenance cost (Kshpm)</td>
<td>-0.0086568***</td>
<td>.002</td>
<td>-3.76</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Number of Workers</td>
<td>-2.310195***</td>
<td>.433</td>
<td>-5.33</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Cost of energy used in production (Kshpm)</td>
<td>.0002141***</td>
<td>.000</td>
<td>2.85</td>
<td>0.004</td>
<td></td>
</tr>
<tr>
<td>Level of education</td>
<td>-2.297943*</td>
<td>1.297</td>
<td>-1.77</td>
<td>0.077</td>
<td></td>
</tr>
<tr>
<td>Level of education of adopter 12345_3</td>
<td>-1.560492</td>
<td>1.288</td>
<td>-1.21</td>
<td>0.226</td>
<td></td>
</tr>
<tr>
<td>Level of education of adopter 12345_4</td>
<td>-1.487073</td>
<td>1.455</td>
<td>-1.02</td>
<td>0.307</td>
<td></td>
</tr>
<tr>
<td>Level of education of adopter 12345_5</td>
<td>-1.003596</td>
<td>1.541</td>
<td>-0.65</td>
<td>0.515</td>
<td></td>
</tr>
<tr>
<td>Marital status of Adopter</td>
<td>.9089251</td>
<td>.522</td>
<td>1.74</td>
<td>0.082</td>
<td></td>
</tr>
<tr>
<td>Wage bill of enterprise (Kshpm)</td>
<td>-.0004992***</td>
<td>.000</td>
<td>-2.68</td>
<td>0.007</td>
<td></td>
</tr>
<tr>
<td>Perceived conferment of higher social status to entrepreneur</td>
<td>2.723096**</td>
<td>1.210</td>
<td>2.25</td>
<td>0.024</td>
<td></td>
</tr>
<tr>
<td>Entrepreneur’s social status in local community</td>
<td>1.263922</td>
<td>1.006</td>
<td>1.26</td>
<td>0.209</td>
<td></td>
</tr>
<tr>
<td>Machine’s production output (Kshpm)</td>
<td>9.03e-06</td>
<td>.000</td>
<td>0.81</td>
<td>0.419</td>
<td></td>
</tr>
<tr>
<td>Promotion activities of sales agents</td>
<td>.6492509</td>
<td>.693</td>
<td>0.94</td>
<td>0.349</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>10.34781***</td>
<td>2.278</td>
<td>4.54</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

Number of observations = 320; LR chi$^2$ (17) = 261.67; Prob > chi$^2$ = 0.0000; Pseudo $R^2$ = 0.5899;
Log likelihood = - 90.973433

Note: ***implies significant at 1 per cent level; ** significant at 5 per cent level and * significant at 10 per cent level.

Source: Derived from data analysis
4.7.3 Diagnostic Tests Results

a) Normality Test

This study adopted a logit regression model, which is based on the cumulative logit distribution, with an S-shaped curve, and where the error term is neither normally distributed nor constant across the entire range of data (Coombs et al., 1987; Peng, Manz, and Keck, 2001; Peng, Lee, and Ingersoll, 2002; Rogers, 2003). Under the logit regression model, instead of the OLS estimator, the maximum likelihood estimator (MLE) was preferred (Schmittlein and Mahajan, 1882; Mahajan, Muller and Bass, 1990).

In an attempt to test for normality on a logistic regression model, Okech (2010) used the standard OLS tests for normality by checking how close the mean was to the median; whether skewness was approximately zero; and whether the kurtosis was close to 3. The results showed that all these three were violated. Further tests for normality on the same model using the Jarque-Bera (J-B) statistic were carried out by Okech (2010) to establish whether the J-B test value was greater than the critical value of the chi-square. The J-B test established that the J-B value was far beyond the critical value of the chi-square. Therefore, Okech’s attempt to use the standard OLS tests to test for normality in the logit model was rendered futile.
This study’s fall-back position was the Central Limit Theorem (CTL), which posits that the mean of the independently and identically distributed random variables will be normally distributed as the sample becomes larger (Halcoussis, 2005). This study’s sample was composed of 320 observations, which was larger than the minimum of 100 observations suggested by previous studies as adequate for survey research (Gall, Borg, and Gall, 1996; Sudman, 1976; Watson, 2001).

Thus, Okech’s normality test results, and the fact that a logistic regression model is based on the cumulative logit distribution, with an S-shaped curve, and where the error term is not normally distributed, made the requirement for a formal normality test for this study’s model redundant.

b) Heteroskedasticity Test Results

Heteroskedasticity is a regression problem that is common with cross-section data, where there are large differences in size between observations. It also arises from a model specification error, where an important predictor variable is missing (Halcoussis, 2005). It manifests itself by means of the error term that does not have a constant variance. One of the OLS classical linear regression model assumptions is that the error terms of observations must be homoskedastic, that is, they must have a constant variance (Halcoussis, 2005). When the error terms of observations have different variances, heteroskedasticity is present in the regression model. If a study uses the OLS as an estimator, the presence of heteroskedastic error terms would lead to incorrect
standard errors. However, as pointed out under the normality test, the error term of the logistic regression model does not have a constant variance. Thus, taking into consideration the fact that a logit model is heteroskedastic by design, and that even when heteroskedasticity is present, the regression can still produce unbiased estimates, the heteroskedasticity test was not considered a helpful test and therefore unnecessary as a diagnostic test for this study’s model.

At this point of analysis, the question that arose was whether the dropped and omitted predictor variables were irrelevant to the study’s logistic model. A closer look at the data for the seven predictor variables dropped or omitted by the regression showed that the information from respondents concerning these seven variables was by coincidence very similar. This was irrespective of whether the respondent was an adopter of adapted or non-adapted technologies. The dropped and omitted discrete variables seem to have been a classic case of dummy traps, where the respondents’ responses were the same accidentally. That is, there was no variation between the two data sets (adapted and non-adapted) to facilitate a result from the regression. For example, the study’s descriptive statistics showed that all the respondents from both adopters of adapted and non-adapted machines said that their attitudes towards perceived usefulness and perceived ease of use of the machines influenced their decision to adopt the machines.

Thus, the fact that a logit model was heteroskedastic by design, and the fact that even when heteroskedasticity was present, the regression could still produce unbiased
estimates, the test for heteroskedasticity was, like the normality test, considered unnecessary for this study’s model.

Table 4.25 shows the parameter estimates of the seventeen variables. The pseudo $R^2$ of the logit regression on seventeen predictor variables was 0.5899. Under the OLS regression procedure, a level of performance of $R^2 = 0.5899$ is considered very low. However, under the logit regression procedure, a measure of performance above Pseudo $R^2 = 0.5$ is considered to be a prediction that the dependent variable is equal to 1 (Halcoussis, 2005). Therefore, for this study, the logit model’s measure of performance of 0.5899 for pseudo $R^2$ was considered satisfactory.

4.7.4 Goodness-of-fit Test Results

Once a logistic regression model has been fitted with a given data, the adequacy of the model is examined by overall goodness-of-fit tests. The purpose of any overall goodness-of-fit test is to determine whether the fitted model adequately describes the observed outcome experience of the data (Hosmer & Lemeshow, 2000; Peng, Ingersoll, & Lee, 2002; and Archer & Lemeshow, 2006). The test outcome for this study was whether a low-income entrepreneur in the informal sector would adopt adapted technology or otherwise. One of the standard classical goodness-of-fit tests, the Hosmer-Lemeshow (H-L) test, was used to test the null hypothesis that the logit model provided a good fit to the data against the alternative hypothesis that the logit model is
not a good fit to the data. Table 4.26 shows the results of the Hosmer-Lemeshow test of goodness-of-fit of the study’s logistic model.

Table 4.26 Logistic model goodness-of-fit test results

<table>
<thead>
<tr>
<th>Probability</th>
<th>Obs 1</th>
<th>Exp 1</th>
<th>Obs 0</th>
<th>Exp 0</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0013</td>
<td>0</td>
<td>0.0</td>
<td>32</td>
<td>32.0</td>
<td>32</td>
</tr>
<tr>
<td>0.0284</td>
<td>2</td>
<td>0.3</td>
<td>30</td>
<td>31.7</td>
<td>32</td>
</tr>
<tr>
<td>0.1243</td>
<td>4</td>
<td>2.6</td>
<td>28</td>
<td>29.4</td>
<td>32</td>
</tr>
<tr>
<td>0.2213</td>
<td>3</td>
<td>5.7</td>
<td>29</td>
<td>26.3</td>
<td>32</td>
</tr>
<tr>
<td>0.5133</td>
<td>9</td>
<td>11.1</td>
<td>23</td>
<td>20.9</td>
<td>32</td>
</tr>
<tr>
<td>0.7333</td>
<td>22</td>
<td>20.2</td>
<td>10</td>
<td>11.8</td>
<td>32</td>
</tr>
<tr>
<td>0.9222</td>
<td>26</td>
<td>26.5</td>
<td>6</td>
<td>5.5</td>
<td>32</td>
</tr>
<tr>
<td>0.9697</td>
<td>30</td>
<td>30.4</td>
<td>2</td>
<td>1.6</td>
<td>32</td>
</tr>
<tr>
<td>0.9896</td>
<td>32</td>
<td>30.4</td>
<td>0</td>
<td>0.6</td>
<td>32</td>
</tr>
<tr>
<td>0.9999</td>
<td>32</td>
<td>31.8</td>
<td>0</td>
<td>0.2</td>
<td>32</td>
</tr>
</tbody>
</table>

Number of observations   =   320
Number of groups         =   10
Hosmer-Lemeshow $\chi^2(8)$ = 13.15
Prob > $\chi^2$ = 0.1068 = the p-value of the H – L test

Source: Derived from Data Analysis

Using the study’s data set, the Hosmer-Lemeshow test yielded a chi-square of 13.15 with eight degrees of freedom. The p-value for the H-L test was 0.1068 which was not significant at either 1 per cent, 5 per cent or 10 per cent levels. Therefore, the null
hypothesis was not rejected, which implied that the logit model was a good fit to the data set for the model.

**4.7.5 Overall evaluation of the model using the likelihood ratio test**

The logit regression model’s effectiveness was assessed using the likelihood ratio test. A logistic model is said to provide a good fit to the data if it demonstrates an improvement over the intercept-only model or one with restricted explanatory variables (Peng, Lee, & Ingersoll, 2002). The likelihood ratio (LR) test is commonly used to evaluate the difference between two nested models that share the same dependent variable. The test is done by estimating the log likelihoods of two models, one, which is without predictor variables and is restricted to the intercept-only, and the other an unrestricted model, with all the predictor variables. A comparison is then made of their log likelihoods estimates. In a regression model, it is assumed that the intercept-only restricted model, when compared to an unrestricted one with the same dependent variable, will almost always make the restricted model fit less well to the data than the unrestricted model (Peng *et al.*, 2002)

For the test in this study, the null hypothesis was that the intercept-only model was a better fit to the data, against the alternative hypothesis of the model with all the predictor variables. The hypothesis was tested using the likelihood ratio test by nesting and estimating the log likelihoods of the two models: log likelihood – 221.8071 for M1
model, which was the intercept-only (restricted) model, and log likelihood – 93.6226 for M2, which was for the model that contained all the seventeen explanatory variables. This was done to find out if leaving out the predictor variables in the M1 model would significantly reduce the fit of the study’s logit model. The likelihood ratio test result was $LR \text{Chi}^2 (13) = 256.37$, while the M1 nested in M2 yielded a p-value of 0.0000.

The likelihood ratio test gave the chi-square value generated by the test as 256.37 with thirteen degrees of freedom, as well as the p-value of the likelihood ratio test of 0.0000, which was statistically significant at 1 per cent level. This result shows that adding seventeen predictor variables to the intercept-only model (M1) resulted in a statistically significant improvement in the model’s fit. Therefore, the results show that the null hypothesis was rejected, implying that, for this study, the intercept-only model is inferior to the model with all the predictor variables. Therefore, the likelihood ratio test demonstrated that the study’s logistic model provided a good fit to the data set of this study.

The results of the regression in Table 4.25 also showed that the coefficients of each of the predictor variables had the expected sign, except for the cost of energy used in production variable. However, the estimated coefficients of the logit model in Table 4.25 could not be interpreted because they were not the marginal effects the study set out to interpret. As a result, it was necessary to undertake step two of the regression in order to get the marginal effect estimates for interpretation.
The second step of the regression was to derive estimates of the marginal effects of the explanatory variables on the probability of adoption of adapted technology. The estimates of the marginal effects of the independent variables helped to show whether the sign of the coefficient and size of the p-value estimates of variables were in line with the economic theory and/or the other findings of empirical studies on the subject. Table 4.27 gives the coefficient estimates of the marginal effects of the seventeen predictor variables.
Table 4.27 Marginal effects estimates for the logit regression

<table>
<thead>
<tr>
<th>Predictor Variables</th>
<th>dy/dx</th>
<th>Std Error</th>
<th>Z</th>
<th>P &gt;</th>
<th>Z</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of machine (Ksh)</td>
<td>-.290e-06**</td>
<td>.000</td>
<td>-2.46</td>
<td>0.014</td>
<td>113</td>
<td></td>
</tr>
<tr>
<td>Age of adopter123 (Middle)_2</td>
<td>-.3788314*</td>
<td>.229</td>
<td>-1.65</td>
<td>0.099</td>
<td>.775</td>
<td></td>
</tr>
<tr>
<td>Age of Adopter123 (Eldely)_3</td>
<td>-.3637129***</td>
<td>.130</td>
<td>-2.79</td>
<td>0.005</td>
<td>.078</td>
<td></td>
</tr>
<tr>
<td>Sex of adopter</td>
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<td>.110</td>
<td>-0.10</td>
<td>0.919</td>
<td>.284</td>
<td></td>
</tr>
<tr>
<td>Machine’s maintenance cost (Kshpm)</td>
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<td>.001</td>
<td>-1.95</td>
<td>0.003</td>
<td>304.875</td>
<td></td>
</tr>
<tr>
<td>Number of workers</td>
<td>-.5194863***</td>
<td>.106</td>
<td>-4.89</td>
<td>0.000</td>
<td>1.846</td>
<td></td>
</tr>
<tr>
<td>Cost of energy used in production(Kshpm)</td>
<td>.0000482***</td>
<td>.000</td>
<td>2.79</td>
<td>0.005</td>
<td>3971.56</td>
<td></td>
</tr>
<tr>
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<td>-2.10</td>
<td>0.036</td>
<td>.272</td>
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</tr>
<tr>
<td>Level of education of adopter 2345 (Tertiary)_3</td>
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<td>.273</td>
<td>-1.25</td>
<td>0.211</td>
<td>.519</td>
<td></td>
</tr>
<tr>
<td>Level of education of adopter 12345(University)_4</td>
<td>-.2541306</td>
<td>.187</td>
<td>-1.36</td>
<td>0.175</td>
<td>.091</td>
<td></td>
</tr>
<tr>
<td>Level of education of adopter 12345(OJT)_5</td>
<td>-.1857127</td>
<td>.229</td>
<td>-0.81</td>
<td>0.417</td>
<td>.044</td>
<td></td>
</tr>
<tr>
<td>Marital status of entrepreneur</td>
<td>.1992872*</td>
<td>.118</td>
<td>1.69</td>
<td>0.092</td>
<td>.547</td>
<td></td>
</tr>
<tr>
<td>Wage bill of enterprise (Kshpm)</td>
<td>-.0001123**</td>
<td>.000</td>
<td>-2.39</td>
<td>0.017</td>
<td>4738.44</td>
<td></td>
</tr>
<tr>
<td>Perceived conferment of higher social status to entrepreneur</td>
<td>.5676178***</td>
<td>.152</td>
<td>3.73</td>
<td>0.000</td>
<td>.072</td>
<td></td>
</tr>
<tr>
<td>Entrepreneur’s social status in local community</td>
<td>.3039425</td>
<td>.236</td>
<td>1.29</td>
<td>0.197</td>
<td>.113</td>
<td></td>
</tr>
<tr>
<td>Machine’s production Output (Kshpm)</td>
<td>2.03e-06</td>
<td>.000</td>
<td>0.83</td>
<td>0.406</td>
<td>117405</td>
<td></td>
</tr>
<tr>
<td>Promotion activities of Sales agents</td>
<td>.1540096</td>
<td>.171</td>
<td>0.90</td>
<td>0.368</td>
<td>.144</td>
<td></td>
</tr>
</tbody>
</table>

Marginal effect after logit: \( y = \text{Pr} (\text{tech10}) \text{ (predict)} = .34146565 \)

Note: ***implies significant at 1 per cent level; ** significant at 5 per cent level and * significant at 10 per cent level.

Source: Derived from the logit estimates of Table 4.26
From the results shown in Table 4.27, it can be observed that the coefficients of ten predictor variables (cost of machine, both categories of age of adopter variable, machine maintenance cost, number of workers, cost of energy, the first category of level of education variable, wage bill of enterprise, marital status of entrepreneur and perceived conferment of higher social status to the adopter) were statistically different from zero at 1, 5 and 10 per cent levels of significance ($p < 0.1$).

4.7.6 Marginal effects of technology-specific factors on adoption

Table 4.28 shows the marginal effects of the technology-specific variables:

Table 4.28 Marginal effects of technology-specific factors

<table>
<thead>
<tr>
<th>Predictor Variables</th>
<th>dy/dx</th>
<th>Std Error</th>
<th>Z</th>
<th>P &gt;</th>
<th>Z</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of machine (Ksh)</td>
<td>-2.90e-06**</td>
<td>.000</td>
<td>-2.46</td>
<td>0.014</td>
<td>113329</td>
<td></td>
</tr>
<tr>
<td>Machine’s maintenance cost (Ksh/machine)</td>
<td>-.0019466***</td>
<td>.001</td>
<td>-1.95</td>
<td>0.003</td>
<td>304.875</td>
<td></td>
</tr>
<tr>
<td>Number of workers</td>
<td>-.5194863***</td>
<td>.106</td>
<td>-4.89</td>
<td>0.000</td>
<td>1.84688</td>
<td></td>
</tr>
<tr>
<td>Cost of energy used in production (Kshpm)</td>
<td>.0000482***</td>
<td>.000</td>
<td>2.79</td>
<td>0.005</td>
<td>3971.56</td>
<td></td>
</tr>
<tr>
<td>Wage bill of enterprise (Kshpm)</td>
<td>-.0001123**</td>
<td>.000</td>
<td>-2.39</td>
<td>0.017</td>
<td>4738.44</td>
<td></td>
</tr>
<tr>
<td>Perceived conferment of higher social status to entrepreneur</td>
<td>.5676178***</td>
<td>.152</td>
<td>3.73</td>
<td>0.000</td>
<td>.071875</td>
<td></td>
</tr>
<tr>
<td>Machine’s production Output (Kshpm)</td>
<td>2.03e-06</td>
<td>.000</td>
<td>0.83</td>
<td>0.406</td>
<td>117405</td>
<td></td>
</tr>
</tbody>
</table>

Note: *** implies significant at 1 per cent level; ** significant at 5 per cent level and * significant at 10 per cent level.

Source: Extracted from Table 4.27
Table 4.28 shows that, using p-values as a measure, six out of seven technology-specific variables were important in influencing the decision to adopt adapted technology. The results of the technology-specific factors are:

a) **Cost of machine in Kenya shillings**

The results show that the coefficient of the cost of machine was negative and statistically significant at 5 per cent as shown by the p-value of 0.014. This implies that holding all the other factors constant, an increase in the cost of the adapted machine by one shilling would reduce the probability of its adoption by 0.0000029. What this result means is that expensive adapted machines have fewer chances of being adopted by the entrepreneurs in the informal sector. The result supports the empirical findings by Coombs *et al*, (1987), Nabsenth & Ray (1974) and price theory by Watson & Getz (2004).

The price theory predicates that the price of a good or service is one of the main determinants of demand (Watson and Getz, 2004). One would therefore expect, *ceteris paribus*, a decline in adoption of adapted machines if their prices increased. However, the reality on the ground is that prices of most adapted machines, like most other prices in Kenya, have been increasing in the past ten years and yet demand for their most popular product of adapted technology (the *Money Maker*) has also been increasing. This could partly be explained by the fact that the rate of increase in prices of the *Money Maker* has been lower than the rate of increase in demand for, and therefore the
prices of the final products. For example, according to KickStart field officials, while the price of the large size *money maker* irrigation pump increased by 16.7 per cent from Ksh 5995/= in 2000 to Ksh 6995/= in 2010, the prices of tomatoes, cabbages, carrots and Irish potatoes produced using the *money maker* machine for irrigation more than doubled during the same period.

b) **Machine’s maintenance cost**

The coefficient of the machine’s maintenance cost factor is negative and statistically significant at 1 per cent level of significance as shown by the p-value of 0.003. This implies that holding all the other factors constant, an increase in the maintenance cost of the adapted machine by one shilling would reduce the probability of its adoption of the adapted technology by 0.0019466. This finding is supported by the Pacey (1996) findings.

The purpose of servicing and maintenance of machines is to minimize breakdowns or the need for frequent repair and replacement of parts. By avoiding adoption of machines that require costly servicing and maintenance, the adopters of adapted machines in this study conformed to expectation. However, the reality on the ground in Kenya’s informal sector indicates that because of the low level of technical knowledge, made worse by the lack of culture of machine servicing and maintenance, the consideration of most technology adopters is to go for adapted maintenance-free or repair-free technology. A good example of maintenance-free adapted machine is the *money maker*
irrigation pump developed by KickStart. Before the money maker irrigation pump became available, it was not uncommon for adopters of the substitute non-adapted pumps in the informal sector to neglect greasing/oiling of the moving parts of their machines until the parts were worn out beyond repair and had to be replaced. Lack of maintenance culture is exemplified by the fact that in most Kenyan vernacular languages, the word maintenance is used synonymously with repair.

c) Number of workers employed to operate the machine

The coefficient of the number of workers is negative and statistically significant at 1 per cent level of significance as shown by the p-value of 0.003. This implies that holding all the other factors constant, an increase in the number of workers of a micro and small enterprise by one employee reduces the probability of its adoption of the adapted technology by 0.5194863. This finding is supported by empirical findings of McPherson (1994) in Zimbabwe and Parker & Torres (1993) in Kenya.

By definition and by the nature of operations of MSEs, individual MSE units employ very few workers. According to Republic of Kenya (1999), 70.1 percent of MSEs employed one worker (in most cases the self-employed owner), 17.9 per cent employed 2 workers, while over 99 percent of all the 1.3 million MSEs fall within the “micro enterprise” size of 1 – 10 workers (Republic of Kenya, 1999). In this study, the employment level per unit for the adapted technology category ranged from one self-employed entrepreneur to three workers.
The preference of a low level of employment resonates with the earlier studies findings, which showed that MSE entrepreneurs are not keen to employ many workers in their enterprises for fear of either the challenges encountered in managing a larger work force or the fear of qualifying for registration to join the formal sector or both. Thus, a combination of limited management skills of entrepreneurs of MSEs, the fear of trade union militancy and the desire to avoid licensing regulations militate against adopting a technology whose operation requires a large workforce. This result seems to support the Chuta (1989) study findings in Nigeria cited in Steel (1993).

Paradoxically, the Government of Kenya defines growth of a unit of a micro and small enterprise using changes in the level of employment. The results for this variable suggest that addressing the unemployment problem by the government would be more appropriate through new start-up adoptions of adapted technology rather than through existing enterprises taking on new workers.

d) Wage bill of the enterprise

The results showed that the coefficient of the wage bill variable is negative and statistically significant at 5 per cent level of significance as shown by the p-value of 0.017. This implied that holding all the other factors constant, an increase in the wage bill of a micro and small enterprise by one shilling reduces the probability of the adapted technology’s adoption by 0.0001123. This result was in keeping with wage theory (Watson and Getz, 2004).
The theory of a firm postulates that in order to maximize profits, a firm considers the wage rate or the marginal factor cost of labour (Watson and Getz, 2004). Since most MSEs face almost perfect competition in both the labour and product markets, and therefore operate on very small profit margins, an increase in the wage bill is something to be avoided. Unlike in the formal sector, the informal sector’s wages are freely set by the entrepreneurs of MSEs. As a result, informal sector wages, defined as remuneration for work done, are generally low, ranging from a monthly wage of Ksh 1000/= for unskilled workers to Ksh7500/= for skilled workers (see Table 4.10 sub-section 4.4.6). A substantial number of employees in the informal sector are paid subsistence wages in kind, comprising of food, shelter, clothing, plus very little cash to buy absolute necessities. By comparison, in the formal sector, where labour laws require wages to be regulated, with the government’s statutory wage guidelines to be followed by formal sector employers, and a minimum wage fixed by the government periodically, the official minimum wage per month at the time of data collection was Ksh 6450/= in Nairobi and Kisumu cities. This official minimum wage is very militantly protected by trade unions in the formal sector, which is one reason why informal sector entrepreneurs fear joining the formal sector.

Part of the explanation for the very low wages in the informal sector is the over abundance of unemployed able-bodied Kenyans, who roam around (“tarmacking”) in a futile search for the elusive jobs. The high level of unemployment forces some of the educated and skilled individuals, including university graduates, to accept low wages
for survival purposes. It would appear that the abundance of unemployed able-bodied people in search of work, and willing to accept low wages, acts as an incentive to entrepreneurs in the informal sector to employ the few workers they currently do. During the interviews all the adopter-employers of adapted technology averred that they would not have hired the number of workers they had if they were required to pay the statutory minimum wage.

e) Cost of Energy in Kenya shillings per month

The coefficient of the cost of energy variable is positive and statistically significant at 1 per cent level of significance as shown by the p-value of 0.005. The fact that the variable’s coefficient has a positive sign implies that, holding all other factors constant, an increase in the cost of energy used to run the machine by one shilling increases the probability to adopt the adapted machine by 0.0000482. This result negates the price and market theory of energy, which stipulate that an increase in energy cost leads to a fall in demand not only for the energy source (petrol/diesel fuel, electricity) but also for the machines, equipment and services that depend on that energy source (Yang, Kang, Zhao and Hu, 2008). The findings also contradict other empirical research findings that support the theoretical proposition that increases in the prices of energy lead to a fall in demand for energy and the machines that use the energy (Saicheua, 1987; Gor, 1994; Yang, et al., 2008). There are a number of possible explanations why contrary to theory and expectations, in this study’s sample an increase in energy cost should increase the probability of adoption of adapted technology.
First, in the rural and peri-urban areas where the majority of the MSEs are located, electricity, which is the cheaper source of energy, is outside the choice of many technology adopters as their enterprises are located far from the national electricity power grid. As a result, fossil fuel (petrol, diesel, kerosene) powered adapted machines are used in many facets of production as substitutes of electricity. Therefore, petrol, diesel or kerosene powered machines are adopted due to the inaccessibility of electricity supply, in spite of the fact that in Kenya, locally manufactured petrol or diesel powered machines are not only more expensive to buy, but their prices have been increasing at a faster rate than the imported electric mortar powered substitutes. According to theory, one would have expected the increase in the already high prices of locally made adapted machines to lead to a drop in the demand for these adapted machines. However, this was not the case in this study’s data set. As shown by the respondents’ responses to the questions D6a, D12, D13, D14, D15, E3, E4 and E6 in the questionnaire (see Appendix I) the demand for petrol/diesel powered machines had been increasing, during the period of survey, concurrently with the increase in fuel prices.

Second, adaptation and use of petrol or diesel powered machines continued to increase despite the frequent global oil crises that had ensured that fossil fuel energy prices continued to rise. In this study, it was easier to find relatively newer petrol or diesel powered machines than older ones, indicating more recent adoptions than before.
Third, entrepreneurs in the informal sector do not have a range of options, where the price of the energy used by the technology is a major factor to consider in the decision to adopt. This was particularly so, because a combination of high rate of population increase and increase in peoples’ disposable income has led to a higher rate of increase in demand for the products of the adapted technology (for example, demand for maize flour ground by adapted maize grinding mills) than the rate of increase in energy cost. That is, the usefulness of the technology overrides cost of energy considerations when it comes to the decision to adopt.

Fourth, because of fossil fuel price leadership in Kenya, increase in the price of petrol/diesel tends to lead to higher price increases of alternative sources of energy. This implies that there is no incentive to switch to other sources of energy occasioned by price increases in fossil fuels. These are four plausible explanations why adapted technology (for example, locally produced maize grinding mills used to produce maize flour) using fossil fuel (petrol or diesel) has continued to attract adopters despite increase in fuel prices.

f) Machine’s product output

The result showed that the null hypothesis that adapted technology, which does not produce higher output, increases probability of adoption of adapted technology was not rejected. The coefficient’s p-value was 0.406, which indicated that there was a 41 per cent chance that the true value of this variable’s coefficient is actually zero. What this
implied was that much as the adopters of adapted technology acquired the machines to solve the supply gaps of their products in the market, there was no evidence that the machine’s average output capacity made any difference in the decision to adopt adapted technology in Kenya’s informal sector.

Taking into consideration the caveat on the veracity of the data, highlighted earlier under descriptive statistics, this result is partly supported by the descriptive statistics (see Table 4.7 sub-section 4.4.3), which shows that for the data sub-set of 160 non-adapted machines, the mean of the machine’s average product variable was Ksh 131,155.6, with a minimum of Ksh 72,000 and a maximum of Ksh 560,000/= On the other hand for the data subset of 160 adapted machines, the mean of the mapokshpm variable was Ksh 103,654.4, with a minimum of Ksh 64,000 and a maximum of Ksh 280,000. Thus, for this study’s data sample, the low level of variability in the values of output data sub-sets, points to there being very little difference between the two options to influence the decision to adopt either adapted or non-adapted technology.

As pointed out earlier in the descriptive statistics, the study found that most MSE entrepreneurs in the informal sector suffer from the curse of what Hardin (1968) termed the tragedy of the commons. That is, the entrepreneur’s instinct to locate a new start-up micro and small enterprise close to those that are already established is so strong that it (instinct) supersedes the fear of market glut of the products of the new start-up. In the informal sector, this militates against adopting a machine whose
production capacity would worsen the glut. As pointed out earlier, since one of the constraints to the growth of MSEs is the limited demand for their products (Gichira, 1998; Parker & Torres, 1993) there is hardly any incentive for a start-up entrepreneur in the informal sector to go out for a machine that produces high output for the limited localized market. This partly explains why this factor is not important in influencing the decision to adopt adapted technology

g) Perceived conferment of higher social status to the owner

The result for this factor shows that there is a significant difference in the probability of adoption of adapted technology between adopters who perceive that adoption of adapted technology would enhance their social status in society and those who perceive that adoption of adapted technology would not enhance their social status. The marginal effects result shows that adopters who perceive that adoption would enhance their social status are 57 per cent more likely to adopt adapted technology than those whose perception is otherwise. This result supports expectations and social theory (Fine, 2001). Social theory posits that, in most of the cases of technology adoption in the informal sector, the adopter (entrepreneur) acquired social capital, which could be mobilized by the entrepreneur for self advancement (Mohan and Mohan, 2002; Molony, 2006).

The study’s regression result showing that there is a significant difference in the probability of adoption of the adapted machine between adopters who perceive that
adoption would enhance their social status in society and those who perceive that adoption would not enhance their social status in society is most likely due to the fact that the regression controls for other variables. However the variables’ descriptive statistics did not support the regression results for this variable. Table 4.11 in subsection 4.4.7 shows that only 11 (6.87 per cent) of adopters of adapted technology said that the adopted technology conferred to them higher social status. This contradictory result (between descriptive and regression results) could partly be explained by the respondents’ perception of the concept of higher social status. The fact that most of the adopters of adapted technology in the informal sector were either less educated or low income earners, might have made them think that their social status had not changed much vis a vis those they considered of higher social status.

However, when one considers the fact that before they adopted the technology, the adopters might have been unemployed or possessed little or nothing that could distinguish them in their respective communities, was indicative of a changed status resulting from acquiring a productive asset. With the acquisition of the adapted machine (such as a maize mill, a meat roasting machine or a manual irrigation pump), they had something to be identified with in the community. For some, not only was the location of the enterprise (maize mill) known after the adopter’s name, but the location became a land mark and a reference point for giving direction to strangers seeking assistance to be shown the way to their destinations. In short, the adopter entrepreneur acquired social capital, which, as social theory posits (Fine, 2001) and empirical studies support(Mohan
and Mohan, 2002; Molony, 2006), is the social aspect of economic activities that can be mobilized by the entrepreneur for self advancement.

4.7.7 Marginal effects of human factors on the decision to adopt

Table 4.29 shows the marginal effects of human factors that influence the adoption of adapted technology.

Table 4.29 Marginal effects of human characteristics factors

<table>
<thead>
<tr>
<th>Predictor Variables</th>
<th>dy/dx</th>
<th>Std Error</th>
<th>Z</th>
<th>P &gt;</th>
<th>Z</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of adopter123 (Middle age)_2</td>
<td>-.3788314*</td>
<td>.22942</td>
<td>-1.65</td>
<td>0.099</td>
<td>.775</td>
<td></td>
</tr>
<tr>
<td>Age of Adopter123 (Eldely age)_3</td>
<td>-.3637129***</td>
<td>.13027</td>
<td>-2.79</td>
<td>0.005</td>
<td>.078125</td>
<td></td>
</tr>
<tr>
<td>Sex of adopter</td>
<td>-.0111816</td>
<td>.11022</td>
<td>-0.10</td>
<td>0.919</td>
<td>.284375</td>
<td></td>
</tr>
<tr>
<td>Level of education of adopter 12345 (Secondary)_2</td>
<td>-.4033246**</td>
<td>.19186</td>
<td>-2.10</td>
<td>0.036</td>
<td>.271875</td>
<td></td>
</tr>
<tr>
<td>Level of education of adopter 2345 (Tertiary)_3</td>
<td>-.3415217</td>
<td>.27315</td>
<td>-1.25</td>
<td>0.211</td>
<td>.51875</td>
<td></td>
</tr>
<tr>
<td>Level of education of adopter12345(University)_4</td>
<td>-.2541306</td>
<td>.18734</td>
<td>-1.36</td>
<td>0.175</td>
<td>.090625</td>
<td></td>
</tr>
<tr>
<td>Level of education of adopter 12345 (OJT)_5</td>
<td>-.1857127</td>
<td>.22892</td>
<td>-0.81</td>
<td>0.417</td>
<td>.04375</td>
<td></td>
</tr>
<tr>
<td>Marital status of entrepreneur</td>
<td>.1992872*</td>
<td>.11814</td>
<td>1.69</td>
<td>0.092</td>
<td>.546875</td>
<td></td>
</tr>
<tr>
<td>Entrepreneur’s social status in local community</td>
<td>.3039425</td>
<td>.23577</td>
<td>1.29</td>
<td>0.197</td>
<td>.1125</td>
<td></td>
</tr>
</tbody>
</table>

Note: ***implies significant at 1 per cent level; ** significant at 5 per cent level and * significant at 10 per cent level.

Source: Extracted from Table 4.27
a) **Age of entrepreneur**

The discrete predictor variable *age* had three categories: The youth group (18–35 years of age); the middle age group (36 – 55 years of age); and the elderly group (over 55 years of age). The youth group category was made the base for comparing with the other two age group categories: the middle age and the elderly group categories.

The p-values for the two coefficients of the age category were 0.099 and 0.005, implying that the age variable was important in the decision to adopt adapted technology. This result implies that there is a significant difference in the probability to adopt adapted technology when the youth age group of adopters is compared to the other two age groups. Both the middle and elderly age groups have lower probabilities of adopting the adapted technology than the youth age group. The marginal effects results show that adopters in the middle age group category are 38 per cent less likely to adopt adapted technology when compared to the youth age group; while the elderly age group category are 36 percent less likely to adopt adapted technology in comparison to the youth age group.

The most likely explanation for the difference between the youth age group and the other two age groups is that members of the former group (youth age group) could be the cost and level of technological sophistication. The descriptive statistics showed that most adopters of the youth group went for the cheaper and easy to use adapted technology. On the other hand, the same descriptive statistics showed that the elderly
group of adopters preferred the non-adapted technology. The elderly group of adopters were risk averse and preferred non-adapted technology due to the fact that it was well established in the local market, in comparison to the new and untested adapted technology. This finding supports other empirical study findings, which postulate that age has a large influence on the adoption and use of technology (Munnukka, 2007).

The regression result is further supported by the descriptive statistics (see Tables A3 and A4 in Appendix II), which show that 45 out of 47 (95.74 per cent) of the youth group adopters adopted adapted technology, while 11 out 25 (44 per cent) of the elderly group adopted adapted technology. By contrast, only 2 out of 47 (4.3 per cent) of the youth group adopted non-adapted technology, compared to 14 out of 25 (56 percent) in the elderly group who adopted non-adapted technology. The implication of this result to policy makers is that the individuals in the youth group are more likely to embrace the new untested adapted technology than the individuals in the elderly group who seem to be more at ease with the well established and long tested non-adapted technology.

The regression result is also supported by learning theory, which posits that younger people are more willing and eager to acquire and learn new ways/methods of performing tasks than older people (Appelbaum, 1990; Agarwal and Karahanna, 2000; Munnukka, 2007). According to theory, the expectation is that more individuals of the youth age group are more likely to adopt new technology, which involves learning new ways or methods of performing tasks, than the individuals in the elderly age group. This
result, however, also brings out one of the differences between what is the norm in the developed economies and developing countries.

While in developed economies new technology implies adopting more advanced technology, requiring higher levels of education in science to muster its use, the new adapted technology in Kenya eschews technological sophistication to suit the local environment. The situation in Kenya can partly be explained by poverty, low levels of education, and lack of access to training in skills to handle advanced technology. Some of these shortcomings are what the government’s and donor agencies’ interventionist activities should try to address as part of the strategy to promote adapted technology.

b) **Sex of entrepreneur**

This was a discrete variable, which was used to test whether a potential adopter’s sex (male or female) affects the decision to adopt technology. The male sex was coded as 1, and 2 for the female sex. These were transformed into 0 and 1 for use in the regression model. The p-value for the coefficient was 0.919, implying that the variable was not an important factor in the decision to adopt adapted technology. What this means is that, given the data set of this study, there was no significant difference in the probability to adopt adapted technology when one compared the male and female potential adopters. This regression result was a surprising result since numerous gender-based studies had shown that, due to Kenyans’ cultural beliefs and practices, one half of the gender (women) were heavily disadvantaged when it came to important factors that facilitate
technology adoption, such as accessing credit from formal financial institutions, owning land and running a business (Wawire and Nafukho, 2010).

However, in the study’s descriptive statistics, the two data sets of non-adapted and adapted technology adopters supported the finding that the sex of a potential adopter in the informal sector was not a factor of consideration in the decision to acquire the adapted technology. Only one of the 47 female adopters (2.13 per cent) who adopted the relatively expensive adapted technology (the maize mill), and 3 of 113 (2.65 per cent) of their male counterparts, who had adopted the adapted technology, used credit facilities from formal commercial banks to acquire the adapted machines they adopted. The rest of the adopters of adapted technology (97.75 percent of the 160) sourced their funding from the familiar sources in the informal sector, namely: family savings, grants from relatives and friends or membership of merry-go-round associations (chamas) or the rotating savings and credit associations (ROSCAs), or the savings and credit cooperative societies (SACCOs), or organized women and youth groups supported by NGOs.

Therefore, the question of one’s sex influencing access to credit did not figure much in the decisions of adopters in the study’s data set. Further, information from respondents in the study showed that none of the 47 female adopters needed to own land to locate their machines or to use land as collateral to borrow money to purchase the machines. The one woman, who borrowed Ksh150,000/= from a formal commercial bank to buy a
maize grinding mill, used her civil service retirement’s savings with the bank, not land, as collateral.

On the other hand, most of the women who owned the relatively cheaper adapted technology like the Money Maker irrigation pump used their own savings or funding from merry-go-round associations to buy the pumps. Most of these women also rented land from men, who were not their husbands, which land they used to grow the cash crops. Ironically, renting land from men, who were not their spouses, empowered these women and made them more independent of their husbands, since as a condition to renting land, they had to open independent accounts with their ROSCAs, SACCOs, or lately, micro finance institutions (MFIs) and the M-Pesa to facilitate rent payments. The study established that, although traditional African customs did not allow most women to own land, the same customary practices allowed women to freely use their spouse’s land to grow food and cash crops. The women who were interviewed conceded that running a business as a woman had challenges, due to a woman’s role in household chores, but refuted the claim that being a woman was a barrier to acquiring a machine (technology).

However, technology adoption studies in more advanced societies have indicated that the sex of an entrepreneur was a factor of influence on adoption. In their study of IT technology adoption and use in the work place, Venkatesh and Morris (2000) used the theory of planned behavior (TPB) to arrive at the conclusion that when compared to
women decisions, men decisions were more strongly influenced by their attitude towards using new IT technology. By contrast the women were more strongly influenced by subjective norm and behavioural control. According to their study, these findings were robust across income, organization position, education and computer self-efficacy levels. Other studies (Venkatesh & Morris, 2000; Munnukka, 2007), supported the proposition that the sex of an individual influenced the decision to adopt and use technology.

c) Level of Education of entrepreneur

The education variable contained 5 categories: 1- primary school level, 2 - secondary school level, 3 – vocational training institute/polytechnic or college level, 4 - university level and 5 – other forms of training, an example of which was on-job training (OJT). The base group for the five categories of this discrete predictor variable was the primary school level coded as 1. Thus, the other four categories of the education level variable were each compared to the primary school level as the base group.

The results showed the p-values of the coefficients of the four categories of the levels of education were 0.036, 0.211, 0.175, and 0.417when the primary school level of education was compared with secondary school level; when primary school level was compared with vocational/ polytechnic/college level; when primary school level was compared was with university level; and when primary school level was compared with other levels of training, respectively. This means that it was only when the primary
school level was compared with secondary school level, whose coefficient had a p-value of 0.036 showed that, in terms of the impact of education on the decision to adopt adapted technology, there was a significant difference in the probability to adopt adapted technology between the primary school and the secondary school levels of education. The marginal effects result shows that secondary school level adopters are 40 per cent less likely to adapt adapted technology than those with primary school level. This category’s result negates the findings of other empirical studies on technology adoption, which showed that education, especially at higher levels of formal education, was associated with the increase in the probability to adopt and use new technology (Rogers and Shoemaker, 1971; Mullen and Lyle, 1994; Akwara, 1996; Caviglia and Kahn, 2001; Kohler et al., 2001; Meso et al., 2005). What this result implied is that, much as adapted technology was new to the market, it was considered by adopters with secondary education as an inferior choice to non-adapted technology.

However, when the primary school level was compared with the other three categories of the education levels, the coefficients’ p-values of 0.211, 0.175 and 0.417, for the three categories, respectively, raised eyebrows. These results implied that there were no significant differences in the probability to adopt adapted technology when the individuals with the primary school level of education on one hand are compared with individuals with the education level of vocational/polytechnic/college, those with university education level and those with on-the-job training level of education. Since the education levels of vocational/polytechnic/college and university are higher than the
secondary school level, this result contradicts both theory and empirical study findings (Rogers and Shoemaker, 1971; Mullen and Lyle, 1994; Akwara, 1996; Caviglia and Kahn, 2001; Kohler et al., 2001; Meso et al., 2005).

The descriptive statistics in Table 4.18 of section 4.5.3 showed that the adopters of adapted technology from the vocational/polytechnic/college level of education were 69 out of 166 or 41.6 per cent; from the university level were 13 out of 29 or 44.8 per cent; and from the others level of education were 6 out of 14 or 42.9 per cent. By contrast, adopters of adapted technology with the primary school level of education were 23 out of 24 or 95.8 per cent. The results showing a much higher proportion of adopters of adapted technology from the primary school level category suggests that there is a significant difference in the probability to adopt adapted technology between the primary school level and these other three education levels.

The explanation for the difference between primary school level and the vocational/polytechnic/college level, according to information from respondents, was that during their practical training sessions in the tertiary and other vocational educational institutions, the practical training lessons were conducted using imported non-adapted machines and tools. The trainees’ exposure to the only technology available in these training institutions increased the probability to adopt non-adapted technology. For adopters who acquired skills through on-the-job training, all the respondents in this category got their training on imported non-adapted machines and
tools. Many administrators in tertiary and other vocational educational institutions held the view that the poor quality and non-standardised products of many adapted machines was an impediment to their use in vocational training institutions.

The data from the descriptive statistics raised questions about the result from the regression analysis that indicated that there was no significant difference in the probability to adapt adapted technology between primary school education level category of adopters and the vocational/polytechnic/college and university education level categories. Therefore, there is a need for caution on the interpretation of the regression results for the three categories of the education level.

If one looked at the historical background of education and skills training—from the time municipal schools were set up during the Middle Ages by the burghers (people involved in trade) to equip their children with literacy, numeracy and writing skills (Rosenberg & Birdzell, 1986) to the time when vocational education became the norm in early 1900s (Steinmetz, 1976; Swanson and Torraco, 1995)—one could find some explanations as to why in Kenya’s informal sector, the most relevant educational level that influences the adoption of adapted technology is the primary school level (which is supposed to equip individuals with literacy, numeracy, and writing skills). In Kenya, the secondary school and the vocational/polytechnic/college levels of education are supposed to expose students to elements of scientific theory and practical science. However, the level of education’s influence on technology adoption in Kenya does not
seem to be motivated by the desire, on the part of the adopters, to be self-employed, as the policy maker’s vocational training objective states (Republic of Kenya, 1992; 2005).

The practice on the ground in Kenya is that, for most young people, secondary school education and above is pursued for purposes of getting certificates for wage employment in the public and private sectors. While a few primary school leavers, who drop out of Kenya’s formal education, are eager to join vocational institutes/colleges for training to acquire skills necessary to facilitate adoption of some of the adapted machines (such as welding machine or carpentry tools) for self-employment, the majority of them join these training institutions with the aim of using the certificates they get at the end of training to look for wage employment (Oketch, 1995).

Uganda’s post-independence experience observed by the author might be of relevance here. State run vocation training institutes (VTIs) were introduced by the Government of Uganda in the early 1960s to train and equip post-primary and post-junior secondary school leavers with skills for self-employment. Graduates of nine years of schooling (Junior Secondary School leavers), some of whom were my classmates, joined these VTIs. The VTIs offered courses in tailoring, carpentry, plumbing, masonry, welding and motor vehicle mechanics, among others. On graduation from the VTIs, the graduates were issued with certificates of their trades plus the equipment, tools and some initial start-up capital to enable them to use their newly acquired skills to be self-employed. The overwhelming majority of the VTIs graduates went ahead to sell the
equipment and tools issued to them by the government to Asian dukawallahs, who in turn employed them for a wage. These VIT graduates used the same equipment and tools they had sold to their Asian employers to make for them products or provide services that enhanced the profit-making goal of the said dukawallahs.

The 1960s Uganda story of VTIs fits the so called “vocational school fallacy” highlighted by Foster (1968) in his pioneering research in Ghana, which advanced the view that African students and their parents preferred academic education to vocational training. While this might have been true during that period when the main source of employment was the public sector, Kenya’s experience since the 1980s, where employment in the public sector has been hard to come by, is different.

In Kenya, from the late 1980s due to the acute unemployment crisis, the majority of primary and secondary school leavers moved straight to self-employment by adopting machines that required little or no skills (such as the money maker or meat roaster). However, most of those who proceeded from primary to secondary school and tertiary education were the ones who were still keen on further studies for white or blue collar jobs in the public or private sector (Oketch, 1995). With the exception of the adapted welding machine, carpentry tools and wood lithe, which required vocational training skills to design, cut or fabricate parts before they could be used to produce products, like windows and doors for buildings or chairs and beds for furniture, the rest of the adapted machines in this study required just basic primary education and good attitude.
towards work to operate them. This suggests that, for self-employment purposes, the core of potential adopters of adapted technology in Kenya, who should be targeted by policy makers and donor agencies are primary school and secondary school drop-outs and not the graduates of vocational, polytechnic and business college institutions.

d) **Marital Status of Entrepreneur**

This was a discrete variable, which was used to test whether one’s marital status affects technology adoption. Marital status was coded as 0 for married and 1 for unmarried. The p-value for the coefficient was 0.092, implying that the variable was important in the decision to adopt adapted technology. What this means is that there was a significant difference in the probability to adopt adapted technology between a potential adopter who is married and one who is not married. The marginal effects result shows that the unmarried adopters are 20 per cent more likely to adopt adapted technology than their married counterparts. This finding was supported by the descriptive statistics which showed that, overall, unmarried individuals were more inclined to adopt adapted technology than married ones. The descriptive statistics showed that 71.88 per cent of married respondents adopted non-adapted technology, while 81.25 per cent of the unmarried respondents adopted adapted technology.

This result could partly be explained by the fact that many entrepreneurs of micro and small enterprises start-ups were employees in the formal sector who acquired the technology for their unemployed spouses who stayed home or the adopters were women.
involved in small-scale farming or business. Many of these micro and small enterprises were meant to act as a second source of income to supplement the low wages of the head of the family or as a source of income to one of the unemployed partners in the marriage, or both. For example, the study found that most of the maize grinding mills located in the urban slums of Kibera in Nairobi North, and the Mathare and Gorogocho slums of Nairobi South were owned and run by the wives of non-professional or clerical employees in the public and the private sectors, who reside in these slums. The same was true of women running tree nurseries on road reserves and power way-leaves in urban and peri-urban areas of Nairobi and Kisumu cities, who used the Money Maker irrigation pump to water the plants in their tree nurseries. Although many of the machines used in these enterprises were purchased (adopted) by the husbands, a substantial number of the machines were acquired by the married women on their own initiative. Some of these women got funds from their welfare associations (chamas) to purchase the machines.

What came out clearly from the follow-up interviews of both male and female respondents was that it was not marriage per se that influenced adoption, but the financial needs of the expanded family unit that led the couple to start small scale businesses. Some of the attributes of adapted technology, such as low cost, ease of use, and low maintenance cost made ownership and use of the adapted machines attractive to the unemployed youths or low income adopters, many of whom were unmarried male youths or single mothers.
e) Entrepreneur’s Social Status in the Community

This was a discrete variable, which was used to test whether one’s social status in the community affects technology adoption. This was a discrete variable coded as 1 for the entrepreneur who had a high social status in society before adoption, and 0 otherwise. The p-value of the coefficient was 0.197, implying that the variable was not important in the decision to adopt adapted technology. What this means is that there was no significant difference in the probability to adopt adapted technology between an individual who had a high social status in society before adoption and one who did not. This result contradicts results of other studies, which showed that in many cases opinion leaders, who are mostly people with high social status in society, wanted to set an example by taking the lead to adopt new technology (Rogers, 2003).

Rogers (2003) pointed out that opinion leadership is earned and maintained by the individual’s technical competence, social accessibility and conformity to the social norms of society. Rogers (2003) defined social norms as established behavior patterns for members of society. Established behaviour, for opinion leaders, should in most cases include taking the lead to adopt new technology. In most social settings in Kenya, high social status is associated with possession of wealth, resources, wisdom and experience. Therefore, when a new technology is introduced in a particular social setting, these attributes associated with high social status are supposed to make one to take the lead to adopt a new technology. Just like the regression result, the descriptive statistics for this study do not support Rogers’ (2003) finding.
The study’s descriptive statistics in Table 4.19 in sub-section 4.5.5 support the regression result finding. The descriptive statistics show that out of the total 160 entrepreneurs, who adopted the adapted technology, 144 (90 per cent) did not have a high social status in the local community before adoption. Of the 16 (10 percent) who had high social status before adopting the technology, nine of them (5.625 per cent) were retired civil servants while the rest were still serving in the public service but in their fifties and therefore nearing retirement. The story was not any different with those who had adopted non-adapted machines. Of the 160 entrepreneurs, who had adopted non-adapted technology, 140 (87.50 percent) had no high social status before they acquired the technology. Only 20 of them (12.50 percent) had high social status before adoption. The overwhelming majority of these (16 of them) were small-scale commercial farmers who produced horticulture products (mostly French beans) and sold them to middlemen for export to Europe and the Middle East. With the exception of the four adopters of adapted technology highlighted in sub-section 4.5.5, there was no strong evidence to suggest that adopters of adapted technology, who had a high social status before adoption, were motivated by altruistic or non-monetary reasons.

4.7.8 Marginal effects of communication channels on the adoption decision

This was the only variable out of the three communication channels that was not dropped from the original model of twenty variables during the multicolinearity tests.
Table 4.30 shows the marginal effects result of the influence of promotional activities of sales agents communication channel in the adoption of adapted technology.

**Table 4.30 Marginal effects of promotional activities of the sales agents communications channel**

<table>
<thead>
<tr>
<th>Predictor Variables</th>
<th>dy/dx</th>
<th>Std Error</th>
<th>Z</th>
<th>P &gt;</th>
<th>Z</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promotion activities of sales agents channel</td>
<td>.1540096</td>
<td>.17117</td>
<td>0.90</td>
<td>0.368</td>
<td>0.14375</td>
<td></td>
</tr>
</tbody>
</table>

**Source: Derived from data analysis**

The p-value of the coefficient was 0.368, implying that the variable was not important in the decision to adopt adapted technology. This result contradicts results from other empirical studies elsewhere, which showed that promotional agents of a new technology play an important role in influencing its adoption (Rayan and Gross, 1943; Rogers, 2003). However, this regression result was supported by the descriptive statistics, which showed that this particular communication channel (promotion activities of sales agents) did not play a significant role as a source of information to potential adopters of adapted technology in the informal sector. For the adopters of adapted technology, it was only available to potential adopters who visited the Agricultural Society of Kenya (ASK) Shows when they sought further information, sometimes after the technology had already been acquired (see sub-sections 4.6.2).
4.8 Summary of Chapter Four

The first objective of the study was to determine the technology-specific factors, which influence the adoption of adapted technology used by entrepreneurs of micro and small enterprises in Kenya’s informal sector. The study’s descriptive statistics and regression results showed that the following technology-specific variables were important factors in influencing the decision to adopt adapted technology: perceived usefulness of the technology, perceived ease of use of the technology, perceived reliability of the technology to the adopter, and the perceived suitability of the technology to the *Jua Kali* environment variables. Other technology-specific variables, which were important in influencing the decision to adopt adapted technology were cost of machine, machine’s maintenance cost, number of workers, cost of energy, the wage bill and the perceived conferment of higher social status to the adopter.

The second objective of the study was to determine the human characteristics, which influence the adoption of adapted technology by entrepreneurs of micro and small enterprises in the informal sector. The study’s descriptive statistics and regression results showed that, based on the study sample, the human characteristics variables that were important in influencing the decision to adopt adapted technology were the age of adopter, level of education of adopter and the marital status of adopter.

The third objective was to determine the communication channels used to acquire information about adapted technology, which was adopted by entrepreneurs of micro
and small enterprises in the informal sector. The study’s descriptive statistics results showed that the overwhelming majority (81.88 per cent) of adopters of adapted technology said they got information about the adapted technology they adopted through the interpersonal contact communication channel. The rest (18.12 per cent) got information through a combination of two or all the three communication channels.
CHAPTER FIVE

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Introduction

This chapter covers a summary of the study as well as the conclusions. The section also highlights the policy implications based on the findings and the study’s contribution to knowledge. It ends with suggestions for further research.

5.2 Summary of the Study

Due to the informal sector’s importance to Kenya’s economy, the government, assisted by donor agencies has since the 1980s, sought to enhance the workers’ productivity in the informal sector. One of the strategies adopted by the government and donor agencies to achieve this objective was to replace the archaic indigenous technology and inappropriate imported technology used by workers in the informal sector with locally designed and produced adapted technology. Despite the fact that KIRDI was established in 1979 for purposes of adapting imported technology for the informal sector, the rate of adoption of the adapted technology has been slow.

The main objective of this study was to investigate factors that influence adoption of adapted technology in the informal sector in Kenya. The specific objectives were to determine the technology-specific factors that influence adoption of adapted technology used by micro and small enterprises in the informal sector; to determine human factors
that influence adoption of adapted technology used by micro and small enterprises in the informal sector; and to determine the communication channels used to acquire information about adapted technology used by micro and small enterprises in the informal sector.

The study adopted a logit regression model, which, with the support of the descriptive statistics, was used to analyse data collected from 320 respondents from six districts, two each from the Nairobi, Kisumu and Nyeri counties. To realize objectives one and two, descriptive analysis and regression analysis was undertaken. The first step regression got estimates of predictor variables. The second step used logit estimates to compute marginal effects. The marginal effects estimates showed the sign of the coefficient and the magnitude of the p-value estimates for the predictor variables.

The first focus of the regression analysis was to establish whether the variable was important in explaining the decision to adopt or not to adopt adapted technology. The second focus was to determine the direction of influence. It is the estimates of marginal effects of technology-specific and human factor predictor variables, which were interpreted on the basis of whether a variable increased or reduced the probability of adoption of adapted technology. The other tasks were to establish whether the findings of the study were in line with theory and were supported by other empirical study findings. To realize objective three, descriptive statistical measures of proportion (percentages, mean and standard deviation) were used.
For the first objective, the study’s analysis of descriptive statistics and regression results showed that a number of technology-specific variables were important factors in influencing the decision to adopt adapted technology. These were perceived usefulness of the technology; perceived ease of use of the technology; perceived reliability of the technology to the adopter; and perceived suitability of the technology to the *Jua Kali* environment. Others were cost of machine; machine’s maintenance cost; number of workers operating the machine; cost of energy used to operate the machine; wage bill of workers operating the machine; and perceived conferment of higher social status to the adopter.

Further, the regression results showed that the important variables, whose effects on the probability to adopt were negative, included cost of machine; machine’s maintenance cost; number of workers needed to operate the machine; wage bill of workers operating the machine. On the other hand, the important variables whose effects on the probability to adopt were positive were cost of energy and perceived conferment of higher social status (in the local community) to the owner.

For the second objective, the study’s analysis of descriptive statistics and regression results showed that, based on the study sample, the human characteristics variables that were important factors in influencing the decision to adopt adapted technology were: age of adopter; level of education of adopter; and marital status of the adopter.
Finally, for the third objective, the study’s analysis of the descriptive statistics results showed that the overwhelming majority of adopters of adapted technology got information about the technology they adopted through the interpersonal contact communication channel. The regression result for this variable showed that the promotion activities of sales agents variable was not important in the decision to adopt adapted technology.

5.3 Conclusion

The first conclusion made from the results of the study’s descriptive statistics was that four of the technology-specific discreet variables dropped from the regression were important factors in influencing the decision to adopt adapted technology. These were perceived usefulness of the technology, perceived ease of use of the technology, perceived reliability of the technology to the adopter, and the perceived suitability of the technology to the Jua Kali environment.

The second conclusion from the results of the study’s regression results was that five of the six continuous variables were important in influencing the decision to adopt adapted technology. Only one continuous variable (machine’s monthly average production) was not important in influencing the decision to adopt adapted technology. For the discrete variables, the regression yielded mixed results, some of which contradicted the results of the descriptive statistics. For example, four discrete variables and one category of the
level of education of adopter (primary versus secondary levels of education) showed that there was a significant difference in the probability to adopt adapted technology in comparison to non-adapted technology. The remaining three discrete variables (sex of adopter, adopter’s social status in the local community and three categories of the level of education of adopter) showed that there was no significant difference in the probability to adopt adapted versus non-adapted technology between the categories in the respective groups.

Although some of the contradictions in the results could be explained by some contradictory responses from respondents, some of them deliberate and some inadvertent, the difficult-to-explain contradictions in the results led to the conclusion that there was a need for a replication of the study to find out if this study’s results would be supported or re-assessed.

The third conclusion made from the results of the descriptive statistics and regression results was that, partly due to the larger numbers of adapted machines in the farming/agriculture and manufacturing sub-sectors, potential adopters from these two sub-sectors were more likely to embrace adapted technology than those from the other three sub-sectors in the sample. The statistics further showed that, proportionately, individuals from the youth group were more likely to adopt adapted technology than those from the middle age and elderly groups.
Fourth, the descriptive statistics led to the conclusion that sex of the entrepreneur did not seem to play an important role in the decision to adopt adapted technology. On the sex factor, the descriptive result was supported by the regression result.

Fifth, the descriptive statistics and regression results led to the conclusion that, much as the educational level, type of education and type of training were important factors in influencing the decision to adopt technology, the results were more clear in showing that the individuals with lower levels of education (primary and secondary school levels) were more likely to adopt adapted technology than those with higher levels of education.

Sixth, the descriptive statistics and regression results led to the conclusion that the overwhelming majority of adopters of adapted technology were unmarried, with only a small proportion of adopters being married.

Last but not least, the study’s descriptive statistics led to the conclusion that the overwhelming majority of adopters of adapted technology in the informal sector got information about the technology they adopted through the interpersonal contact communication channel. This conclusion was important as it related to the third objective of the study.
5.4 Policy Implications

First objective: To determine the technology-specific factors that influence adoption of adapted technology. The study’s findings led to the following policy recommendations.

First, the government institutions and donor agencies involved in the process of adaptation of technology should ensure that the products of the adaptation process are less expensive than the non-adapted products they seek to substitute. This is because on the cost of machine factor, the results of the study implied that expensive adapted machines have lower chances of being adopted by MSEs in the informal sector. On the supply side, production of less expensive adapted technology could be done by facilitating mass production of the adapted technology to take advantage of economies of scale. This could be done through public-private partnership (PPP) to set up production units, which on account of scale would not be economically viable for private investors during the early years of production. On the demand side, through the Kenya national Federation of Jua Kali Associations (KNFJKA) and microfinance institutions, government policy could be directed at facilitating easier access to credit to potential adopters of adapted technology. What should be avoided is government involvement in providing direct subsidies or tax incentives to adopters, which, although well intentioned, would provide avenues for corruption.

Second, government institutions and donor agencies involved in the process of adaptation should strive to produce adapted technology that is maintenance-free or
require low servicing and maintenance cost. This is because on the machine’s maintenance cost factor, the results of the study implied that high maintenance cost reduced the probability of adoption of the adapted technology by MSEs in the informal sector. Although KIRDI and KickStart are already doing this, government should put more emphasis on this guide-line. Good examples of adapted technology that require little servicing and therefore low maintenance cost in the study are the meat-roasting charcoal oven and the Money Maker manual irrigation pump.

Third, much as government policy towards MSEs is partly informed by the desire to reduce unemployment government institutions and donor agencies involved in the process of adaptation should eschew production of adapted technologies that are labour-intensive. This is because on the number of workers needed to operate the machine factor, the study results implied that increase in the number of workers needed to operate the machine reduces the probability of adoption of the adapted technology by entrepreneurs of MSEs in the informal sector. MSE entrepreneurs avoid employing many workers due to management challenges, fear of trade union activism and fear of registration for tax purpose. This would mean that government’s and donor agencies’ policy of combating unemployment should be pursued, not through labour-intensive adapted machines, but through programmes that promote self-employment by facilitating widespread adoption of single-employee adapted technology.
Fourth, the government officials, in their eagerness to widen the tax base or through trade union pressure, should resist the temptation to extend the mandatory minimum wage requirement to employers in the informal sector who are potential adopters of adapted technology. This is because the study finding on the wage bill of workers operating the machine factor implied that an increase in the wage bill of workers operating the machine in the informal sector reduced the probability of adoption of the adapted technology. All the entrepreneurs in the informal sector considered the government fixed minimum wage as too high for them to afford as wages for their employees. Since most of the economic activities of MSEs in the informal sector are market force-driven, government intervention actions in the informal sector should be seen to facilitate rather than impede market force-driven decisions of entrepreneurs in the sector.

Second objective: To determine the human characteristics that influence adoption of adapted technology. The study’s findings led to the following policy recommendations. First, government policy makers and donor agencies should make use of the government’s Youth Enterprise Development Fund and Uwezo Fund programmes to promote the adoption of adapted technology among the youth groups. This is because the study findings on the age of adopter factor implied that there is a significant difference in the probability to adopt adapted technology when individuals in the youth group are compared with individuals in the middle age and elderly groups. The fact that the descriptive statistics also showed that the individuals in the youth group were more
eager to embrace the newly introduced and untested adapted technology than the individuals in the middle age and elderly age groups should be of great interest to policy makers. This is because the demographic bulge in Kenya’s unemployment pyramid is greatest at the lower end of the working age bracket and thinnest at the top.

Second, in their promotional activities, government policy makers and donor agencies should target potential adopters of the primary school level drop-outs. This is because on the level of education of adopter factor, the regression result showed that that there is a significant difference in the probability to adopt technology between the primary school level and the secondary school level of education in terms of the impact of the level of education on the decision to adopt adapted technology. With the exception of one adopter, all the primary school level adopters had adopted adapted technology, most probably because adapted technology was cheaper and did not require specific skills to operate them.

Third, government and donor agencies involved in vocational and artisans’ training programmes should make a deliberate effort to ensure that adapted technology is used in vocational training institutions during practical training as a way of exposing graduates of these institutions to adapted technology well before they are faced with the decision to choose between adapted and non-adapted imported technology. However, adapted technology should only be introduced in training institutions when the question of poor quality of adapted technology and their products has been addressed. This is
because the study’s descriptive statistics showed that most graduates of vocational training institutions, and those with on-the-job training, adopted non-adapted technology because this was the technology they were exposed to during training.

Fourth, government institutions and donor agencies involved in the adaptation processes should target, as a top priority to attain, the objective of designing and producing low cost and easy-to-use adapted technology. This is because the study findings on the marital status of the adopter factor showed that, compared to married adopters, there is a significant difference in the probability to adopt adapted technology when the married adopter is compared with the unmarried adopter. The unmarried adopters cited the technology-specific attributes of low cost and easy-to-use as the main influences on their decision to adopt adapted technology.

**Third Objective:** To determine the communication channels used to acquire information about adapted technology. The study’s finding that there is an overwhelming dominance of the interpersonal contact communication channel as the first and most important source of information led to the following policy recommendation.
The government and donor agencies should take advantage of the fact that most micro and small enterprises’ economic activities are market driven, to resurrect, and where they did not exist, establish at every sub-county headquarters a *business centre* where potential adopters can get information, watch demonstrations of how products of research and development work and attend training and promotion workshops as implied in Sessional Paper No. 2 of 1992 (Republic of Kenya, 1992). This means interpersonal contact, observation and trials not administrators’ barazas (policy information meetings) should be the strategy used to promote adoption of adapted technology. Since Kenya has over 100 sub-county headquarters, entrepreneurs who are keen to get information updates on adapted technology would get it at these sub-county *business centres*.

Further, for urban and rural trading centres, the government and donor agencies should resurrect the programme of providing infrastructural facilities, like building *industrial sheds*, to be rented by *Jua Kali* artisans. The *business centres* at sub-county headquarters and *industrial sheds* in urban and rural trading centres would become centres of contact for entrepreneurs in need of information about adapted technology. The centres should also be used by the government and donor agencies to promote the diffusion of information about technology-specific attributes of the adapted technology.
5.5 Contribution to Knowledge

The study findings that a number of technology-specific characteristics, human characteristics and the interpersonal contact communication channel were important factors in influencing the decision to adopt adapted technology supported earlier studies’ findings in other countries. What the study contributed to knowledge was to pinpoint the technology-specific attributes that are important influences in the decision to adopt adapted technology in Kenya’s informal sector. These are perceived suitability of the technology to the Jua Kali environment, cost of machine, machine’s maintenance cost, the number of workers, cost of energy, the wage bill and the perceived conferment of higher social status to the adopter. The study’s contribution was also to pinpoint the human characteristics, which influence the adoption of adapted technology by entrepreneurs in Kenya’s informal sector. These were age of adopter, level of education of adopter and the marital status of adopter factors.

The study had two surprise contributions to knowledge from the findings. First, the finding that the sex of a potential adopter did not influence the decision to adopt adapted technology was contrary to general belief. Second, was the finding that entrepreneurs who had adopted technology were more apprehensive of government and trade union intervention for fear of entering the tax bracket and qualifying to pay the minimum wage than they were eager to seek assistance from government to acquire the technology. This is a welcome contribution as it helps to promote government facilitation of access to technology without undermining the established culture of
market-led activities in the informal sector. This is why there is no recommendation in this study for direct government subsidies to potential adopters to buy adapted technology in the informal sector.

Finally, the study finding that of the three communication channels used to acquire information about adapted technology, the overwhelming majority of adopters of adapted technology in the informal sector got information about the adapted technology through the interpersonal contact communication channel, was a contribution that is useful to government’s and donor agencies’ promotion efforts to market adapted technology.

These study contributions are relevant to government institutions and donor agencies involved in designing and developing appropriate technology for the informal sector. The findings are expected to help them to come up with guidelines for the appropriate designs of adapted technology for the informal sector, to come up with appropriate education and training programmes targeting appropriate levels of education to promote the goal of adoption of adapted technology and to choose the most appropriate communication channel to use in disseminating information about the adapted technology they deliver to the market.

Further, the study’s contribution that the sex of an entrepreneur is not an important factor in the decision to adopt adapted technology is another contribution to knowledge
in Kenya as it negates the strategy of gender activism as a promotional tool for adapted technology adoption. Lastly, the study’s finding that an adopter’s social status in the community is not an important factor in the decision to adopt adapted technology is a contribution to knowledge in Kenya. What this finding implies is that administrators (chiefs) or political leaders such as members of parliament (MPs) are poor agents in a promotion strategy of adapted technology.

### 5.6 Limitations of the Study

The first limitation that partly stood in the way of achieving the objectives of this study was the fact that the study sample was limited to only the agricultural, manufacturing, construction and to a lesser extent, the service sub-sectors. The commercial sub-sector, which contributes the largest number of MSEs, was not included in the sample. This implied that the study’s results could not be generalised to all micro and small enterprises in the informal sector. Second, practical difficulties, such as the MSE entrepreneurs’ desire to keep business secrets, stood in the way of extracting some information from the respondents. For example, accurate information about output and profitability of enterprises was difficult to get from respondents as most of them feared that such information could be used by local authorities to levy taxes on them. Finally, reliability of information about enterprise performance was of great concern since most MSE entrepreneurs did not keep records of their operations.
5.7 Suggestions for Further Research

The fact that the study’s regression results of the three categories of the level of education variable contradicted both theory and empirical study findings of studies elsewhere suggests that there is a need for further research to support or not support this study’s findings for this variable. The other variable whose results raised doubts was the perceived conferment of higher social status to the owner. While the descriptive statistics indicated that this variable was not important, the regression results indicated that it made a difference in the decision to adopt or not to adopt adapted technology. This dichotomy in results for this variable calls for further study to clarify the position. Finally, during the course of this study, the information and telecommunication technology, particularly the mobile telephony technology, has acquired a much greater role in the economic and social lives of Kenyan residents, including those operating SMEs in the informal sector. There is therefore a need for further studies to be undertaken to establish the role of mobile phones in accessing information about adapted technology used in the informal sector.
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KickStart's Annual Reports (2000 - 2010)


APPENDICES

Appendix I: Letter of Introduction of Field Research Assistants to Respondents

My name is Patrick Masette Kuuya, a PhD student from Kenyatta University. I am conducting a research study on “Adoption of Adapted Technology by Micro and Small Enterprises in the Informal sector in Kenya”. This letter of introduction is to kindly request you to co-operate in answering a set of questions that are in the structured questionnaire and any follow-up questions that may arise as a result of your responses to the questions in the questionnaire.

The purpose of this research questionnaire is to collect data that will be treated with a lot of confidentiality and will be used sorely for the PhD research study and other academic purposes, such as seminars and workshops.

I take this opportunity to thank you in advance for your co-operation in participating in this research study. For any further information, kindly contact the undersigned.

Patrick Masette Kuuya

Department of Economics

Kenyatta University

P. o. Box 43844  Code 00100  Nairobi

E-mail: pkuuya@yahoo.com
THE SURVEY INSTRUMENT: QUESTIONNAIRE

BY

PATRICK MASETTE KUUYA
Target Sub-sector(s), Technology, Machine(s) and their Codes

Sub-sector

<table>
<thead>
<tr>
<th>Sub-sector</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farming/irrigation/water supply</td>
<td>1</td>
</tr>
<tr>
<td>Food processing</td>
<td>2</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>3</td>
</tr>
<tr>
<td>Technology: Adapted</td>
<td>1</td>
</tr>
<tr>
<td>Construction</td>
<td>4</td>
</tr>
<tr>
<td>Service</td>
<td>5</td>
</tr>
<tr>
<td>Non-adapted</td>
<td>0</td>
</tr>
</tbody>
</table>

Machine type

<table>
<thead>
<tr>
<th>Machine type</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Money Maker/Manual irrigation pump</td>
<td>1</td>
</tr>
<tr>
<td>Baking machine/Meat roaster</td>
<td>2</td>
</tr>
<tr>
<td>Deep fryer for potato chips/ sausages</td>
<td>3</td>
</tr>
<tr>
<td>Diesel-engine powered Posho mill</td>
<td>4</td>
</tr>
<tr>
<td>Imported non-manual water pump</td>
<td>5</td>
</tr>
<tr>
<td>Waste oil-cooled locally made welder</td>
<td>6</td>
</tr>
<tr>
<td>Locally fabricated moulder</td>
<td>7</td>
</tr>
<tr>
<td>Locally designed stone-shaper</td>
<td>8</td>
</tr>
<tr>
<td>Locally designed brick/block maker</td>
<td>9</td>
</tr>
<tr>
<td>Locally designed timber mill machine</td>
<td>10</td>
</tr>
<tr>
<td>Local designed wood lithe/band saw</td>
<td>11</td>
</tr>
<tr>
<td>Imported air cooled imported welder</td>
<td>14</td>
</tr>
<tr>
<td>Imported electric motor posho mill</td>
<td>15</td>
</tr>
<tr>
<td>Imported wood lithe/band saw</td>
<td>16</td>
</tr>
<tr>
<td>Imported moulder</td>
<td>17</td>
</tr>
<tr>
<td>Imported stone-shaper</td>
<td>18</td>
</tr>
<tr>
<td>Imported brick/block maker</td>
<td>19</td>
</tr>
<tr>
<td>Imported timber mill</td>
<td>20</td>
</tr>
<tr>
<td>Imported car battery charger</td>
<td>21</td>
</tr>
<tr>
<td>Imported electric/gas baking</td>
<td>22</td>
</tr>
<tr>
<td>Imported electric/gas deep fryer</td>
<td>23</td>
</tr>
<tr>
<td>Product</td>
<td>Number</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Local designed car battery charger</td>
<td>12</td>
</tr>
<tr>
<td>Weaving and knitting machine</td>
<td>13</td>
</tr>
<tr>
<td>Imported weaving and knitting machine</td>
<td>24</td>
</tr>
<tr>
<td>Imported electric motor popcorn maker</td>
<td>25</td>
</tr>
</tbody>
</table>
INSTRUCTIONS:

- Tick where there is a box
- Fill where there is a rectangular parenthesis, open ended dashes or dots
- Explain where required.
- Where you find a 1-7 Likert-like rating scale, circle the appropriate number representing the respondent’s rating on the Likert-like scale 1 2 3 4 5 6 7

A. GENERAL INFORMATION

1. Research area:
   a) NAIROBI (NBI) SOUTH (S) - A
   b) KISUMU (KSM)
   c) NYERI (NYR)
   d) NAIROBI (NBI) NORTH (N) - B

2. Location/ward District
3. Interview date(s)

<table>
<thead>
<tr>
<th>Day</th>
<th>Month</th>
<th>Time</th>
<th>Day</th>
<th>Month</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Name of interviewer
5. Name of supervisor
6. Name of contact in the research area
B. PERSONAL INFORMATION OF RESPONDENT

1. Name of respondent (optional) …………………………………………
   
a) Is he/she the owner? [YES] [NO]
   
b) Is he/she an employee? [YES] [NO]
   
c) If employee, how long have you been in the job [            years]
   
d) If he/ she is an employee, is he/she 
   
   (i) A close family relative of owner? [son] [daughter] [wife] [brother] [sister]
   
   (ii) A relative of the owner? [cousin] [uncle] [aunt] [nephew] [niece] [other]
   
   (iii) Not related to the owner? [YES] [NO]
   
e) Age of owner ………………. years of age.

2. Gender of owner:
   
a) i) Male youth (18 - 35 yrs) [ ] b) i) Female youth (18 - 35 yrs) [ ]
   
   ii) Male mid-age (36 - 55 yrs) [ ] ii) Female mid-age (36 - 55yrs) [ ]
   
   iii) Male elderly (over 55 yrs) [ ] iii) Female elderly (over 55 yrs) [ ]

3. Marital status of owner:
   
a) Married [ ] (b) Single [ ] (c) Single [ ]
   
d) Co-habiting [ ] e) Divorced [ ]

4. Did the marital status influence the decision to adopt? [YES] [NO]

5. Highest level of education attained by owner:
a) Formal schooling
   i) Primary school [std…];   ii) Secondary school [form……];
   iii) Tertiary/College/Vocational Training Institute (VTI) [….. yrs]
   iv) University [……… yrs] [BA, Bsc];  v) Other [ see (b) below ]

b) Skills training of entrepreneur:
   i) On-the-job /apprenticeship training : specify duration [ yrs]
   ii) Vocational training without formal education: specify duration [ months/ys]

5. Was the owner an elder/chief/opinion leader before acquiring the technology?  YES  NO

C. ENTERPRISE INFORMATION

1. Name of enterprise ……………………………………………………………

2. Sub-sector:
   a) Food and other raw material production  1
   b) Food and other raw material processing  2
   c) Manufacturing e.g Metal working  3
   d) Construction  4

3. Type of activity of enterprise …………………………………………………

4. Product of enterprise activity …………………………………………………

5. Which technology is used by enterprise?
6. What type of machine/tool (name/function) …………………………………………………

7) Is the entrepreneur/owner also an employee? YES NO

8) If also employee, how long have you been doing the job [ years]

9) What is the current number of employees? [ ]

10) What was the number of employees at start-up? [ ]

11) What is the current average monthly wage per worker? [Shs .............]

12) What is the average monthly wage for the self employed owner? [Shs .............]

13) Which year did the enterprise start operations? [ ]

14) Has the enterprise operated continuously since start-up YES NO

15) If NO, for how long did the enterprise remain non-operational? [ ............ wks/months]

16) Give reasons for interruption in operations:

   a) Lack of market for the products
   b) Lack of inputs
   c) Lack of working capital
   d) Poor or non-strategic location
   e) Government/local authority regulations
   f) Business risk e.g competition from other producers
   g) Harassment by local authorities
   h) Other reasons
   i) Name any other reason(s)………………………………………………..

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17) Does the enterprise operate in shifts day and night? [YES] [NO]

18) If NO, Explain why .................................................................

If YES, how many night shifts? ...........................................

19) What is the duration of each shift […….hrs] […….hrs] […….hrs] per night; ……days/wk

20) How many days of the week does the enterprise operate […………days]/wk

21) What was the average output at start-up per hr [ ]; per day [ ]; per wk [ ]

22) What was the average output 2yrs ago per hr [ ]; per day [ ]; per week [ ]

23) What was the average output last year per hr [ ]; per day [ ]; per week [ ]

24) What is the current average output per hr [ ]; per day [ ]; per week [ ]

25) Did the operation of the technology require training? [YES] [NO]

26) If YES:
   a) Was the training done formally in a training institution? [YES] [NO]
   b) Was the training done informally by the on–job training (OJT) arrangement? [YES] [NO]
   c) What was the estimated cost of formal training? [shs …………………]

27) What is the technology’s source of power?
   [Diesel/Paraffin] [Petrol] [Manual] [Firewood] [Charcoal]
   [Electricity] [Specify others]
D) OTHER INFORMATION

1. How did the entrepreneur/owner come to know about the new technology?
   a) Through the press □ □
   b) Through attending trade shows □ □
   c) Through a sales/promotions agent □ □
   d) Through interpersonal networking with other people □ □

2. Is the technology readily available in the market? [YES] [NO]

3. Was the decision to adopt the technology made by:
   a) The entrepreneur? [YES] [NO]
   b) A group/SACCO/local authority? Specify ____________________________
   c) Another organization e.g. Government department/agency? □ □

4. Was the adoption of technology influenced by:
   a) Persuasive salesmanship of the promotions agent? [YES] [NO]
   b) Close relationship between the entrepreneur and the agent? [YES] [NO]
   c) Close relationship between the entrepreneur and the areas’ opinion leaders (e.g. Chiefs, business leaders, community leaders, DATO officials) [YES] [NO]
   d) High demand for the product by local residents? [YES] [NO]
   e) Increase in income of the entrepreneurs? [YES] [NO]
   f) Marital status of owner [YES] [NO]

5. Perceived attributes (characteristics that appeal) of the technology:
   a) Is the technology useful to the owner? [YES] [NO]
b) Use items i – vi (1-7) to show how and the degree of “Perceived usefulness” of the technology

<table>
<thead>
<tr>
<th></th>
<th>Using the technology improves the quality of products</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>ii.</td>
<td>The technology enables me to accomplish tasks more quickly (saves time)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>iii.</td>
<td>Using the technology increases my Productivity</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>iv.</td>
<td>Using the technology enables me to employ less physical and mental labour/effort</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>vi.</td>
<td>Using the technology increases quantity of output</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>vii.</td>
<td>Overall, I find the technology useful to my job</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

c) Is the technology easy to use? YES NO

d) Use items i- vi (1-7) to show how and the degree of “Perceived ease of use” of the technology

<table>
<thead>
<tr>
<th></th>
<th>I find it easy to make the technology do what I want</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>ii.</td>
<td>I find it easy to learn to operate the technology</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>iii.</td>
<td>It is easy for me to be skillful at using the technology</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>iv.</td>
<td>Using the technology enables me to spend less time on work supervision</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>v.</td>
<td>I can use the technology any time of day/year</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>vi.</td>
<td>Overall, I find the technology easy to use</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

6. Other perceived attributes of technology.

a) Purchase cost of the technology/machine

i. What is the nominal (market) price of the technology? Ksh …………………..
ii. Affordability (relative price) of the technology/machine to low income investor in the informal sector:

<table>
<thead>
<tr>
<th>Affordable</th>
<th>Median</th>
<th>Expensive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most</td>
<td>More</td>
<td>Moderate</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Up to 9,999/=); (10,000-19,999/=); (20,000-29,999/=); (30,000-39,999/=); (40,000-49,999/=); (50,000-59,999/=); (> 60,000/=)

7) What was the source funds used to buy the machine?

a) Family savings
b) Relatives and friends
  Roscas
  Saccos

c) NGO funded women groups

d) MFI

e) Shylocks

f) Formal banks

28) What is the monthly maintenance cost of the machine? Ksh ............... 

9) Is the machine reliable (no break-downs) during use? YES NO

10) Use item i – iv (1_7) to show how and the degree of “Perceived reliability”
of the technology during operations

<table>
<thead>
<tr>
<th>Strongly agree</th>
<th>Neutral</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Machine operates for 8 hrs without stoppages</td>
<td>2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>ii. Machine has not broken down since inception</td>
<td>2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>iii. Machine has not broken down in the past year</td>
<td>2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>iv. Machine only breaks down occasionally</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>v. Machine breaks down frequently</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>vi. Overall, the machine is reliable to us under Jua Kali conditions</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
</tbody>
</table>

11) Monthly cost of labour (wage bill) Ksh .................................

271
12) Perceived energy economy (manual/ firewood/ charcoal /paraffin/diesel/petrol/electricity):

Specify source of energy

13) Does the use the technology save cost in energy use? YES NO

14) Use items i-iv (1-7) to show how and the degree to which the “technology saves on energy use”

Strongly agree neutral strongly disagree

i) No direct energy cost; it is manually operated 1 2 3 4 5 6 7

ii) The technology uses renewable energy 1 2 3 4 5 6 7

iii) The technology is free of carbon emissions 1 2 3 4 5 6 7

iv) The energy source is safe & readily available 1 2 3 4 5 6 7

v) The indirect cost of energy is affordable 1 2 3 4 5 6 7

iv) Overall, the technology saves on energy use 1 2 3 4 5 6 7

15) What is the cost of energy per month? (Ksh).................................

16) Is the technology suitable for use in the Jua Kali environment? YES NO

17) Use items i–vi (1-7) to show how and the degree to which the technology is “Perceived to be suitable” to the Jua Kali or informal sector environment

Strongly agree neutral strongly disagree

i. The technology is footloose and can conveniently be located anywhere for operations 1 2 3 4 5 6 7

ii. The technology is easily transported to the site of operations 1 2 3 4 5 6 7

iii. The technology uses more local raw materials as inputs in production 1 2 3 4 5 6 7

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iv. The technology requires minimal imported spare parts

v. The technology requires no permanent premises to locate operations

vi. Overall, the technology is suited to the Jua Kali environment

18) Does the technology confer higher social status to the owner? YES NO

19) Use items i – vi (1_7) to show how and to what degree adoption of the technology confers of higher social status to the owner

i. Before acquiring the technology, he/she was hardly known beyond the village

ii. The owners has since been appointed a chief (administrator)

iii. The technology has made the owner a role model consulted by others in the area

iv. The location of the technology is known by his/her name & is now a reference point

v. Other entrepreneurs have followed him/her and acquired the technology

vi. Overall, the technology has conferred higher social status to the owner

20) Did the adoption of the new technology lead to change in the number of employees immediately or afterwards?

a). (i) It led to a decrease in number of employees

   (ii) Number of employees involved in the decrease was [ ]

b). (i) It lead to an increase in No. of employees

   (ii) Number of employees involved in the increase was [ ]
(ii) Number of employees involved in the increase was [ ]

21) Did adoption of the technology lead to:
   a) Improvements in skills of workers? YES NO Explain
      ……………………………………………………………………………………
   b) Improvements in record keeping at the enterprise? YES NO
      Explain------
      ……………………………………………………………………………………
   c) Increase in sales of the product? YES NO Explain-------
      ……………………………………………………………………………………
   d) Increase in the profits of the enterprise? YES NO Explain-----
      ……………………………………………………………………………………
   e) Change in workers’ attitude towards work? YES NO Explain-----
      ……………………………………………………………………………………
   e1 Reduction in absenteeism? YES NO Explain………………
      ……………………………………………………………………………………
   e2 Increase in absenteeism? YES NO Explain…………………………
      ……………………………………………………………………………………
   h) Improvements in the welfare of workers (e.g. wages etc)? YES NO
      Explain…………………………………………………………………………………

22) What is the unit price of the product/service? [Shs.………...…] per [ ]

23) Have sales of output increased since the technology was introduced? YES NO
    Explain if YES (sales have increased) …………………………………………..

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24) If sales have increased, is the increase due to:
   a) Competitiveness on price  YES  NO  Explain  ……………………

   b) Competitiveness on quality of product  YES  NO  Explain ……..

   c) Increase in incomes of customers?  YES  NO  Explain ………

   d) Networking/good salesmanship of the owner?  YES  NO  Explain……

   e) Sub-contracts from firms in the formal sector?  YES  NO  Explain ………

24) Has the overall performance of the enterprise been influenced by:
   a) **Better** performance of the economy in the area?  YES  NO  
      Explain  ………………………………………………………………..

   b) **Poorer** performance of the economy in the area?  YES  NO  
      Explain  ………………………………………………………………..

25) What have been the average total monthly costs of production over the last four years?
   Yr………  [ shs………………..]  Yr………  [ shs …………………..]
26) What was the average total monthly cost of production during the start-up year?  
[ shs……]  

27) What has been the estimated average total monthly revenue over the last four years?  
Yr………….. [shs…………………….] Yr…………… [shs ………]  
Yr………….. [shs…………………….] Yr……………. [shs………………]  

28) Does the local environment affect operations of the new technology due to:  
a) Change in the weather?  
   YES ☐  NO ☐  
   Explain …………………………………………………………………………

b) Current location of the enterprise?  
   YES ☐  NO ☐  
   Explain …………………………………………………………………………

c) Availability of raw materials?  
   YES ☐  NO ☐  
   Explain …………………………………………………………………………

d) Harassment by local authorities?  
   Explain………………

e) Knowledge and skills of employees?  
   Explain …………………

29) Role of perceived gender-related cultural beliefs and practices in influence the decision to own and/operate the technology:  
a) Do gender related cultural beliefs and practices influence the decision to adopt?  
   YES ☐  NO ☐
b) Use items I – vi (1_7) to show how and the degree to which “Perceived gender-related cultural beliefs and practices” influence technology adoption:

<table>
<thead>
<tr>
<th>Strongly agree</th>
<th>neutral</th>
<th>strongly disagree</th>
</tr>
</thead>
</table>

i. It is taboo for a man/ woman to own the machine  
ii. Owning the machine will interfere with the owner’s traditional household responsibilities  
iii. Cultural beliefs and practices require that ownership of the be reserved for men/women  
iv. Owning the machine by a man/woman will make other men/women to ostracized him/her  
v. Being a man/woman makes the owner lack the authority to exercise control over the employees  
vi. Overall, cultural beliefs & norms influence the decision to adopt technology

30) What other cultural practices influence ownership/operation of the technology?

a) Problems with punctuality/absenteeism hinder optimal use of the machine

Explain…………………………………………………………………………………………

b) Casual approach towards maintenance of the machine

Explain ……………………………………………………………………………………………

c) Problems with inventory stock keeping of inputs

Explain ……………………………………………………………………………………………

c) Problems with inventory stocking of outputs

Explain ……………………………………………………………………………………………
e) Problems with book-keeping of accounts of:
   i) Production statistics [YES] [NO]
   ii) Sales statistics [YES] [NO]
   iii) Income and expenditure statistics [YES] [NO]
   iv) Inventory stocks (in storage) statistics [YES] [NO]

f) Problems with skills training to handle new technology [YES] [NO]

g) Problems of interference by relatives [YES] [NO]

h) Other problems [YES] [NO]

i) List these other problems in (h) above ………………………………………

31) Does the entrepreneur attend trade shows/ exhibitions? [YES] [NO]

32) If he/she attends shows/exhibitions:
   a. Does he/she come back with new ideas that promote the performance of the enterprise? [YES] [NO]
   b. Does he/she encourage workers to attend trade shows? [YES] [NO]

33) How many enterprises use the same technology in the location? [ ]

34) Of the enterprises that use the same technology in the sub-location / ward:
   a) How many started operations before yours? [ ]
   b) How many started operations after yours? [ ]

35) Has your enterprise grown horizontally i.e with new start-ups? [YES] [NO]

36) If YES, how many new start-ups? [ ]
37) How many workers are employed in the new start-up(s)? [ ]

38) Are the new start-ups similar to the parent one or are they in another sub-sector(s)/economic activity?
   a) Same sub-sector [YES] [NO]
   b) Not same sub-sector [YES] [NO] Explain

………………………………………………………………………………………………………………
………………………………………………………………………………………………………………

27. What influenced the decision to invest in new start-ups?
   a) Saturation of market with similar products [YES] [NO]
   b) Presence of market for products of new start-ups [YES] [NO]
   c) Fearing to fall in income tax bracket if the parent MSE grows [YES] [NO]
   d) Fearing to qualify for licensing and registration to pay [NSSF] and [NHIF] [YES] [NO]

E. SELLERS OF TECHNOLOGY (SECOND LOT OF RESPONDENTS)

1. Name and address of seller of technology…………………………………………………..

2. Is he an agent of the main supplier (say, ApproTec/KickStart)?

3. Number of units offered for sale annually [ ] [YES] [NO]

4. Number of units actually sold [ ]

5. Percentage of E (4) over E (3) above annually [ ]

6. The price of the technology 10 years ago [Ksh ]; 5 yrs ago [Ksh ]?

END OF SURVEY INSTRUMENT
## Appendix II

### Table A1 Sex of adopters of adapted technology by subsector

<table>
<thead>
<tr>
<th>Subsector</th>
<th>Gender of adopter</th>
<th>Farming &amp; raw materials production</th>
<th>Food &amp; raw materials processing</th>
<th>Manufacturing</th>
<th>Construction</th>
<th>Services</th>
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**Data source:** Survey data

### Table A2 Sex of adopters of non-adapted technology by subsector

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<tr>
<th>Subsector</th>
<th>Gender of adopter</th>
<th>Farming &amp; raw materials production</th>
<th>Food &amp; raw materials processing</th>
<th>Manufacturing</th>
<th>Construction</th>
<th>Services</th>
<th>Total</th>
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**Data source:** Survey data
Table A3 Age of adopter of adapted technology by sub-sector

<table>
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<th>Subsector</th>
<th>Age group</th>
<th>Farming &amp; raw materials production</th>
<th>Food &amp; raw materials processing</th>
<th>Manufacturing</th>
<th>Construction</th>
<th>Services</th>
<th>Total</th>
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<tr>
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<td>Youth (18-35yrs)</td>
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<tr>
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<td>Middle age (35-55yrs)</td>
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<td>41</td>
<td>10</td>
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<td>104</td>
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<td>Elderly (&gt;55yrs)</td>
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<td>0</td>
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Data source: Survey data

Table A4 Age of adopter of non-adapted technology by sub-sector

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<th>Subsector</th>
<th>Age group</th>
<th>Farming &amp; raw materials production</th>
<th>Food &amp; raw materials processing</th>
<th>Manufacturing</th>
<th>Construction</th>
<th>Services</th>
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<td></td>
<td>Middle age (35-55yrs)</td>
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<td>Elderly (&gt;55yrs)</td>
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Data source: Survey data
### Table A5 Level of education of adopter of adapted technology by sub-sector

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<th>Subsector</th>
<th>Education level</th>
<th>Farming &amp; raw materials production</th>
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<th>Construction</th>
<th>Services</th>
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<td>3</td>
<td>3</td>
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<td>Other training</td>
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<td>2</td>
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<td>0</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Total</td>
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<td>41</td>
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</tbody>
</table>

**Data source:** Survey data

### Table A6 Level of education of adopter of non-adapted technology by sub-sector

<table>
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<tr>
<th>Subsector</th>
<th>Education level</th>
<th>Farming &amp; raw materials production</th>
<th>Food &amp; raw materials processing</th>
<th>Manufacturing</th>
<th>Construction</th>
<th>Services</th>
<th>Total</th>
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<td>0</td>
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<td>Secondary</td>
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<td>Tertiary</td>
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<td>Other training</td>
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**Data source:** Survey data
Table A7 Marital status of adopter of adapted technology by sub-sector

<table>
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<th>Subsector</th>
<th>Marital Status of adopter</th>
<th>Farming &amp; raw materials production</th>
<th>Food &amp; raw materials processing</th>
<th>Manufacturing</th>
<th>Construction</th>
<th>Services</th>
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<td>2</td>
<td>130</td>
<td></td>
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<tr>
<td>Total</td>
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<td>2</td>
<td>160</td>
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Data source: Survey data

Table A8 Marital status of adopter of non-adapted technology by sub-sector

<table>
<thead>
<tr>
<th>Subsector</th>
<th>Marital Status of adopter</th>
<th>Farming &amp; raw materials production</th>
<th>Food &amp; raw materials processing</th>
<th>Manufacturing</th>
<th>Construction</th>
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<tbody>
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Data source: Survey data
### Table A9 Cost per unit of adoption of adapted technology by sub-sector

<table>
<thead>
<tr>
<th>Subsector</th>
<th>Machine cost (Ksh)</th>
<th>Farming &amp; raw materials production</th>
<th>Food &amp; raw materials processing</th>
<th>Manufacturing</th>
<th>Construction</th>
<th>Services</th>
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Data source: Survey data

### Table A10 Cost per unit of adoption of non-adapted technology by sub-sector

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<tr>
<th>Subsector</th>
<th>Machine cost (Ksh)</th>
<th>Farming &amp; raw materials production</th>
<th>Food &amp; raw materials processing</th>
<th>Manufacturing</th>
<th>Construction</th>
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Data source: Survey data
Table A11 Monthly maintenance cost per unit of adoption of adapted technology by sub sector

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<th>Subsector</th>
<th>Monthly maintenance cost (Ksh)</th>
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<th>Food &amp; raw materials processing</th>
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Data source: Survey data

Table A12 Monthly maintenance cost per unit of adoption of non-adapted technology by sub-sector

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<tr>
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<th>Monthly maintenance cost (Ksh)</th>
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<th>Food &amp; raw materials processing</th>
<th>Manufacturing</th>
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Data source: Survey data
Table A13 Monthly value of output per unit of adoption of adapted technology by sub-sector

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<th>Subsector</th>
<th>Farming &amp; raw materials production</th>
<th>Food &amp; raw materials processing</th>
<th>Manufacturing</th>
<th>Construction</th>
<th>Services</th>
<th>Total</th>
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<td>2</td>
<td>47</td>
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</table>

Data source: Survey data

Table A14 Monthly value of output per unit of adoption of non-adapted technology by sub-sector

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<th>Manufacturing</th>
<th>Construction</th>
<th>Services</th>
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<td>52</td>
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Data source: Survey data
### Table A15 Number of employee per enterprise of adapted technology by sub-sector

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<th>Manufacturing</th>
<th>Construction</th>
<th>Services</th>
<th>Total</th>
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<td><strong>41</strong></td>
<td><strong>50</strong></td>
<td><strong>12</strong></td>
<td><strong>2</strong></td>
<td><strong>160</strong></td>
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</tbody>
</table>

**Data source:** Survey data

### Table A16 Number of employee per enterprise of non-adapted technology by sub-sector

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<th>Farming &amp; raw materials production</th>
<th>Food &amp; raw materials processing</th>
<th>Manufacturing</th>
<th>Construction</th>
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**Data source:** Survey data
Table A17 Cost of energy of adapted technology by sub-sector

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<th>Manufacturing</th>
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Data source: Survey data
Table A18 Cost of energy of non-adapted technology by sub-sector

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Data source: Survey data
Table A19 Communication channels used to get information about adapted technology by sub-sector

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<th>Food &amp; raw materials processing</th>
<th>Manufacturing</th>
<th>Construction</th>
<th>Services</th>
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Data source: Survey data

Table A20 Communication channels used to get information about non-adapted technology by sub-sector

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</tr>
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<td>Mass media &amp; promotional activities of sales agents</td>
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<td>2</td>
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Data source: Survey data
Table A21: The First Pairwise Correlation Matrix of 20 Variables

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<th>Mmc kshpm</th>
<th>Mapo kshpm</th>
<th>ll_50</th>
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Data Source: Derived from the data analysis
Table A22 The Third Pairwise Correlation Matrix of 13 Variables

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<th>Number of workers per unit</th>
<th>Cost of energy (kshpm)</th>
<th>Level of education</th>
<th>Marital Status of entrepreneur</th>
<th>Wage bill cost (kshpm)</th>
<th>Perceived conferment of higher social status</th>
<th>Entrepreneur’s Social status in local community</th>
<th>Machine’s Production output (kshpm)</th>
<th>Promotional activities of sales agents</th>
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Note: The star (*) in the correlation matrix indicates that the correlation coefficient (r) is significant at 5 per cent. The fact that all the correlation coefficients in the matrix were much lower than 0.80 was an indication that the model was not encumbered with serious multicollinearity.

Source: Derived from Data Analysis