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Technology Diffusion and Its Effects on Product Quality in the Informal Metalworking Sector in Kenya

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Abstract:
This paper focuses on technology diffusion and its effects on product quality in small scale informal industries in Kenya. The research design used in the study was cross-sectional survey whereby data was collected from 112 firms out of a population of 1,076 firms in Nairobi province. The research findings show that ideas for product development in the informal metalworking sector are obtained from friends or colleagues, consultation with experts in the metalworking sector, co-operation with other firms both in the formal and informal sectors, customers and existence of training programmes for employees. Hence these results in the production of goods that varies in terms of design, variety and overall quality.

Keywords: *Technology diffusion, product quality, Small and Medium Scale Enterprises (SMEs) and informal metalworking sector*

1. Background of Study

Technology transfer can be defined in general terms as the process of conveying a technology from one party and applying it to the other party. In the process, the technology which is not necessarily derived from a competitor organization is converted into a form that can be applied [Edwards (1997)]. This definition of technology transfer applies to the informal sector of our Kenyan situation. However, it is evident from previous surveys that there is a crude copying of product designs in the Kenyan informal sector which results in the duplication of very many similar products in the market. These products do not meet customer demands in terms of quality, quantity and time. In order to solve this problem, there is the need to employ professional and academic knowledge in the transfer of technology in the informal sector.

2. Significance of the Study

Ngahu (1999) states that there is inadequate relevant technology to suit our local industries. Therefore, artisans in the sector cannot produce quality products in desired quantities and on schedule. Moreover, the conventional process of product development which involves idea generation, idea screening, concept development and concept testing [Meredith (1994: 97- 98)] is not practised by any of the artisans or owners of firms in the informal sector. This is brought about by lack of research and development which should be aimed at upgrading the technology in the informal metalworking sector with a view of addressing the limitations relating to product development processes, skills and quality of outputs. Therefore this study investigates technology diffusion and its effects on product quality in small scale informal industries within Kenya.

3. Literature Review

Seaton and Cordey – Hayes (1993: 13(1), 45 – 53) argue that inward technology transfer can be successful. This can only occur if an organization has not only the ability to acquire but also the ability to effectively assimilate and apply ideas, knowledge, devices and artefacts. Research done by Oakley (1988) on the subject of the search for technical knowledge shows that small firms in particular do not recognise the importance of external technical contacts. The problem of management has been identified as a major obstacle to the advancement of small enterprises. The typical small enterprise owners or managers develop their management through a process of trial and error. A consequence of poor managerial ability is that entrepreneurs are less prepared to respond to changes in the business environment and to plan for appropriate changes in technology [Ngahu (1999)].

The entrepreneur's level of education affects their access to technological information and their ability to understand, respond to, use and control technologies [Anderson (1985)]. Ngahu (ibid) has also shown that the process of technology improvement at the enterprise level may also be affected by physical constraints such as lack of suitable premises, power and other infrastructure facilities. Lack of market information is another problem. Small enterprises are unable to estimate market potential for their products and to determine

product modifications or improvements sought by customers. Another problem that hinders technological improvements in this sector may be the lack of protection for the innovator. In a sector where imitation is so easy, entrepreneurs may lack the incentive to invest in technological improvement.

Godkin (1988:3(5), 597-603) carried out a comprehensive review of technology transfer literature and suggested that the following factors would foster technology transfer: First, high quality of incoming communication. Second, a readiness to look outside the firm. Third, a willingness to share knowledge. Fourth, a willingness to take on new knowledge as well as the ability to license and to enter joint ventures. Fifth, effective internal communication and co-ordination mechanisms. Sixth, a deliberate survey of potential ideas and an awareness of costs and profits in research and development departments. Seventh, use of management techniques. Eighth, identification of the outcome of investment decisions as well as good quality intermediate managers. Ninth, high status of science and technology on the board of directors. Lastly, high quality chief executives and a high rate of expansion.

4. Research Methodology

The researcher employed cross-sectional survey in this study. From these cross-sectional surveys, it was possible to identify associations that had metalworking activities such as fabrications, bending, forging and joining processes. After a period of research of about four months, which involved travelling, locating and interviewing artisans belonging to the particular associations, a total of about 1000 members of the metalworking sub-sector were identified. During the research the number of qualified and skilled owners of Small and Medium Scale Enterprises (SMEs) in the informal metalworking sector from fifteen zones was found to be 1,076. The researcher used the statistical method of non-probability sampling. In this method a convenient percent of the total population for each zone that is 10% was used which realized a sample size of 112 owners of SMEs from whom data for this study was collected.

5. Findings

Table 1 below was constructed from the scores ranging from 1 to 5 that rated the effectiveness of the various sources of skills for product development by owners of SMEs. The score of 5 had the greatest extent and the score of 1 the least extent in describing the source as a method of technology diffusion. The mean scores of each method and standard deviations were also determined and included in the tables. It is therefore evident from the analysis given in Table 1 that skills acquisition from friends or colleagues is the most common method of technology transfer in the informal metal working sector as confirmed by its high mean score of 4.35. Non-governmental organizations as a means of technology diffusion are rated with a mean score of 1.17. This shows that NGOs play a minor role in the transfer of technology in the informal metalworking sector.

Government training as a medium of skills acquisition for product development has a mean score of 1.51 which is relatively low when compared with the mean scores of other methods of technology transfer in the informal metal working sector that are shown in Table 1. This shows that the Kenyan government plays a minor role in the process of technology diffusion in the informal metal working sector. Furthermore, research institutions such as Polytechnics and Universities which have a mean score of 1.24 are also not actively involved in the transfer of technology in the informal metalworking sector when compared with other methods of technology diffusion as illustrated on Table 1. Moreover, participation in research by the firms in the informal sector as a medium of technology diffusion has a low mean score of 1.79 which shows that carrying out of research is rarely done in the informal metalworking sector.

It is also evident that other sources of skills for product development which are not listed on Table 1 have a high mean score of 3.79 which shows their popularity among the artisans in the informal sector. These other methods of technology diffusion were reported to include: existence of training programmes for the employees, consultations with experts, co-operation with other firms both in the informal and formal sectors as well as getting ideas from customers.

Sources of Skills for Product Development	Number of Respondents	Mean Score	Standard Deviation
Research institutions e.g. polytechnics	101	1.24	0.666
Participation in research	104	1.79	0.844
Non-government organizations	104	1.17	0.565
Government training	103	1.51	1.056
Friends or colleagues	105	4.35	0.679
Others	19	3.79	1.182

Table 1: Rating of methods of technology diffusion
Source: Field Data

Note: Other sources of skills for product development include the following:

i. Existence of training programmes for employees.
ii. Consulting of experts in the informal metal working sector.
iii. Cooperation with other firms both in the informal and formal sectors
iv. Customers.

5.1. Output Rating of Employees and Routes of Training

The performance of employees with different routes of training in day-to-day activities in the informal metalworking sector in terms of output is illustrated in Table 2. The data from Table 2 shows that 66.7% of owners of SMEs in the informal metalworking sector

who have employed workers with the route of training A_{RT} informed the researcher that the output of these employees was reasonable but it did not meet the required standards. Moreover, only a small percentage of 3.7% of this category of workers with A_{RT} route of training were reported to be hard working and able to achieve right standard output. This shows that a majority of artisans that is 96.3% with an educational level below standard eight cannot be relied upon to achieve products of desired quantity.

The results in Table 2 show that 67.9% of firm owners in the informal sector who have workers that have undergone B_{RT} route of training reported that the output of their employees was reasonable but not yet up to standard. Moreover, it is a relatively low percentage of owners that is 28.2% in the informal sector who reported that their employees who have undergone B_{RT} route of training produce products that are satisfactory and up to a standard. It is therefore evident that artisans who have attained complete primary education that is up to standard eight level do not possess the necessary training to give the desired output.

The data in Table 2 further reveals that 100% of respondents who have employed workers with C_{RT} route of training informed the researcher that their workers' output was not up to the expected standard. Furthermore 75% of owners in the informal sector who have employed workers with the route of training C_{RT} indicated that they produce products with a few mistakes. Therefore, it can be inferred from these statistics that a majority of artisans who have experienced vocational training after they have completed their primary education are not able to give an output that is up to the required standard.

Table 2 shows that 71% of owners whose employees have undergone D_{RT} as a route of training reported that the output of their workers was satisfactory. This reveals that a majority of artisans who have complete general education that is up to secondary level possess adequate knowledge and skills. This enables them to produce products that are relatively satisfactory when compared to other products produced by other artisans with lower levels of education and training. It has also been determined as shown in Table 2 that 75% of firm owners who have workers that have undergone route of training H_{RT} reported that the output of their employees is satisfactory. The other 25% of owners with the same kind of employees revealed that the output in their firms was of the required level.

The findings for workers with the route of training K_{RT} show that they are rated lowly by their employers when compared with their counterparts with the route of training H_{RT} as indicated in Table 2. It is therefore evident that employees who have acquired complete general education and enterprise based training in the formal manufacturing sector are rated better than those with enterprise based training provided by the informal sector. This is observed when it comes to the achievement of products of the desired quantity. Moreover, it has been illustrated that the rating of employees by their employers in the informal sector tends to improve with the levels of education and technical training of the workers. Therefore, those artisans who have undergone higher levels of technical training at tertiary institutes were rated highly by more than 85.7% of their employers. These respondents felt that their workers do guarantee production of products of desired quantity.

The Chi-square analysis of the data in Table 2 gives Chi-square of 27.256 and Significance of 0.021 at 95% confidence level. Since the p-value of 0.021 is less than the set significance level of 0.05, it therefore implies that the rating characteristic is influenced by the route of training of an employee before employment. The rating of the employees by their employers becomes more favourable to production of the desired quantity at higher levels of education and technical training.

Route of Training of Employees	**Rating Characteristic**									
	OR_1		**OR_2**		**OR_3**		**OR_4**		**OR_5**	
	Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
A_{RT}	1	3.7	18	66.7	6	22.2	1	3.7	1	3.7
B_{RT}	0	0	53	67.9	22	28.2	2	2.6	1	1.3
C_{RT}	0	0	4	100	0	0	0	0	0	0
D_{RT}	0	0	4	12.9	22	71	5	16.1	0	0
E_{RT}	0	0	0	0	0	0	1	100	0	0
F_{RT}	0	0	0	0	0	0	6	85.7	1	14.3
G_{RT}	0	0	0	0	0	0	1	100	0	0
H_{RT}	0	0	0	0	3	75	1	25	0	0
I_{RT}	0	0	0	0	0	0	3	100	0	0
J_{RT}	0	0	1	10	8	80	1	10	0	0
K_{RT}	0	0	4	15.4	20	76.9	2	7.7	0	0
L_{RT}	0	0	2	100	0	0	0	0	0	0

Table 2: Output rating of Employees and Routes of training
Source: Field Data

Confidence level = 95% Chi-square = 27.256 Degrees of Freedom =15 Significance = 0.021

5.1.1. Key for Route of training and Output Rating in Table 11

A_{RT} = Below standard eight ⟶ Self employment.
B_{RT} = Standard eight (complete primary education) ⟶ Self employment.
C_{RT} = Standard eight ⟶ Vocational training ⟶ Self employment.
D_{RT} = Complete general education (secondary level) ⟶ Self employment.
E_{RT} = Complete general education ⟶ Tertiary training ⟶ Self employment.
F_{RT} = Complete general education ⟶ Tertiary training ⟶ Wage employment ⟶ Self-employment.
G_{RT} = Complete general education ⟶ Enterprise based training (Formal) ⟶ Self employment.
H_{RT} = Complete general education ⟶ Enterprise based training (Formal) ⟶ Wage employment ⟶ Self employment.
I_{RT} = Complete general education ⟶ Vocational training ⟶ Self employment.
J_{RT} = Complete general education ⟶ Vocational training ⟶ Wage employment ⟶ Self employment.
K_{RT} = Complete general education ⟶ Enterprise based training (informal) ⟶ Self employment.
L_{RT} = Complete general education ⟶ Enterprise based training (informal) ⟶ Wage employment ⟶ Self employment.
OR_1 = Slow
$OR_{\square}$ = Reasonable but not yet up to standard
OR_3 = Satisfactory output to standard
OR_4 = Works hard
OR_5 = Exceptionally quick

5.2. Rating of Ability of Employees to Produce Products of Desired Quality and Route of Training

The rating of employees with different routes of training in terms of their ability to produce desired quality products is shown in Table 3. The data from Table 3 shows that 59.3% of respondents who have employed workers with route of training A_{RT} revealed that the quality of the products produced in their firms were satisfactory with very few mistakes. Moreover, 62.8% of owners in the informal sector who have undergone B_{RT} route of training reported that their employees produced products that had few mistakes. Hence, these products were not completely reliable. This shows that artisans who have attained standard eight level of education do not possess the necessary knowledge and skills to achieve quality products.

The results in Table 3 show that 75% of owners in the informal sector who have employed workers with the route of training C_{RT} indicated that they produce products with a few mistakes. It can therefore be inferred from these results that a majority of artisans who have experienced vocational training after standard eight are not able to produce products of the desired quality. Table 3 shows that 77.4% of firm owners whose employees have undergone D_{RT} as a route of training informed the researcher that the quality of their products was satisfactory. This indicates that a majority of artisans who have graduated from secondary schools possess adequate training. Thus enabling them to produce products of better quality when compared to other products produced by artisans with lower levels of education and training.

The data in Table 3 shows that 50% of the owners who employ workers who have undergone route of training H_{RT} reported that the quality of products produced were completely reliable and accurate. The remaining 50% of the owners also indicated that their employees who have experienced route of training H_{RT} make very few mistakes and their products are satisfactory in quality. Furthermore, the findings show that workers with H_{RT} route of training were rated highly by their employers when compared with those artisans who have undergone K_{RT} route of training. This indicates that artisans who have achieved secondary level education and experienced enterprise based training in the formal manufacturing sector are rated better. This is when they are compared with those artisans who have acquired enterprise based training in the informal sector when it comes to the production of products of the desired quality.

The Chi-square analysis of the data in Table 3 gives Chi-square of 21.689 and Significance of 0.018 at 95% confidence level. Since the p-value of 0.018 is less than the set significance level of 0.05, it therefore implies that the rating characteristic is influenced by the route of training of an employee before employment. The rating becomes more favourable to production of desired quality products at higher levels of education and technical training.

Route of training of employees	Rating characteristic									
	QR_1		QR_2		QR_3		QR_4		QR_5	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
A_{RT}	2	7.4	8	29.4	16	59.3	1	3.7	0	0
B_{RT}	0	0	49	62.8	26	33.3	2	2.6	1	1.3
C_{RT}	0	0	3	75	0	0	1	25	0	0
D_{RT}	0	0	2	6.5	23	77.4	5	12.9	1	3.2
E_{RT}	0	0	0	0	0	0	1	100	0	0
F_{RT}	0	0	0	0	0	0	5	71.4	0	0
G_{RT}	0	0	0	0	0	0	1	100	0	0
H_{RT}	0	0	0	0	2	50	2	50	0	0
I_{RT}	0	0	0	0	0	0	3	100	0	0
J_{RT}	0	0	3	30	6	60	1	10	0	0
K_{RT}	0	0	14	53.8	10	38.5	2	7.7	0	0
L_{RT}	0	0	1	50	1	50	0	0	0	0

Table 3: Rating the ability of employees to produce desired quality products
Source: Field Data

Confidence level = 95% Chi-square = 21.689 Degrees of freedom = 11 Significance = 0.018

5.2.1. Key for Routes of training and Rating of Employees' ability to produce quality products in Table 12

A_{RT} = Below standard eight ⟶ Self employment.
B_{RT} = Standard eight (complete primary education) ⟶ Self employment.
C_{RT} = Standard eight ⟶ Vocational training ⟶ Self employment.
D_{RT} = Complete general education (secondary level) ⟶ Self employment.
E_{RT} = Complete general education ⟶ Tertiary training ⟶ Self employment.
F_{RT} = Complete general education ⟶ Tertiary training ⟶ Wage employment ⟶ Self-employment.
G_{RT} = Complete general education ⟶ Enterprise based training (formal) ⟶ Self employment.
H_{RT} = Complete general education ⟶ Enterprise based training (formal) ⟶ Wage employment ⟶ Self employment.
I_{RT} = Complete general education ⟶ Vocational training ⟶ Self employment.
J_{RT} = Complete general education ⟶ Vocational training ⟶ Wage employment ⟶ Self employment.
K_{RT} = Complete general education ⟶ Enterprise based training (informal) ⟶ Self employment.
L_{RT} = Complete general education ⟶ Enterprise based training (informal) ⟶ Wage employment ⟶ Self employment.
QR_1 = Inclined to make mistakes
QR_2 = Makes only a few mistakes
QR_3 = Very few mistakes, satisfactory
QR_4 = Completely reliable and accurate
QR_5 = Unusually good

6. Conclusions

It is also evident from the study that ideas for product development are obtained from the following sources: friends or colleagues, consultation with experts in the metalworking sector, co-operation with other firms both in the informal and formal sectors, customers and existence of training programmes for employees. Hence these results in the production of goods those vary in terms of design, variety and overall quality. In this regard the researcher recommends that technical training institutes, industrial research institutes, local industrial sector (both formal and informal), National standards institutions such as Kenya Bureau of Standards should be linked to the informal metalworking sector through policy formulation to facilitate sharing of product development ideas as well as quality management procedures. Formation of trade associations made up of artisans in the informal sector should be encouraged to help in the setting up of technology information centres which should be reference points for consultants, trainers and non-governmental organizations who are involved in technology diffusion.

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