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Extent to which university- industry linkage exists in Kenya: A study of medium and large manufacturing firms in selected industries in Kenya

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The idea of technology transfer and university-industry linkage are related in the sense that the former deals with the transfer of ideas and skills between those who have them and those who need them, while the latter addresses the issue of the bond between generators of ideas and users of the ideas. It is an important aspect especially among the developing countries because it sets the phase for development, for without new ideas and skills being developed by research institutions and being applied in the industry, meaningful development would be difficult to come by. This article assesses the extent of University- Industry linkage in Kenya its objective being to determine the extent to which university- industry linkages exist in Kenya. Findings show that local government research institutions are the main source of technology transfer for manufacturing firms in Kenya, although the firms still indicated local universities as their priority number one as a source of technology. It was also found that multinational firms rely more on imported technology than the indigenous firms, which supports the hypothesis that manufacturing firms rely more on imported technology than indigenous firms.

Key words: Technology, Technology transfer, university-industry linkage

INTRODUCTION

Research institutions play an important role in the generation and dissemination of knowledge and new ideas. In the words of Wright (1983:197), '*knowledge is the business of universities, and ....universities account for half or more of the ideas leading to technological breakthroughs*….' This statement can be generalized for universities all over the world, both in the developing as well as in the developed countries. In Kenya, for instance, public and private universities, polytechnics and industrial training institutions are continuously carrying out research on various technological aspects. Results of these researches finally find their application in industry. This may be through manpower training, collaborative research, advisory services, or consultancies. In the National development Plan of 2002 to 2008, the government of Kenya proposes to strengthen Kenya Industrial and Research Institute (KIRDI) to support technical diffusion in industry, and also strengthen industrial training institutes such as Kenya Industrial Business Training and Kenya Industrial Training Institute.

Currently, there is an increasing desire by universities to establish collaborative links with manufacturing firms for purposes of developing new products together. Universities have found that they need more funds to subsidize the decreasing government funding, and they need market oriented research that allows them to market their ideas and technologies to manufacturing firms. They also need the firms to financially support them in their research activities. However, Barnett as quoted by Blumenstyk (2004) argues that the traditional idea of patent - license arrangement in which universities aim at earning money out of their patented ideas hinders

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the process of technology transfer. This is because the firms are reluctant to pay for the new ideas, while universities tend to become too profit oriented as opposed to transferring the inventions to seek relationships with companies.

Promoting start-ups makes universities increase the likelihood of effectively localizing the economic benefits of technology transfer. Other research institutions include Kenya Agricultural Research Institute (KARI) Kenya Forestry Research institute (KEFRI), Kenya Medical Research Institute (KEMRI), and Kenya Industrial Research and Development Institute (KIRDI). As observed earlier, there has been little if any attempt to understand university-industry linkage in Kenya (Commission for Higher Education, 2000). If there are any such linkages, the extent of such a linkage is expected to be weak. This study sought to establish the extent of the university – industry linkage in Kenya

Theoretical framework

According to the report of the Commission for Higher Education workshop held in Nairobi in 2000 on University - Industry linkages, it was observed that there has been little if any attempt to understand university - company linkages in developing countries such as Kenya (Commission for Higher Education, 2000). The current study attempts to identify the level of university - industry linkage in Kenya and therefore provides some insight into the level of University – Industry linkage in Kenya, which is useful both to the Universities as well as the industry.

Barnett as quoted by Blumenstyk (2004) argues that the traditional idea of patent - license arrangement in which universities aim at earning money out of their patented ideas hinders the process of technology transfer. This is because the firms are reluctant to pay for the new ideas, while universities tend to become too profit oriented as opposed to transferring the inventions to seek relationships with companies. Kenyan Universities are trying to raise money in many ways in order to sustain themselves, and the current researcher would want to extent his inquiry to find out the extent to which the universities have links with the manufacturing sector in terms of research. Further, the university-industry linkage is important in promoting economic development, as ideas developed by universities would find their way into industry application.

Danhof (1949), as quoted by Trott (1998), carried out one of the earliest studies in the area of inward technology transfer. Danhof's study was based on the adoption of innovations by industrial companies. The study found that there was a considerable difference in the responsiveness of organizations to take up externally developed technology. The question that comes to mind is why the firms should respond differently even when they are faced with similar environmental conditions, for instance, by being within the same country and therefore facing the same business environment conditions.

Godkin (1988) in a comprehensive review of literature on technology transfer, recognises that the existence of certain activities or practices within the recipient organization is necessary for successful technology transfer. The current study attempts to assess these activities or practices, which include managerial competencies, corporate culture and corporate governance, to find out their influence on the relationship between technology transfer and organizational performance. The current study also assesses the influence these activities have on the relationship between source of technology and technology transfer, as previous studies have not clearly explained these issues.

Danhof's findings have been corroborated by Kroonenberg (1989), who carried out a study among 3,000 firms in the Netherlands. These two studies show clear distinctions between firms in terms of their ability or willingness to adopt new technology. Reasons for the differences have not been given and it will be necessary to find out what they are.

More recent studies have dealt with such areas as the problems affecting mastery of information technology transfer (Toussea-Oulai (1991); provision of information about access to technology (Seaton and Cordey-Hayes, 1993), nature of internal processes of inward technology transfer (Trott and Cordey-Hayes, 1996), hindrances to effective technology transfer (Baker, 2004), and the effect of commercialising technology transfer by universities (Blumenstyk, 2004). One realises that all these studies are based on experiences in developed countries where firms operate under very different environments compared to firms in developing countries. Developed countries are high-income countries with per capita incomes of over US $ 2000 as opposed to Kenya, a developing country with per capita income of less than US $ 400. Further, developed countries are mainly capital- intensive; while Kenya's production is mainly labour-intensive.

Trott (1998) found that firms exhibited a willingness to share technology, sometimes by forming strategic alliances, but concluded that 'the extent to which it is possible for an organization to acquire externally developed technology is uncertain'. Elsewhere and particularly in Europe, companies have been working together with research institutions to come up with new technologies, but evidence of such collaborations in Kenya is minimal. It is not clear how different firms employ technology transfer to come up with innovations especially for new product development. The current study has tried to shed some light on these issues.

In his study on the issue of technology transfer in Africa with a focus on global trends, Akainwor (2002) identified superstition, conservatism, ethnic jingoism, graft, religious extremism and political differences as the main constraints to the goal of technology transfer in Africa. This study does not deal with such crucial issues as

university-industry linkage or the extent of use of technology transfer among developing countries.

Siegel et al (2003) has pointed out that the relationship between university science parks and other aspects of university-industry technology transfer warrants further attention. But science parks are just one of the many models that try to link research institutions and the manufacturing firms. Baker (2004) argues that transfer of technology in developing countries is impaired by poorly developed co-ordination between groups that are key players, namely the government, research organizations, extension services, and the producers. This again raises the need to investigate the strength of the links between the research organizations and the industry. The current study has addressed these issues by attempting to establish the overall picture of use of technology transfer among the Kenyan manufacturing firms.

From the foregoing, it is clear that previous studies in technology transfer have failed to fully address certain aspects, thus creating major deficiencies and knowledge gaps in those aspects. There is lack of focus on the influence of technology transfer on performance, yet it has been argued that technology transfer is very important in the economic development of a country (Adams, 1997). Furthermore, the effect of demographic characteristics and organizational activities on the relationship between technology transfer and organizational performance has not been investigated by previous studies. This study is therefore designed to investigate the effect of technology transfer on the performance of manufacturing firms, and the effect of demographic characteristics and organizational activities on the relationship between technology transfer and organizational performance

In its broadest sense, technology may be considered to be specialized knowledge related to either the process of production (innovation on how new products are made) or to products (as in innovation of new products or product modifications) (Langdon, 1975). In either case, the focus is on knowledge or information, and transfer of technology is therefore in the current study, seen from this point of view. Oketch-Owiti (1980) identifies two major categories of technology: the 'non-human' technology (which includes technology involving machinery and other equipment used in manufacture, and technology embodied in the formulae which forms the basis of the product); and the 'human' technology, normally referred to as know-how, which constitutes the human skills that make the whole process move (Managerial, organizational and technical skills)

Technology transfer is defined as the application of technology to a new use or user, and is the process by which technology developed for one purpose is employed in a different application or by a new user (Langrish et al, 1982). Seaton and Cordey-Hayes (1993) define technology transfer as the process of promoting technical innovations through the transfer of ideas, knowledge, devices and artefacts from leading edge companies and research institutions to more general and effective application in industry and commerce. Malairaja (2004) identifies three types of technology transfer: material transfer (transfer machines and plants); design transfer (transfer in the form of blue prints, formulae and handbooks); and capacity transfer (transfer of scientific knowledge and technical capacity and capability)

In this study, technology transfer is used to imply the transfer of 'soft' or 'human' technologies or people-driven technologies such as skills and knowledge, rather than transfer of 'hard' or 'non human' technologies like computers, machinery, and equipment. In deed, when technology transfer is viewed as a process, it excludes the purchase of existing products such as new computer hardware (Trott, 1998). Thus, for purpose of this study, the researcher's interest is on the process part of technology, which involves the acquisition of skills, knowledge and ideas relevant for the growth and development of organizations.

Formulation of hypotheses

On the basis of the above discussion, the following hypotheses are proposed:

H1: Manufacturing firms acquire more technology from local universities than from other local institutions of higher learning.

H2: Multinational firms rely more on imported technology than indigenous firms.

RESEARCH METHODOLOGY

The study adopts the descriptive design approach of the cross sectional nature. This is because the study attempts to describe the use of technology transfer among multinational and indigenous firms, and to make specific predictions. The study is cross – sectional in the sense that the relevant data was collected at one point in time, that is each respondent filled only one questionnaire during the data collection period without filling the questionnaires at some other time in the future.

Population of the study

The relevant population for this study comprises of medium and large multinational and indigenous manufacturing firms in Kenya. This includes all manufacturing firms in the selected industries in all major towns in Kenya. The sampling frame was developed from firms registered in the Nation Business Directory (2005), Kenya Association of Manufacturers Directory (2002), Kenya Industrial Research Institute (KIRDI), and the Yellow Pages of the Telephone Directory (2005). Three categories of the consumer manufacturing firms were considered. These are;

(i) firms dealing with edible oils,
(ii) firms dealing with soaps and detergents, and
(iii) firms dealing with beverages (both alcoholic and non alcoholic drinks).

Since the researchers were only dealing with medium and large firms as defined by the number of permanent employees, and considering that only one manager per firm was to be interviewed, it was found prudent to do a census study instead of getting a sample. The entire population identified had 67 firms and hence

Table 1: Summary statistics for preferred source of technology

Source	n	Mean score (Max 5)	Std. error	% of total proportion *
Local public Universities	26	2.65	0.24	21.20
Local private Universities	26	2.54	0.25	20.32
Local Govt. Research Institutions	26	2.81	0.26	22.48
Foreign Universities	26	2.12	0.19	16.96
Foreign Research Organizations	26	2.38	0.24	19.04
Total				**100**

* Computed by dividing the mean score for a particular source by the total of the means, then converting to percentage.

sampling was not necessary.

Data collection and instrument development

The main data collection instrument was a questionnaire, which was completed by the Production manager, Brand manager, marketing manager, or the relevant manager dealing with innovations and product development. The questionnaire was administered mainly through personal interviews, in which the researcher delivered the questionnaires to the relevant managers, who either filled it in his presence, or an arrangement was made to collect the questionnaire later. This mode of data collection is preferred owing to its high response rate as compared to either mail or telephone interview. Further, the mode provides for clarification of questions. Kibera (1979) used a similar method in his doctoral research work among coffee farmers in central province of Kenya. Secondary data from existing company and government records will also be reviewed and utilized as appropriate.

Likert – type statements anchored by a five- point scale ranging from strongly disagree (1) to strongly agree (5) were used to capture specific aspects of performance. The Likert scale is widely used in many social science studies. For instance, Andy and Lockett (2003) used a five-point scale and got the mean and standard deviations for each indicator. Zou and Tamer, (2002) used a seven- point scale in their study. In this study, a five point scale was used as it provides clear distinctions between the points as opposed to a seven point scale which is too fine to differentiate between two close points, like between a 6 and a 7, or between a 1 and a 2.

Instrument validation

Instrument validation was done in several ways which included content analysis in which each item of the instrument was carefully analyzed and checked to ensure that it conveyed the necessary message. Content validity is the extent to which an instrument provides adequate coverage of the topic under study (Emory, 1985). In this case the instrument was divided into several sections to ensure that each section marched a specific aspect of university-industry linkage.

A pre - test in which the instrument was administered to three conveniently selected managers fill, without disclosing to them that this was not the final research. The managers were also asked to evaluate the statements for relevance and whether they are meaningful and clear, loaded or offensive. This approach of pre-testing a questionnaire was successfully used by Dixon, Spiro and Jamil (2001) in testing for validity and reliability of the questionnaire they were using. On the basis of the responses, the instruments were adjusted as appropriate to make those questions that were not clear clearer, before embarking on the data collection exercise.

Instrument Reliability

Kothari (2004) stresses that reliability of an instrument can be assessed by assessing such issues as who collected the data, sources of the data, and whether proper methods were. In this study, the researcher collected the data personally and only in a few cases did he seek assistance from qualified members of staff from the University of Nairobi's Extra Mural Centres. These were staff with either Masters degrees in Social Sciences or were doing their Masters degrees, and were very conversant with data collection procedures. Data was collected from senior managers of the companies involved, which further raised the reliability of the instrument. As has been stated earlier, the researcher used personal interview approach of data collection, which minimizes chances of the 'wrong' people filling the questionnaire.

DATA ANALYSIS AND PRESENTATION OF RESULTS

Data analysis followed the four phases normally used in many researches, namely data clean up, data reduction, data differentiation, and data explanation. Data clean up involved editing, coding and tabulation, in order to detect any anomalies in the responses, and assign specific numerical values to the responses for further analysis.

This study targeted 67 manufacturing firms which were identified from the various sources as specified earlier. A total of 34 firms responded out of the expected 67 firms targeted for the study, giving a response rate of 51%. Of these, 23 were indigenous while 11 were multinational firms. The sampled firms were asked to indicate the extent to which they relied on various sources of technology transfer. Table 1 shows the mean scores as far as preference for various sources by the manufacturing firms is concerned.

Results in Table 1 show that manufacturing firms get technology through technology transfer from all types of sources, but to different degrees. It was evident that government research institutions are the key source of technology transfer for manufacturing firms (mean score of 2.81), followed by public universities (mean score of 2.65), while foreign universities are the least preferred (mean score of 2.12). Given that these scores are based on a maximum score of 5, it would appear that the link between research organizations in general and universities in particular in Kenya is still rather low. The implication is that many of the manufacturing firms in Kenya rely on locally trained personnel and local consultants for their activities. There is therefore the need to ensure that local institutions of learning are conversant with industry operations so that they may continue to provide quality graduates who can fit well in the industry.

Table 2: Sources of technology transfer ranked

Source	Mean position*	Rank
Local Universities	2.11	1
Foreign Universities	3.86	4
Local Private universities	3.2	3
Government research institutions	3.1	2
Foreign Research organizations	4.0	5

* Obtained by dividing the total of positions given to a particular source by the number of firms ranking the source.

Table 3: Cumulative percentage of firms ranking the various sources to the first three positions

Rank	Local Public University (Cumulative %)	Local Private University (Cumulative %)	Local Government research Organization (Cumulative %)	Foreign University (Cumulative %)	Foreign research Organization (Cumulative %)
1	47.4	6.7	25	0.0	5.9
2	73.7	20.0	35	28.6	17.6
3	84.2*	66.7*	45*	28.6*	29.4*

* Remaining percentage is for the 4th and 5th positions

Table 4: Relative importance of various source of technology transfer

Source of technology transfer	Mean	Std. Deviation	Std error	Analysis N
Local public Universities	2.65	1.35	0.24	26
Local private Universities	2.54	1.45	0.25	26
Local Govt. Research Institutions	2.81	1.39	0.26	26
Foreign Universities	2.12	.99	0.19	26
Foreign Research Organizations	2.38	1.20	0.24	26

To augment the university industry linkage, the firms were asked to indicate some of the common practices related to their linkage with research institutions. It was found that sponsoring staff to study in the local universities was the commonest practice (mean score of 2.94), followed by use of consultants from local universities (mean score of 2.42). Carrying out joint research with research institutions was practiced, with a mean score of 2.3. When the firms were asked to rank their sources of technology transfer, (Best being number one and last being No five) public universities were rated highest as shown in Table 2.

Table 2 shows that local universities are still the best as a source of technology, followed by government research institutions. The reasons why public universities are not used as much as the government research organizations may be due to the expenses and admission criteria into public universities, which may not favour manufacturing firms. Further, Kenya's public universities spend a lot of time on theoretical teaching, leaving very little time for actual research. However as we have said, the situation is changing as universities come up with more flexible programmes. Table 4.3 shows the cumulative percentage proportion of the firms that ranked the various sources to the top three positions.

From Table 3, it is realized that local public universities are the most preferred sources, with 47% of the firms ranking them as position one, followed by local government research institutions in which 25% of the firms ranked them as number one. No firm ranked foreign universities to position one, and only 28.6% placed the firms in the top three positions, meaning that 71.4% ranked them in the 4th and 5th positions, making foreign universities the least preferred source of technology transfer among the manufacturing firms in Kenya.

Hypothesis testing

Hypothesis 1

In testing this hypothesis, data was collected by asking the manufacturing firms to indicate the extent to which they used the various sources of technology transfer, categorized as local public universities, local private universities, local government research institutions and foreign research institutions other than universities. The results in Table 4 show the mean scores out of a maximum of 5, for the various sources of technology transfer.

Table 4 shows that local public universities have a

Table 5: Hypothesis testing for preferred source of technology

Local Govt. Research Institutions – Public universities	Paired Differences			95% Confidence Interval of the Difference		T	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
	.23333	1.29810	.23700	-.25138	.71805	.985	29	.333

Table 6: Comparison of external source of technology transfer between multinational and indigenous firms

Firm's Category	Mean	Variance	Std. Deviation	N
Indigenous Firms	3.44	1.44	1.2	18
Multinational Firms	3.8	1.44	1.2	10

mean score of 2.65 as compared to local government research institutions which show a mean score of 2.81, indicating that manufacturing firms rely more on local government research institutions than they do on public universities. When the results were subjected to statistical testing as shown in Table 5, the difference was found to be statistically insignificant at 95%.

Table 5 shows that the mean difference lies within the 95% critical limits, indicating that the difference is not statistically significant. From table 5, it appears that manufacturing firms get more technology from government research institutions than from public universities and therefore reject the hypothesis that manufacturing firms get more technology transfer from local universities that from other local institutions of higher learning. Majority of manufacturing firms, by their nature may prefer more technically oriented people than theory oriented people. The technical people trained for various jobs in middle level colleges and government research institutions such as polytechnics are more preferred by many companies, perhaps because they are more practical oriented as opposed to the university graduates who are more theory oriented. Further, companies find it easier to take their staff for short term training in the local Polytechnics than to take them to universities which mainly deal with training of students straight from school.

However this perception is now changing as people working in the manufacturing firms seek more training opportunities from the public universities through the now famous module two pogrammes.

Hypothesis 2

This hypothesis sought to investigate whether multinational firms rely more on imported technology than indigenous firms. In testing the hypothesis, composite indices were computed for imported source of technology for both indigenous as well as multinational firms. The results are presented in Table 6.

As shown in Table 6 multinational firms rely more on imported technology than the indigenous firms. There is an average composite index of 3.80 with a standard deviation of 1.20 for multinational firms as compared to an average index of 3.44 for indigenous firms with standard deviation of 1.2. This supports the hypothesis that manufacturing firms rely more on imported technology than indigenous. Given their strong financial base and international linkage multinational firms may find it easier to import technology than their financially weaker indigenous counterparts. Multinational firms interact a lot with the foreign countries by virtue of having branches in those countries. This perhaps explains why such firms are more inclined to get technology from abroad than indigenous firms. These findings therefore support the hypothesis that multinational firms rely more on imported technology than indigenous firms.

DISCUSSIONS

This study has established that that local government research institutions are the main source of technology transfer for manufacturing firms in Kenya, although the firms still indicated local universities as their priority number one as a source of technology. The local government research institutions act as training ground for the organization by providing trained manpower to young graduates who later find jobs among the manufacturing firms, or by providing training opportunities to people working in the industry who are either sponsored by their employers or are self sponsored to update their technical and/or managerial skills while still on employment. The fact that local public universities were still rated the highest is an indication of opportunities in the industry that are not being harnessed. It shows that manufacturing firms still rate universities highly as a source of technology, and perhaps the problem is that universities are not utilizing this favourable rating to strengthen the linkage between themselves and the industry.

The second major finding is that multinational firms rely more on imported technology than the indigenous firms, which supports the hypothesis that manufacturing firms rely more on imported technology than indigenous firms.

Imported technology may be in the form of machinery, equipment and human labour, usually in the form expatriates. Singer (1974) points out that the transfer of technology from the developed to developing countries may take several forms, such as importation of equipment, technical assistance, or private foreign investment (in the form of capital, management, and marketing), which was evident from the results of this study). Multinational firms interact a lot with the foreign countries by virtue of having branches in those countries. This perhaps explains why such firms are more inclined to get technology from abroad than indigenous firms. Multinational firms have closer links with other countries with whom they trade, and easily access technology from those countries. Further more, sourcing for technology from abroad is expensive and many indigenous companies may prefer local sources of technology transfer.

These findings imply that there is need for both the manufacturing and public universities to come up with ways of strengthening their linkage in order to enhance research relevant to industry requirements. Research institutions and particularly universities need to become more practical oriented by exposing students to the industry through practical industry attachment in the relevant disciplines. It is apparent that so long as universities continue doing research and coming up with findings that do not find application in the industry, the gap between universities and the industry will continue to widen and become weaker. The research findings by Grandi and Grinaldi (2003) that young companies can use names of reputable universities with which they may have collaboration to market themselves should be used by both the young as well as the relatively older manufacturing firms to enhance their image. Likewise, universities and other research institutions should try to enhance their image as being centres of excellence so that manufacturing firms can be attracted to them.

Suggestions for further research

Two suggestions for further research are suggested: First, the current study lays emphasis on the recipients rather than donors (sources) of technology transfer. As such the research instruments targeted the recipients (manufacturing firms). A similar study focusing on the sources of technology transfer (research institutions) may shed more light on the practices in these institutions. For instance, one may wish to know such issues as the level of involvement of the research institutions with relevant research that aims at solving practical industry problems and the intensity of industry - research organizations linkage that exist between the industry and specific research institutions.

Secondly, the current study focuses on the soft form of technology with little emphasis on the hard form of technology. Technology transfer involves transfer of both soft and hard technology. Future research should therefore focus on the hard form of technology transfer, that is, acquisition of such hard forms of technology as machinery, computers, plant and other such form of technology.

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