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Impact Of Business Location On Product Quality

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The Case Study of Arc Welding in Small Scale Metalworking Enterprises in Kenya

ABSTRACT: *The quality of products from the micro and small enterprise sector is affected by both the entrepreneur's and enterprise's attributes. This paper presents and discusses findings of a study that was designed to investigate experimentally the relationship between the quality of arc welding in the Small Scale Metalwork sub-sector and the artisan's business location. Four pairs of groups with a total of 36 with secondary education and 36 with primary education consisting of formally and informally trained artisans from urban and rural areas participated in the evaluation. A mild steel product was fabricated by each participating artisan, assessed and scores awarded based on the quality of arc welding. The analysis of variance (ANOVA) was used to show any variation in the quality of arc welding;comparisons of means using the Least Significant Difference (LSD) at the alpha level of 5% were done to determine which pairs of artisans affected quality significantly. The study found out that artisans from urban areas performed better those from rural areas.*

Keywords—*Business location, Product Quality, MSE, Metalworking sub-sector, Arc welding*

I. INTRODUCTION

The quality of products from the MSE sector is affected by both the entrepreneur's and enterprise's attributes. Many school leavers, retirees and retrencheesas well as those dissatisfied with formal wage employment resort to entrepreneurial activities within this sector as a means of earning a living. However, the MSE sector entrepreneurs suffer various deficiencies in business management. These deficiencies are attributable to their low education levels, which in turn adversely affects their ability to produce high quality products among others.

The influence of the entrepreneur's attributes such as age, gender, educational level, mode of training, work experienceand membership to business support groups on the productivity and performance of enterprises has been reported. Similarly, enterprise attributes such as its age, location, ownership structure, and formal status and business activity determine production outcomes (Kimuyu, 2001).

This paper discusses the findings of a study that was designed to investigate experimentally the relationship between the quality of arc welding in the Small Scale Metalwork sub-sector and the artisan's business location.The understanding and validation of this relationship is important forthe effective marketing of the MSE products.

The majority of the MSE/informal activities arein the rural areas or small towns and markets in Kenya. However, there is very little literature relating the performance of the MSEs and their business locations. Most of the literature available is on financial support to the sector followed by education and training in the MSE sector. Most of these studies have been carried out mainly in urban areas.Most of the previous studies obtained their data through the use of one or more of the following instruments: questionnaires, desk reviews, observations, interviews, focus group discussions, and content analysis. These studies were either qualitative or survey researches, while the present study was mainly experimental research (with a bit of qualitative using observation as far as the use of welding equipment and welding techniques are concerned to find out which groups – secondary/primary or urban/rural - were proficient or understood the welding process).

In arc welding processes the most common defects are either surface defects (cracks, distortion, overlaps and rolls, undercuts, excessive spatter, and bad weld surface appearance) or subsurface weld defects. These defects (Parmar, 1997) come as a result of:

a) Improper selection of process, for example, using a very deep penetrating heat source on a narrow Vee angle so causing cracking in the root run due to large depth-to-width ratio;

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b) Applying the welding process incorrectly for the particular application, such as incorrect current setting or excess weld metal deposition;
c) The interactionof the weld metal with prior defects in the base metal, e.g. laminations and impurities like phosphorous, sulphur, and silicate, etc. that cause brittle and weak zones resulting in, for example, lamellar tearing;
d) Undesirable metallurgical structure with respect to grain size and hardness as well as undesirable inclusions such as tungsten oxide and slag. Hydrogen is a most undesirable inclusion as it is often the main cause of cold cracking in steels;
e) Undesirable shape and size of weld bead due to overfill and/or poor profile;
f) Incorrect joint preparations and poor fit-up leading to inaccessibility and lack of fusion, cracking, etc.;
g) Stray arcing, tool marks, undercuts, inclusions, poor finish, lack of fusion and penetration, and incorrect weld shape causing a reduction in fatigue life and joint strength;

For one to produce a quality product the sequence of welding techniques commonly used, as outlined in the book by Parmar (1997), are:

1. The preliminary operations like cleaning, edge preparation, and the fixing of tab-in and tab-out plates are accomplished;
2. Parts are assembled by tack welding or by employing jigs and fixtures;
3. The assembled work piece is presented to the machine or vice versa;
4. Welding is initiated by striking the arc for fusion welding or by bringing electrodes in contact with the work and switching on the current for resistance welding;
5. Relative movement between the welding head and the work to attain the desired welding speed is created;
6. The welding variables like arc voltage, welding current, and wire feed rate are controlled- controlling the welding variables like arc voltage controls the arc length, welding current, and wire feed rate;
7. Welding process is stopped by stopping the relative movement between the welding head and the work;
8. The welding head is shifted to the position wherefromthe next welding cycle is to be initiated;
9. The completed work is removed.

1.1 Objectives of the Study

The objectives of this study were to compare the product quality in terms of the mean scoresfrom artisans with businesses in the urban areas with those artisans with businesses in rural areas, both with the following attributes:

i) Formallyand informally trained artisans with secondary education;
ii) Formally and informally trained artisans with primary education.

II. MATERIAL AND METHODS

2.1 Sampling

The target population of the study consisted of artisans who had completed class eight of the Kenyan primary education and artisans who had completed form four of the Kenyan secondary education. The artisans were selected both from rural and urban areas with two modes of training (on-the-job training and formal technical training). The Kenyan MSE sector engages about 8.33 million operators (Government of Kenya, 2010). Out of this the *Jua Kali* sector (the MSEs that are engaged in technical work) wasabout 18% according to the National MSE baseline Survey conducted in 1999. The most widely used welding method is arc weldingfor mild steel products, and according to the survey the number of artisans engaged in welding and fabrication is about 37,485 (Government of Kenya, 1999). About 60% and 40% of this number comprise primary education class eight graduates and secondary education form four graduates respectively (Government of Kenya, 2004).

Based on these figures the total population for primary class eight artisans was taken to be 22,491 and for secondary formfour was takento be 14,994. A total of 36 artisans with primary education class eight and a total of 36 artisans with secondary education formfour were selected for assessment. The sample size determination was based on the relation:

$$n = \frac{Nc^2}{c^2 + (N-1)e^2}$$; where n = sample size, N = population size,

c = coefficient of variation (≤ 30%), and e = error margin (≤ 5%).

This formula enabled the researchers to minimize the error and enhance stability of the estimates (Nassiuma, 2000). In this study *c* was taken to be 30% and *e* to be 5% (using the maximum percentage in each case). Table 1 show the number and category of artisans who participated in this study.

Table 1: Number and category of artisans who participated

Education Level	Attributes	Urban Area	Rural Area	Total
Secondary Education	Formally trained	5	14	19
	Informally trained	10	7	17
	Total	*15*	*21*	*36*
Primary Education	Formally trained	6	10	16
	Informally trained	8	12	20
	Total	*14*	*22*	*36*
Total		29	43	72

The Directorate of Industrial Training (DIT) testing centers were used for this research. This was meant to minimize the effect on the quality of the fabricated products due to the condition of the welding equipment; (the welding equipments used in all DIT testing centers are more else of the same working condition). The selected DIT testing centers were those with high concentrations of welders, and easily accessible by the researchers. A total of ten (10) DIT testing centers were used as shown in Table 2. Work started at the same time in all testing centers. Research assistants (who had been selected from among the DIT trained examiners) were used to supervise the participating artisans.

Table 2: DIT Testing Centres and Number of Participating Artisans

DIT Centre (Province)	Education Level	Urban		Rural		Total
		F	I	F	I	
1. NIVTC (Nairobi)	Primary	2	2	0	0	4
	Secondary	2	3	0	1	6
2. Ruaraka (Nairobi)	Primary	1	0	0	0	1
	Secondary	1	2	0	0	3
3. Kakamega (Western)	Primary	0	0	1	1	2
	Secondary	0	0	1	0	1
4. Turbo (Western)	Primary	0	0	4	0	4
	Secondary	0	0	11	1	12
5. Kiambu (Central)	Primary	0	0	2	2	4
	Secondary	0	0	0	1	1
6. Machakos (Eastern)	Primary	0	0	3	7	10
	Secondary	0	0	0	2	2
7.Mombasa (Coast)	Primary	0	5	0	0	5
	Secondary	1	2	0	1	4
8. Eldoret (Rift Valley)	Primary	0	0	0	0	0
	Secondary	0	1	0	0	1
9. Nakuru (Rift Valley)	Primary	0	0	0	1	1
	Secondary	1	0	1	0	2
10.Kisumu (Nyanza)	Primary	3	1	0	1	5
	Secondary	0	2	1	1	4
Total		11	18	24	19	72

F – Formally Trained; I – Informally Trained (i.e. trained-on-the-job)

The independent variable of the study was the artisan's business location, while the dependent variable was the scores awarded to indicate the quality of the product fabricated by the artisan using arc welding processes.

The effect of business location level was evaluated by comparing the mean scores of the following groups:

a) Trained artisans with secondary education form four working in urban areas with those working in rural areas.
b) Artisans that are trained-on-the-job with secondary education form four working in urban areas with those working in rural areas.

c) Trained artisans with primary education class eight working in urban areas with those working in rural areas.
d) Artisans that are trained-on-the-job with primary education class eight working in urban areas with those working in rural areas.

Besides the above primary groups, the effect of business location was also evaluated by comparing the mean scores of the following combined groups composed of artisans with different other attributes:

e) All artisans with secondary education formfour working in urban areas with those working in rural areas.
f) All artisans with primary education class eight working in urban areas with those working in rural areas.
g) All trained artisans working in urban areas with those working in rural areas.
h) All artisans trained-on-the-job working in urban areas with those working in rural areas.
i) All artisans working in urban areas with those working in rural areas.

2.2 Data Generation Tools

Two instruments were used to collect the required data. These were:

i) Structured questionnaires, and
ii) Assessment of fabricated product.

The questionnaire was used mainly to get information regarding the artisan's attributes and business characteristics. The participating artisans were generally observed to find out how proficientthey were in using the welding equipment and methods/techniques as outlined in the introduction.

2.3 Assessment of Product Design

Drawing of the product shown in figures 1 was used in the research. The welding project was marked out 100%. The product was designed in such a way that most of the welding techniques were to be used in fabricating it.

In this study, manual welding was employed; the artisans were given materials in the form of sheets and they were supposed to measure and cut the parts to the sizes shown. The parts were joined together using arc welding processes. The assessment was carried out by checking for the correct part sizes (by using vernier calipers), and examining for the correct part alignment, correct welding and product finish; visual inspection was used to detect surface defects. Careful visual inspection of welds can detect about 80% to 90% of the defects and flaws (Parmar, 1997).

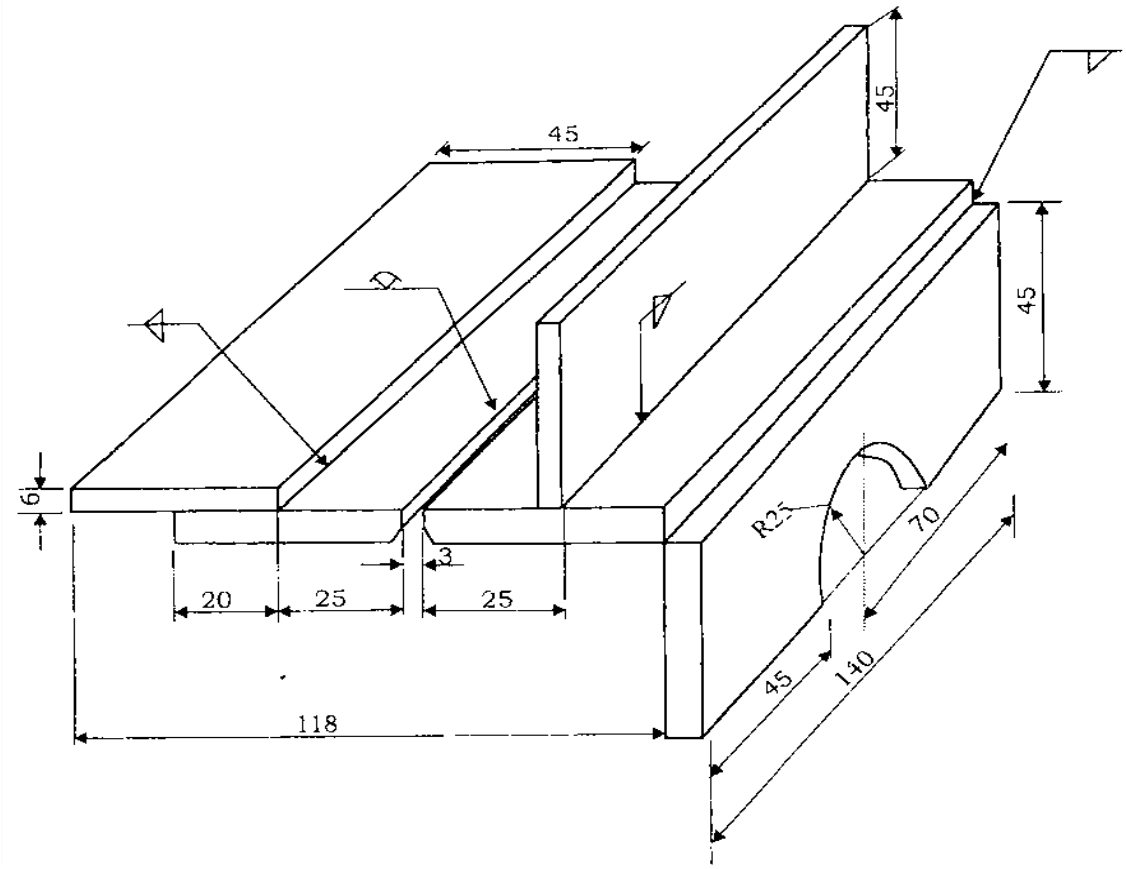

Figure 1:Mild Steel Welding Project

The quality of welded joints depends upon the design of the product, the performance of welding equipment, the welding procedures followed, and the skill of the operator. In this study any deficiency in the design and equipment affected all artisans equally. Therefore, the skillof the welder was to determine the scores obtained.

III. RESULTS AND DISCUSSION

The data scores collected were analyzed using the Statistical Analysis System (SAS) and excel spreadsheet. The means and standard deviations were generated to describe the quality of arc welding with regard to business location. The scores were matchedwith the artisans' attributes and business characteristics to find their relationships.

The analysis of variance (ANOVA) was used to show any variation in the quality of arc welding in each of the eight groups of artisans due to the different treatments, that is, business location. Comparisons of all possible pairs of means using the Least Significant Difference (LSD) method with alpha set at 5% were done to determine which pairs of artisans with quality performances that was significantly different.

The eight primary groups could broadly be divided into two: those artisans working in theurban areas and those artisans working in the rural areas. A total of 29 participating artisans were selectedfrom urban areas and 43 participating artisans were selected from rural areas for evaluation in this study. The artisans' scores awarded for quality of arc welding provided the data for determining the impact of business location on product quality.

The objective sought to determine whether there were differences in product quality when using arc welding processes by artisans from urban areas and artisans from rural areas. The specific objective was to find out whether there is any relationship between the (quality of arc welding and business location.

The analysis of variance was carried out and the results are presented in Tables 3 and 4. Table 3 shows mean scores of product quality for business locations forprimary groups of artisans with the same attributes, and Table 4 showsmean scores of product quality for business locations forcombined groups of artisans with different other attributes.

Table 3: Mean scores of product quality for business locations forprimary groups of artisans with same attributes

Business Location	**Mean Scores**				**Cumulative Mean Scores**
	secondary		Primary		
	Formally Trained	Informally Trained	Formally Trained	Informally Trained	
Urban	68.70[a]	73.45[a]	66.58[b]	70.25[a]	**70.33[a]**
Rural	69.86[a]	65.07[b]	60.35[b]	50.88[c]	**61.57[b]**

The means followed by the same letter in the same column are not significantly different at $\alpha = 5\%$ using LSD

Table 3 shows that there is no significant difference in the mean scores in the first and third columns. Thus the performance of both formally trained artisans with secondary or primary education from urban and rural areas does not significantly differ. This implies that the business location does not have asignificant impact on product qualityofthese groups of artisans.

However, there is a significant differencein the mean scores in the second and fourth columns; this implies that the business location has significant impact on product quality ofthese groups of artisans. The highquality was exhibited by the informally trained artisans with secondary education working in the urban areas, while the lowquality was exhibited by the informally trained artisans with primary education working in the rural areas. Overall artisans in urban areas emerged with the best product quality as compared with product quality from artisans in rural areas.

Table 4: Mean scores of product quality for business locations forcombined groups of artisans with different other attributes

Business Location	**Secondary Education**	**Primary Education**	**Formal Training**	**Informal Training**	**Overall Mean**
Urban	**71.83[a]**	**68.68[a]**	**67.55[b]**	**72.03[a]**	**70.33[a]**
Rural	**68.26[a]**	**58.18[c]**	**65.90[b]**	**56.11[c]**	**61.57[b]**

The means followed by the same letter in the same column are not significantly different at $\alpha = 5\%$ using LSD.

Table 4 shows that there is no significant difference in the mean scores in the first and third columns, that is, the overall performance of artisans with secondary education or with formal training is moreelsethe same irrespective of the business location. However, in the second and third columns the differences in mean scores

are significant; this implies that in overall artisans from urban areas with primary education or informally trained have their product quality higher than their counterparts from rural areas.

Overall artisans in urban areas emerged with the best product quality as compared with product quality from artisans in rural areas. The results agree with Sonobe *et al*, (2002) who, when studying on the performance of garment enterprises in Jili, China, found out that the performance in producing quality products between enterprises in urban and remote centres(rural areas) were different; urban enterprises performed better than rural enterprises.

The mean score for the informally trained artisans working in rural areas is significantly different from the other mean scores. The majority in this group have primary education class eight artisans (12 out of 19 artisans). It is evident from Tables 3 and 4 that the informally trained artisans working in urban areas perform better than their counterparts who are formally trained.

However, it was expected that the formally trained could perform better than those informally trained since they are all working in the same urban areas. From the questionnaires it was found out that more than 60% of the formally trained artisans working in urban areas planned to look for formal employment, while less than 20% of those artisans trained-on-the-job working in urban areas planned to look for formal employment. In the case of those in rural areas the result was different; less than 25% of the formally trained artisans and less than 10% those trained-on-the-job planned to look for formal employment. This means that the formally trained artisans in urban areas are not contented with their self-employment and therefore do not concentrate on their work as much as those without formal training do. This therefore could probably explain why the informally trained artisans in urban areas perform better than the formally trained artisans. The formally trained artisans can easily get formal employment because they hold certificates, while those trained-on-the-jobs find it difficult to be employed in the formal sector without certificates. On the other hand those in the rural have very little opportunity for formal employment as most formal employment is found in urban areas, hence even those formally trained artisans concentrate on their jobs as much as those without formal training do.

From this analysis it can be concluded that the urban artisans perform better than the rural artisans because they have more exposure and more information, have more work and therefore more experience, more competition, better equipments and tools, better methods of working, and more contact with other more experienced artisans.

IV. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The following are the conclusions drawn from this study:

1) Business location has a significant impact on product quality; urban work experience has a higher positive impact on product quality as compared to rural work experience.
2) Urban work experience when combined with higher education level, even without formal training, has a higher positive impact on product quality than higher education level combined with formal training.
3) Business location does not affect the performance of formally trained artisans at any education level, but it affects the performance of those artisans trained-on-the-jobs at any education level.
4) Urban work experience contributes more significantly to product quality than education level alone and formal training alone.

Overall, there is a significant difference in product quality between artisans working in urban areas and artisans working in rural areas as evidenced from the last columns of Tables 3 and 4 of mean scores. This implies that business location alone has significant impact on product quality.

4.2 Recommendation for Further Research

The following research activities are recommended in order to further augment the present achievements:

a) This study investigated the impact of business location in the metalwork sub-sector. Research studies should be designed to investigate how other attributes affect product quality and/or the performance of the MSE sub-sectors.

b) Research should also be conducted to investigate how business locationaffectsthe quality of product quality in other disciplines especially those that are mostly dominated by women, for example tailoring, tie and dye, embroidery, and basketry.

c) It was observed that artisans working in urban areas with the same education levels, those without formal training performed better than those artisans with formal training. However, it was expected that the formally trained artisans should perform better than those trained-on-the-jobs as was the case with the artisans working in rural areas. It is, therefore, recommended that further research be conducted to investigate this phenomenon.

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