Technological Innovation: Higher Education, Small Manufacturing Enterprises Growth and the Five (i) Technological Development Model In Kenya

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Abstract: **In Less Developed Countries (LDCs), most graduates from higher institutions learning are absorbed in the informal sector and/or micro and small enterprises. Knowledge development through training, research and experiential learning may lead to creating or discovering new knowledge/technology or creating new value by applying knowledge/technology to societal or business challenges. While the Small Manufacturing Enterprises (SMEs) do not have the capacity to develop knowledge through Research and Development (R&D), it is not clear how universities and institutions of higher learning should help bridge this gap. There is need to develop strategies that enhance acquisition and development of technologies among SMEs in LDCs that in turn makes them competitive in the global market. This paper explores the five (i)s Importation, Imitation, Improvement, Innovation and invention in technology acquisition and development by SMEs and the role played by institutions of higher learning in Kenya. The discourse is informed by primary data collected from 137 SME owner/managers sampled from five (5) municipalities in Kenya and tested using the production function theory that seeks to establish interrelationships between the variables technology Importation, Imitation, Improvement, Innovation and Invention among SMEs in Kenya and the extent to which they influence enterprise growth. Real life Cases are used to illustrate this discourse. The paper establishes significant relationships and concludes that for Kenya and other LDCs to become knowledge based economies, SMEs have to be looped in through empowerment and capacity building, roles universities and institutions of higher learning should brace themselves to undertake. For the SMEs to be innovative and technologically savvy, the five (i) model would come in handy. The government support policies should facilitate the models application and use.**

Keywords: **Technological Development; Importation; Imitation; Improvement; Innovation and Invention;**

I. INTRODUCTION

Youth unemployment continues to be a challenge in the World. According to the United Nations [1], 75.8 million youths globally were unemployed as at 2012. Statistics indicate that the problem is experienced in both developed and developing countries. In Spain, youth unemployment stood at 51.45%, 46.6% in Greece, 30.7% in Portugal and 22% in the UK [2] In Africa, youth unemployment stood at 26.6% in 2010, Middle East 24.0% and South East Europe 22.6% [3]. In Kenya, overall unemployment stood at 12.6% with urban unemployment rate 19.9%, higher than rural unemployment that was 9.8% [4]. Refuge has been sort in the informal sector and in Small and Micro Enterprise (SME) sector. According to the 2003 Economic Survey by the Government of Kenya, employment within the SMEs sector increased from 4.2 million in 2004 to 5.1 million in 2006; with the informal sector accounting for 70.4% of total employment opportunities. In 2005, the informal sector accounted for 72.8% of total employment opportunities. This percentage rose to 74.3% in 2006 and 76.5% cent in 2008 [5]. The ability of youth to engage in productive activities has both social and economic consequences for an economy. This underscores the importance of Higher education preparing their graduates for self employment in the informal and SME sector.

II. PROBLEM STATEMENT

Kenya in its vision 2030 blue print, aims to transform into a newly industrialized, middle class income country that will provide high quality life to all her citizens in a safe and secure environment by the year 2030. To achieve this, generation and management of a knowledge based economy and the contribution of inventions and technologies has been recognized as vital. The Universities, Research Institutions and other institutions of higher learning are expected to encourage research, innovation and contribute to community service among other objectives [6]. That the main employer in Kenya has emerged to be the informal and the SME sector, graduates need to be prepared specifically for this market. While research institutions, Universities and other institutions of higher learning continue to conduct research, create and disseminate new and innovative technologies, their impact does not seem to subdue the grim statistics of unemployment. The technology developed, innovations created and documented do not seem to percolate and reach the "critical masses" who need to adopt it and change their lot. This paper presents findings of a study designed to look at the model adopted by the SME sector in technological development that would enhance the growth of the enterprises and competitive advantage in a liberalized global market.

III. PURPOSE OF THE PAPER

This paper explores the extent to which the five i (5-i) model (Importation, Imitation, Improvement, Innovation and Invention) is employed in technological development among SMEs in Kenya and the role higher education plays to influence it and SMEs growth. The specific objectives were to investigate the extent to which the five (i)s are employed by SMEs in technology acquisition and development and the relationship between enterprise growth and the five (i)s. It also investigated the extent to which the level of education affects the adoption of the five (i)s.

IV. LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

This section presents brief literature on the youth unemployment status, their role in economic development and the role of the university and higher education in general in preparing the youths for self employment. It then goes on to review literature on the Constructivists Learning Environment, the 5I and the small and micro enterprise development and incubation concepts that would facilitate inculcation of entrepreneurial skills and foster technological development once micro enterprises are started by the young entrepreneurs.

Youth, Unemployment, Economic Development and the role of Higher Education

ILO [7] indicates that 400 million new jobs would be needed to absorb today's youths. Unfortunately, labor markets in many countries are unable to accommodate the expanding pool of skilled young school, college and university graduates. In Kenya, youths (aged between 18-35 years) account for more than 30% of the total population with only 41% employed and about 12,824,624 economically inactive [8]. This situation forces young people into the informal and small and micro enterprise sector in self employment. Horn [9] observes that school leavers and graduates of institutions of higher education are forced to be more enterprising create their own job opportunities, thus enterprising mindsets need to be inculcated that favor formation of employers not employees. Entrepreneurs are people who are able to take risks, break new ground and play an innovative role in the economy thereby effectively addressing unemployment by revitalizing the economy and creating jobs for themselves and for others [9]. The education system and higher education in particular have to play a significant role in developing entrepreneurial skills and shaping attitudes towards entrepreneurship [9]; [10].

Higher education institutions are urged to provide quality teaching in order to enhance employment skills [11]. Furthermore, there exists a broad consensus as to the nature of the pressures on higher education throughout the world to become more entrepreneurial or enterprising [12]. Consequently, it has become imperative on higher education decision makers and takers alike to embed entrepreneurship education in their pedagogies. Volery and Mueller [13] emphasize the importance of encouraging and fostering entrepreneurship. Several business schools, institutions and universities have set up initiatives to create awareness about entrepreneurship and to train prospective entrepreneurs. In this paper, the institutions of higher education are urged to create a Constructivists Learning Environment (**CLE**), establish Small and Micro Enterprise Development and Incubation Centers (**SMEDIC**) that will foster Technology Adoption Facilitation and seek to employ the **5-I** (Importation, Imitation, Improvement, Innovation and Invention) model for technology acquisition and development.

Constructivists Learning Environment

The notion of a learning environment is somewhat new in the context of instructional design. The goal for instructional designers has been to create an instructional episode for the students, with measurable outcomes, that required the learners to interact in some way with knowledge which was prescribed for them and transmitted to them either via a teacher or some other mechanism. The active participation of the learner in the learning process has become the basis for new directions for learning theories since the seventies.

Constructivist theories of learning assume that meaning is imposed by the individual because people construct new knowledge and understandings based on what they believe, prior experiences, and socio-cultural contexts [14]. The fundamental difference between constructivism and objectivism in learning is that constructivism emphasises the construction of knowledge while objectivism concerns the object of knowing. Prior knowledge plays a vital role in actively constructing knowledge, creating, inventing and developing one's own knowledge and meaning [15]. Central to the principle of constructivism, learning is an active process [15];[16]. Constructivist approaches in teaching and learning originated from work of Jerome Bruner, Jean Piaget and Lev Vygotsky [17]. Gordon [18] advocated that in a constructivist classroom setting teacher and student-direct learning is equal, requiring teachers to take an active role in the learning process. The teacher can act as facilitator whose role will be to help students become active participants in their learning in order to connect prior knowledge with new knowledge.

The International Society for Technology in Education (ISTE) (2007), says learning should provide educators with a blue print for designing educational and technological experiences to equip students to thrive in the modern, connected world. The categories of skills emphasized include creativity and innovation, communication and collaboration, research and information fluency, critical thinking, problem solving and decision making, digital citizenship and technology operations and concepts (ISTE, 2007). When undergraduate and graduate students undertake projects, several constructivists learning activities may include experimentation, research on topics and presentations, field activities or trips, films or role play as well as classroom discussions. In a University and other institutions of higher education, the constructivists learning environment would be conceptualized as in Figure 1.

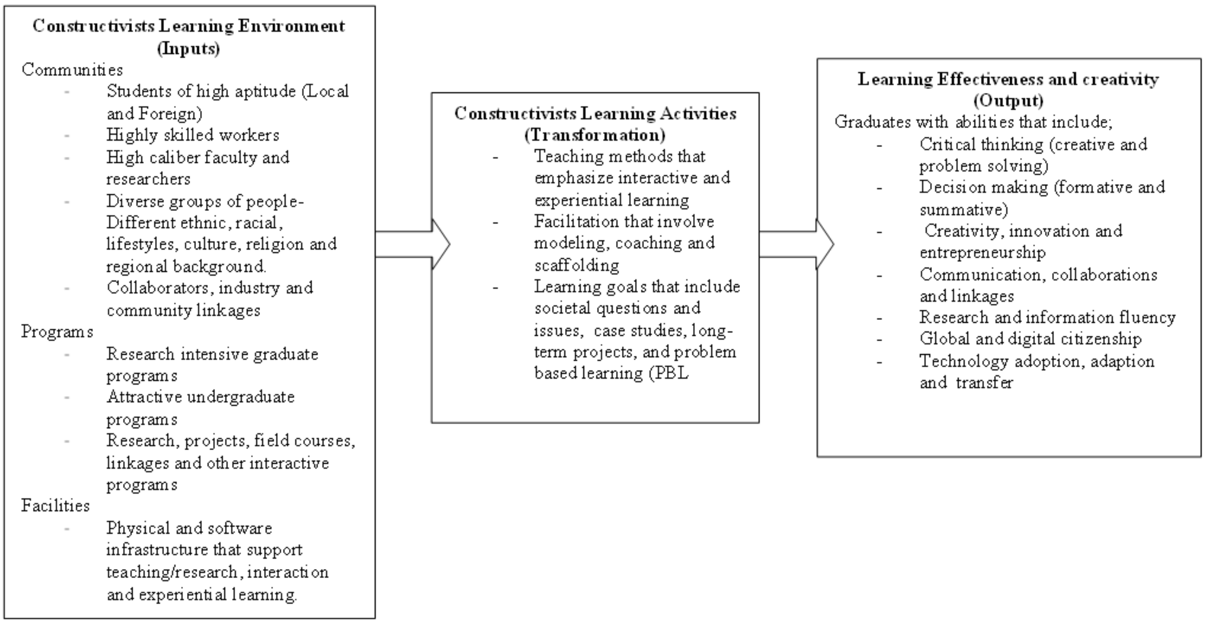

Figure 1: Constructivist learner transformation process
Source: Ng'ang'a et al 2012

Constructivism learning envisages that, the learning activities are anchored in teaching methods that emphasize interactive and experiential learning, that addresses the needs and goals of the society and the labor market with emphasis to the sector that absorbs the critical mass.

The five I (5I) Model in Technological Development

Technological innovation and management is considered to be a key driving force in the development of an economy. The economic growth of both developed and developing countries depends upon it. Likely, the concept of indigenous technological innovation capabilities (ITICs) is also inevitable in both developed and developing countries. ITICs have grown vastly in the last few decades and seems as growth trend will continue. The case of Japan, South Korea, Taiwan (China) and Singapore shows that the development of their ITICs is based on "*initiation-imitation-improvement-innovation".*

Even the U.S's development in technology and innovation is also based on the same model [19].Researchers like Ali and Park [20] propose a spiral process model of TICs. This model comprised of four stages like, 1) technological innovation (TI), 2) transfer of technology, 3) adaptive technological innovation and finally 4) indigenous technological innovation (ITI). Most of TICs are developed through the spiral process, this study proposed 5I model.

It is evidenced that ITIC is essential to transform the mode of economic growth from relying on natural resources and imitation of imported technologies to one driven by innovation [21]. For example, China's previous experience they have made indigenous innovation as national strategy. The ITIC problems at the strategic levels in developing countries have restricted development in technological innovation capabilities. For small and medium enterprises in the developing world with limited resources and relatively low national advantage, ITIC is much more difficult [22].

Firms in developing countries have to compete not only with suppliers in advanced economies, but also among themselves. Competitiveness generally refers to the comparative ability of a nation or company to bring products or services to the market. This depends on technology employed which may be more comparatively expensive for Small Manufacturing Enterprises that are unable to accumulate capital for enterprise development. Infrastructure and technology are a challenge for SMEs in LDCs who are hard put to accumulate capital hence can do little on their own to support infrastructure and technology development. Infrastructure offers supportive structure for the growth of other sectors raises growth of enterprises and reduces income inequity [22]. However LDCs have not fully succeeded in creating a direct connection between infrastructure development, technology acquisition, adoption and development and thus the growth of individual SMEs. In these circumstances, the innovativeness of Small Manufacturing Enterprises is influenced to a large extent by the technology they import in the form of equipment, efforts made to adopt and adapt the machinery, efforts to imitate the functioning of the machinery and replicating them, improvements made on such imitations and innovations arising there from, leading eventually to the ability to come up with a completely new-invent. This is represented through the 5Is model (Importation, Imitation, Improvement, Innovation and Invention).

V. TECHNOLOGY IMPORTATION

The first stage for developing TI is importing foreign technology which is usually known as transfer of technology or international transfer of technology. Large multinational corporations are a major source of technology. They have also become key transfer agents [23]. According to Lööf and Andersson, [24] the learning effect operates through technology diffusion of goods with high knowledge and technology content: increased access to new imported inputs and equipment can raise productivity, as the higher technology embodied in those inputs can allow firms to improve production methods. This mechanism is very much alike the learning spillovers explored in the learning-by-exporting literature, and has been called learning-by-importing.

Goldberg et al. [25] find that firms' access to new imported inputs produces substantial gains in India, by enabling the creation of new varieties in the domestic market. Kasahara and Rodrigue [26] estimate a positive productivity effect from imported intermediates for Chilean manufacturing firms. Lööf and Anderson [27] incorporate in the analysis the distribution of imports across different origin countries, finding that imports from the most knowledge intensive economies (the G7 countries) have a stronger impact on Swedish firms' productivity than those from other markets.

A technology importation is the most important sources of knowledge acquisition by enterprises in developing countries. Technology importation may be in the form of capital goods. Imports of goods that embody foreign technology can raise a country's output in two ways. Firstly, use of more advanced foreign technology directly increases domestic output. Secondly, reverse engineering of these goods should positively affect domestic imitation and innovation. Spillovers from imports of high technology goods from developed countries to domestic imitation and innovation in both developed and developing countries allow gradual technological development on the part of the developing country. Technology acquisition through external sources does not confer competitive advantages on all firms automatically and equally. Firm-specific technology absorption and development capabilities are crucial in determining performance-enhancing effects of technology acquisition and improving international competitiveness [28]; [29];[30]. Most developed and developing countries used foreign technology at the beginning. They imported technology and with time, imitated it. With continuous research and development that they instituted in their firms; they improved the technology and later became innovative. The entire process has been recommended for any developing nation which wants to develop technologically [31]. International technology diffusion is therefore an important condition for economic growth. This approach, to technological development in LDCs needs to be anchored in national policies. The growing technological diversification of companies makes successful integration of new external knowledge into the innovation process increasingly important. Such successful integration fosters further innovation. The factors that also explain the accelerating trend of using external sources of knowledge include, among other things, technological convergence, declining costs to acquire external R&D inputs, and shortening product cycle times [32].

VI. TECHNOLOGY IMITATION

Boltan [33] comparing the innovation in the American firms and imitation in the Japanese *keiretsu* (business groups). She proposes that the competitive strategy as "imitation" is viable than "innovation: in the industry characterized as 1) weak property rights, 2) technological interdependence, 3) high technical and market uncertainty, 4) rapid technological change and 5) extensive information flow. She also states that many firms in the US are pursuing "learning-by-doing" strategy involving primarily experiential learning *within* the firms. In contrast, Japanese firms are focusing the *external* development of new knowledge, importing ideas and technology across organizational boundaries which are characterized as "learning-by-watching" strategy.

Broda, Greenfield and Weinstein [34], estimate that the growth in new traded varieties has a positive impact on productivity in India, with little dynamic effects as measured by the increase in the creation of new domestic varieties. Goldberg et al. [35] estimated, also for India, that trade liberalization in the form of lower input tariffs led to imports of new intermediate products, which in turn account for the introduction of new products by domestic firms.

Technology imitation is like a free transfer of part of the innovator's technology to non-innovators who will simply copy what has been made. Successful imitation allows for the diffusion of technology embodied in a product, as imitators' do reverse-engineering of that good. Imitation, like innovation, facilitates learning. Entrepreneurs gradually acquire the skills, initially on how to use the technology, then how to repair and maintain and finally how to replicate. In particular, successful imitation by a firm increases that firm's insight into how goods are engineered and improved upon. So, imitation not only makes a firm better at future imitation, but also improves its chances of successfully improving, innovating and finally inventing the next quality level on its own. Bell and Pavitt [36] (1992, 1995) notes that acquiring new technology is not simply a matter of purchasing new machinery or product designs but that learning how to use and adapt technologies to local circumstances and imitating existing products and processes takes considerable effort. Goldberg et al. [37] distinguishes four types of imitative strategies namely; Replica (Legal through links obtained from the pioneer or illegal through copying); Mimicry (often produced through reverse engineering where the imitative products resembles closely the original or at least reproduces some key elements of the original); Analogue (either functional or structural and; Emulation (creative imitation where the follower tries to equal or suppose the pioneer product or process).

VII. TECHNOLOGY IMPROVEMENT

From the imitation stage, comes the improvement stage. At this stage, the imported technology is adapted localization process which makes technology suitable to firm's environment and improved. Local firms emerge as large multinational or international firms that can compete firms from developed countries which is originally as a source of innovation for these local firms. Sometimes these local firms developed their TICs in such a way that they do not need to rely further upon or imitate other firms in the future. The countries like Japan, Korea, China, Singapore and Taiwan have established several multinationals through this process. Some Korean industries are now developing their own TICs and competing industries from advanced countries in the international market [39]. Even TI in many developed and advanced countries passed through the same pattern of innovation development.

In developed countries, technological improvement efforts are based on scientific or applied research, but in developing countries it comes from imitation and improvement of imported technology. On the basis of Chinese's technological innovation experience, Xu et al, [40] proposed a model "3-I Strategy" or "3-I Pattern" stands for imitation, improvement, and innovation as shown in the Fig.1.

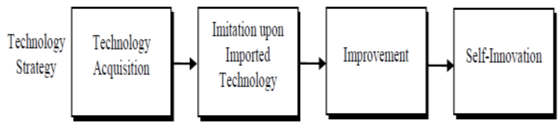

Fig.1: A Stage Model of Technological Innovation Pattern in Chinese Firms

As the imported technology is successfully transferred and properly adapted in the local environment, the firms then need to develop their ITICs on the basis of their own innovation resources. In this stage, firms are capable to generate their own innovation and sometimes, these innovations challenge the industrial leadership of advanced countries. For example China's Haier discovered that some people in the rural areas used washing machines not only for laundering clothes but also for cleaning vegetables [41]. Keeping in view of the specific needs and requirements of the local people, Haier was able to produce dual driven technology machines as versatile enough to wash both clothing and vegetables and soon became the market leader in rural area of its home country. The example shows that Haier developed this technology totally based on their indigenous knowledge and own resources. On the other hand, innovation and technology management at grass root level in developing countries is a new emerging attention.

A variety of approaches and theories have been employed over time to enhance technological development through improvement. Advocates for total quality management (TQM) and Just-in-Time (JIT) systems, often emphasize the importance of continual gradual process improvement [42]. Manufacturing excellence is often based on a foundation of overlapping practices, such as employee involvement, preventive maintenance, supplier relationships, and attention to quality and advanced manufacturing technology [43]. Continuous improvements make a firm more competitive and adaptive to the dynamic market expectations.

VIII. TECHNOLOGY INNOVATION

The acquisition and effective assimilation of innovations generated abroad are crucial for developing countries. Many authors have highlighted that developing countries largely depend on technologies generated abroad. However, mere acquisition of foreign technologies is not sufficient. Once innovations have been acquired (or technology imported), local efforts are critical to master its tacit elements [44], adapt them to local conditions and improve them over time. This insight is complimentary to the perspectives of user-initiated innovation [45].

In the 5I model from improvement stage, follows the innovation stage or indigenous technological innovation (ITI). The technology borrowed from abroad plays a pivotal role in the development of ITI. In this stage, countries establish their own technological innovation by using their own resources. They become more competent to innovate without any assistance from advanced countries. Newly industrialized economies like Korea show that borrowing technology is crucial for ITI. Lazonick and Mass [46] described that the borrowing technology does not consist of only imported technology and foreign experts, but what must be borrowed is existing knowledge on the basis of which indigenous entities can develop new knowledge and develop unique productive capabilities at home. This is the stage of new product/innovation and commercialization. Many countries have successfully entered this stage. Japan, Korea, Taiwan, Singapore are good examples. The newly industrializing countries like China and India are also successfully entering this stage.

Innovation is also at times called generation stage. The critical event here is the innovation of products and processes which at the time are not in use in the target market. Innovation means introduction, establishment, institution, commencement, novelty, departure from the old, and introduction of new and improved methods and things into an existing market or new market. It involves the use or development of an addition, extension, simplification or adapting something for some useful and specific purpose for a target consumer. According to Schumpeter [47], entrepreneurship is a creative activity. An entrepreneur is basically an Innovator who introduces something new into the economy. Accordingly, innovation is the commercialization of all combinations based upon the application of new materials and components, introduction of new processes, opening of new markets and the organization of new organizational forms. Wagner [48], recommends that the development of productive capacities, including policies to promote technological learning and innovation, need to be put in place that will in turn promote sustained economic growth and poverty reduction in the LDCs.

IX. TECHNOLOGICAL INVENTION

An invention is a novel composition, product, tool or process. An invention may be derived from a pre-existing model or idea, or it could be independently conceived, in which case it may be a radical breakthrough. Invention is the most important product of scientific knowledge. Invention, often involves a leap into the unknown, where trial and error, the unexpected or even chance can have a substantial influence on the outcome. The high risk of invention can act as a deterrent to many organizations and individuals, particularly when rewards cannot be clearly anticipated. The accumulation of creativity, knowledge, skills and experience is a vital prerequisite for any nation or region to become a major source of invention, innovation and new technology. This process of accumulation requires time, since the talents and intangibles needed may not be widely known, are usually difficult to specify, or may not be marketed at all. The key challenge for SMEs is how to best exploit and transform the promising technologies into new products and processes rather than be inventive. SMEs have neither the exposure, skills resources and organizational capacity to engage in efforts that would lead to invention such as Research and Development (R&D) which is only gradually being adopted by some manufacturing firms in LDCs but mostly left to research institutions and Universities.

X. SMALL AND MICRO ENTERPRISE DEVELOPMENT AND INCUBATION CENTER (SMEDIC)

Business incubators aim to assist new entrepreneurs with business start-up. The business incubator helps to fill a void which is found in many areas. Not everyone is able to spend the time or money necessary to attend college and obtain a business administration degree. Further, not everyone has access to resources that can fund a new business effort until it becomes profitable.

Incubator programs help to fill the gap by providing rudimentary training to entrepreneurs, a space to launch the business, and in some cases contacts between the new business owner with others who are in a position to invest in the future of the company, Burns [49]. About one-third of business incubation programs in developed countries like Europe are sponsored by economic development organizations. Government entities (such as cities or counties) account for 21% of program sponsors. Another 20% are sponsored by academic institutions, universities and colleges. In many countries, incubation programs are funded by regional or national governments as part of an overall economic development strategy [50]. However, in developing countries the concept is still new and yet to be fully adopted and due to lack of an enabling environment that would result in a thriving ecosystem for small businesses to start, develop and mature, Africa accounts for only 30% survival rate for business start-ups in the first year, compared to 71.3% survival rate in 3 years in the UK (OECD, 2002) and 69% 3year in the US (US Small Business Administration, 2002) hence the need for business incubation centers.

According to Keller [51] technology adoption is a process that progresses through a series of steps that include creating **awareness** where potential users learn enough about the technology and its benefits and decide whether to investigate further. The second step is **assessment** where potential users evaluate the usefulness and usability of the technology and the ease or difficult of adopting it. This is followed by **acceptance** at which point the potential users decide to acquire and use the technology or not to adopt it. After acquiring, the users **develop skills and knowledge** required to use the technology effectively. The final step is usage when users take up, apply and demonstrate appropriate and effective use of the technology that benefits the individual, the enterprise, the house hold, the society and the Nation. This is the process Institutions of Higher Education are expected to facilitate in a constructivists learning environment (**CLE**). Effective technology and skills acquisition is based on multifaceted interaction between internal education, research and development and the Enterprise Accelerator (incubator for student entrepreneurs), processes , and constant interaction with customers and other external actors. True industrial research and development projects are offered to students as platforms for learning. The lecturers/facilitators have opportunities to work in projects as experts and as mentors for the student entrepreneurs. Projects are seen as an important tool for the continuous personal development for teachers. Effective implementation includes the integration of the innovation chain where research, development and application are connected to each other. In open innovation different channels for innovation creation and commercialization are considered equal [52]. Innovation created at incubation process may be commercialized by regional firms or a firm created by a student and the student is expected to carry on with the line of the project in real life work situation and also use skills developed in an innovative way in different situations. A typical technology adoption facilitation model in an institution of higher education would work as illustrated in Figure 2.

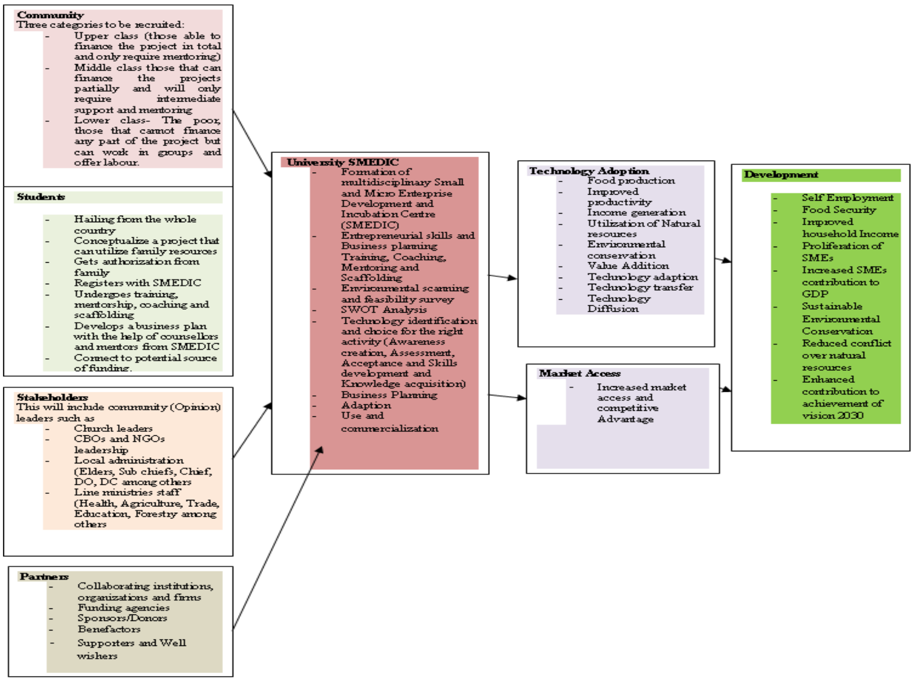

Figure 2: Technology adoption and facilitation model in a SMEDIC

The Technology Adoption Facilitation model (TAFaM) in a Constructivist Learning Environment (CLE) and managed via a small and micro enterprise development and incubation center (SMEDIC) in an institution of higher learning will play a pivotal role not only in creating and disseminating technologies but also in anchoring and overseeing technology adoption, transfer and diffusion by SMEs. The role of higher education in technological development by SMES based on the concepts on constructivists learning environment, technology adoption and facilitation in small and micro enterprise development and incubation centers in institutions of higher education and their effect on SMEs 5-Is and enterprise growth is schematically shown in figure 3.

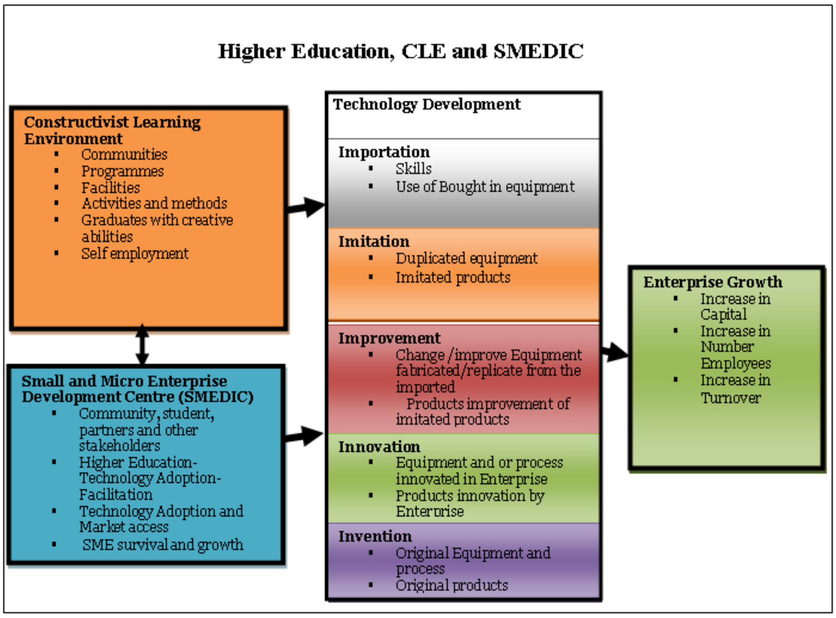

Figure 3: Higher Education, Constructivist Learning Environment, Business Incubation Centre and the Small Enterprise Growth

XI. RESEARCH METHODOLOGY

Data for this paper were obtained by a combination of survey and case study approaches. Triangulation was also employed in data collection instruments, administrators and analysis to facilitate collaboration and cross checking of data for accuracy and validation. Denzin [53] as quoted in Patton (1990, pg 555) observes that by combining multiple observers, theories, methods and data sources, researchers can hope to overcome the intrinsic bias that comes from single – methods, single-observer and single-theory studies.

The target population was Jua Kali firms owner/managers in the Municipalities of Eldoret, Kisumu, Nakuru, Nairobi and Nyeri that actually fabricate (manufacture) capital equipment (Products that are used for further processing of goods in other enterprises) through various innovative strategies. A multistage sampling strategy was employed. The sampling frame could not be established since the Jua Kali Enterprises who engage in this type of activities are licensed in the municipalities as workshops. It is only on literally going to them one establishes the nature of their activities and whether or not they qualify to be included in the sampling frame. This activities are observed I all towns, municipalities and urban centers in Kenya. The sampling procedure employed in this study included cluster sampling based on the geographic location of the town and municipality, stratified sampling where enterprises were segregated by the nature of operations they undertake focusing mainly on those that produce artifacts that are bought and used by other enterprises as tools/equipment for manufacturing other products for use by consumers. An example is the enterprises that fabricate welding machines or make egg incubators. Simple random sampling was used in selecting the towns/municipalities to be included in the study and Snow balling sampling in selecting target enterprises in each municipality where one SME owner would lead and enumerator to the next enterprise who engage in activities of interest to the study. Data was obtained from 137 SME owner/managers, coded and indices developed for the five (i)s. Linear and multivariate regression analysis was used in testing the relationships between each of the five (i)s and SME growth as well as their combined effect. Case study narratives and photographs are also used to illustrate findings and performance of exemplary respondents with their approval.

XII. STUDY FINDINGS

Findings on the SME owner/managers bio data, descriptive statistics for are the SME growth and technology development variables are presented as follows.

XIII. SME OWNER/MANAGERS BIO DATA

The respondents were either owners 61(44.5%) or employees 76(65.5%) who also work and manage the enterprise with the higher proportion 118(86.1%) being male. Most 81(59.1%) of the Owner/Mangers are middle aged (36-45 years) with a significant 54 (39.4%) being youths aged between 15 and 35 years. The mean age is 34.3 years, standard deviation 0.60 with the majority 104(75.9%) being married. On the level of education, most 63(46.0%) of the owner/managers have attained secondary education, 22(16.1%) primary education but most importantly, a significant 45(32.4%) have college/university education. Asked where they acquired the skills they use in their enterprises, 69(50.3%) indicate they either learnt on the job 41(29.9%) or got artisan training 28(20.4%) while 68 (48.6%) were in institutions of higher education that include institutes of technology 34(24.8%), Polytechnics 16(11.7%) and universities 18(13.1%).

XIV. ENTERPRISE GROWTH AND THE FIVE (I) S IN SMES TECHNOLOGICAL DEVELOPMENT

Descriptive statistics of all the variables, enterprise growth; technology importation; imitation; improvement; innovation and invention show low performance in the sector with a mean index lying below 0.32 on a 0-1 continuum as shown in figure 4.

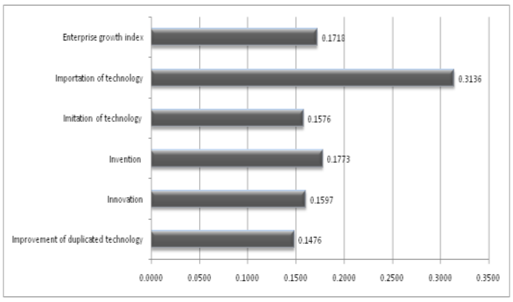

Figure 4: Enterprise growth and the five (i)s in SMEs Technological development

This show the SMEs are not doing well in all fronts of technology development as well as enterprise growth. This position is further shown in figure 5 after all enterprises were grouped according to the measure and score of variable and it can be seen they are almost all position in the predominant low performance category.

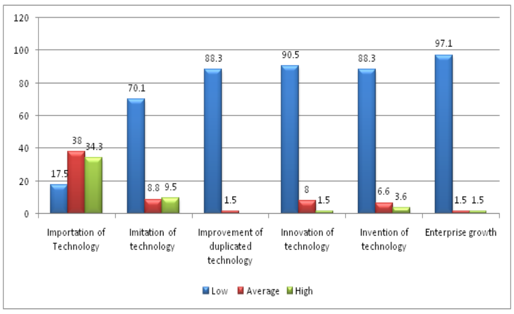

Figure 5: SMEs grouped according to performance in growth and mode of technology development

The data shows that the sector is performing poorly in terms of enterprise growth and very little exist to support technology development thus preparing to build competitive advantage.

A multivariate regression analysis shows that a significant combined effect of the 5Is on the enterprise growth (R=0.349, R2=0.122) at the 95% confidence level as shown in Table 1.

Table 1: Multivariate regression analysis coefficients of the 5Is on enterprise growth Coefficients[a]

Model		Un standardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.112	.027		4.096	.000
	Improvement technology Index	.136	.079	.330	1.714	.089
	Innovation of Technology Index	-.082	.379	-.204	-.217	.828
	Invention of Technology Index	-.059	.354	-.157	-.166	.868
	Importation of technology Index	.141	.106	.158	1.335	.184
	Imitation of technology Index	.048	.064	.122	.747	.457

Model		Un standardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.112	.027		4.096	.000
	Improvement technology Index	.136	.079	.330	1.714	.089
	Innovation of Technology Index	-.082	.379	-.204	-.217	.828
	Invention of Technology Index	-.059	.354	-.157	-.166	.868
	Importation of technology Index	.141	.106	.158	1.335	.184
	Imitation of technology Index	.048	.064	.122	.747	.457

a. Dependent Variable: Enterprise growth index

While the effect of the 5Is on technology development and hence enterprise growth is significant, it is however low with only 12.2% of a unit change in enterprise growth being attributed to the combined effect of the 5Is. A possible regression model is suggested in the form of;

$$y = 0.112 + 0.136x_1 - 0.082\,x_2 - 0.059x_3 + 0.141\,x_4 + 0.048x_5 + 0.027$$

Where

Y= Dependent variable (Enterprise growth index)

X= Independent variables;

X_1 = Imitation of technology Index

X_2 = Importation of technology Index

X_3 = Innovation of Technology Index

X_4 = Improvement of duplicated technology Index

X_5 = Invention of Technology Index

ε = Error term

XV. CHALLENGES HINDERING SMES COMPETITIVENESS AND INNOVATIVENESS

Asked to indicate the challenges they encounter that hinder the SMEs competitiveness and innovation, most of the owner/mangers said the main challenges include harsh conditions 43(31.4%), lack of customers 40(29.2%) and expensive raw materials 38(27.7%). The other challenges that need to be addressed are as in Table 2.

Table 2: Challenges hindering SMEs competitiveness and innovation

	Reported by	
	Freq	**%**
Harsh conditions including weather vagaries	43	31.4
Few customers for the products	43	31.4
Some raw materials being purchased are expensive	40	29.2
Copying by other firms lower number of customers	38	27.7
Products are inferior to imported ones	31	22.6
High competition especially from imported products	31	22.6
Inadequate skills to innovate	27	19.7
Inadequate raw materials that are locally available	26	19.0
Little government support on the Jua kali sector	26	19.0
Inadequate capital for expansion due to high interest on loans	24	17.5

Lack of advanced machinery	23	16.8
Erratic power supply(black outs) interfere with innovation and competitiveness	23	16.8
High cost of renting the premises	20	14.6
Limited workspace and also inadequate land for expansion	17	12.4
Security is not guarantied	17	12.4
The unclean environment under which jua kali products are made discourage customers from purchasing the products	16	11.7
Frequent machinery breakdown	14	10.2
High government taxes	12	8.8
High cost of transportation	12	8.8
Poor infrastructure	12	8.8
Poor medication interfere with being innovative	11	8.0
Blisters from trainees discourage some of them from continuing with the same job	3	2.2

This suggests that SMEs experience a wide range of problem that need to be addressed by policy makers and other support institutions.

XVI. CASES THAT ILLUSTRATE THESE GENERAL FINDINGS

Two cases are used in this paper to show the situation in the SME sector in Kenya.

Case one: Production of Incubators

A family owned enterprise in Nyeri Municipality has turned out to be of sustainable business benefit for poultry farmers in the County and beyond. This is a brain child of a former self-employed mechanical engineer who ventured into manufacturing incubators early 2010. The entrepreneur has never been formally employed since leaving college. He studied how an incubator imported from South Africa worked. Out of inability to raise enough money to buy one, he used his mechanical engineering skills and imitated the imported one using scrap metal from his garage and other locally available materials to make small sized incubator as shown in figure 8. The success rate of his incubator proved higher than the imported one.

Two years later he designed an improved incubator that could use solar energy and car batteries as alternative sources of energy at a competitive price of Ksh.38,000 for an incubator holding 50 eggs. The success rate kept on improving to 160 -170 for every 200 eggs. He ventured into using the incubators to hatch quail eggs that occupied 1/3 times less of space.

Figure 6: Imitation and improvement of imported incubators

The major challenge is to meet the demand for the incubators. This type of technology that has been a result of research and experiential learning can be improved if institutions of higher learning assist such entrepreneurs by building their capacity in operational management. This will go a long way in helping such brilliant entrepreneurs to be more innovative and inventive

Case Two: Technology Adoption in the Automobile Industry

With absolutely no formal education a Nyeri blacksmith has since 1974 been using technology to innovate and invent new products to solve problems observed in his neighborhood. Inspired by the memories of the colonial struggle for independence, he uses scrap metal from imported machines such as tractors, motorcycles, cars, power saw and generators. Out of these he has modified and improved the old scrap metal into working machines such as a dummy helicopter, a car, an engine bicycle, electric wood plane, cross bows some of which are shown in figure 7.

Figure 7: Imitation of automobile technology in production of farm machinery

The entrepreneur innovates through observation and creativity. He has since trained over 2,000 artisans through apprenticeship and are now working as entrepreneurs in Nyeri and its environs. He indicates that his greatest challenge is access to capital and proper record keeping.

XVII. DISCUSSION OF FINDINGS

The Small Manufacturing Enterprises owner/Managers are youthful with a mean age of 34.3 years. With secondary level education (46.0%) of whom 32.4% have higher education exposure at college and university levels and married (75.9%) although only 9.5% are female. These background characteristics of SME owner managers are as observed in Kenya and other developing countries [54]; [55]; [55]; [56]. It reinforces the need to refocus education systems towards the reality that the majority of the graduating youths will end up in the informal and micro and small enterprises sectors. As noted earlier, 76.5% of all employment in Kenya is in the informal sector hence the importance of higher education to prepare graduates for self employment in these sectors.

On the SME growth, the findings indicate very poor performance putting them in very precarious position in terms of competition in a liberalized global market. Despite the high proportion of SMEs owner/managers with exposure to higher education- training, the SMEs are not able to build competitive advantage hence the demand for quality education that enhances entrepreneurial skills necessary for self employment [57];[58];[59]. This will best be done if the institutions of higher learning create constructivists learning environment and in-build business incubations that facilitate technology adoption in their programmes, methods and activities. Technology acquisition has been established to be mainly through skill training and importation of technology embodied in equipment and machinery. It has been shown that there is a link between general imports and technological diffusion [60];[61]. Although a significant amount of imitation, improvement and innovation has been shown to take place in the SME sector, it is however minimal but necessary. Technological imitation has been shown to improve existing technologies in firms and some countries such as Japan, Korea, Taiwan, and China, Malaysia, Indonesia and Thailand have been known to formulate policies that support technology imitation. Robinson [62] observes that imitation has been a key dimension of technology diffusion and is still a basic input in the catching up in developing countries. Often, imitation in LDCs precede improvement of technology and innovation. Although this study has shown low levels of technology improvement and innovation, it is still important in bringing market innovative products ahead of competitors [63]. Invention, on the other hand may be a tall order to the SMEs given the limited infrastructure and in capacity to sustain research and development programmes as shown by the minimal existence in the study. On the whole, it has been noted that the 5-I model exists and influences significantly the growth of SMEs. The applications of the findings of this study are however limited to least developed countries and the firms (Micro and Small) that engage in the production of capital equipment. The circumstances and the condition in which they operate is significantly different from similar firms in developing and developed countries that have fairly well developed infrastructure, access modern technology and support both in capital for investment and also for R&D.

XVIII. CONCLUSION AND WAY FORWARD

According to UNESCO (2006) Education for sustainable Development (ESD) is a dynamic concept that should encompass new vision of education that seeks to empower people of all ages to assume responsibility for creating enjoyable and sustainable future. Since in LDCs means of livelihood, as shown in this paper are mainly in the informal and SME sector, higher Education graduates should be prepared to enter, survive and grow in this sector. Technological innovation and development is crucial for SME competitiveness. Thus, institutions of higher learning should play a role in facilitating technology adoption. It is recommended that institutions of higher education should re-engineer their programmes to enhance preparation of graduates for self employment in the

MSE sector, create Constructivists Learning Environment (CLE) and start and manage Small and Micro Enterprise Development Incubation Centers (SMEDIC) engaging participation and input from all stakeholders. Policies should also be formulated to facilitate technology development through the five (i)s (Importation, Imitation, Improvement, Innovation and Invention) model.

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