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Innovative welding technology's impact on the productivity of small and medium enterprises in Bulawayo, Zimbabwe

Albert Makore *

Faculty of Commerce, Department of Marketing Great Zimbabwe University, Box 1235 Masvingo, Zimbabwe

Abstract

This research paper focuses on the evaluation of innovative welding technology's impact on the productivity of Small and Medium Enterprises (SMEs). The paper examines business operational sector and size, technology currently in use, customer/supplier relationships, and technical knowledge levels, skills in use on the shop floor level, training, safety standards implementation and quality control aspects in the SMEs. The companies are evaluated on their use of Oxygen and Acetylene gas welding, Manual Metal Arc Welding (MMA), Metal Inert Gas Welding (MIG) and Tungsten Inert Gas Welding (TIG) for maintenance and productive purposes. Both exploratory and descriptive research designs are applied in this study. A structured survey instrument was administered to seventy five (75) SMEs selected based the researcher's judgement of companies' industrial classification. The findings are that technological innovativeness has both positive and negative effects on the commercial success of companies, however management in SMEs do not leverage on the use of innovative welding technology. The findings on the non-significance of the influence of technological innovativeness of welding processes can be as a result internal managerial controllable factors and outward uncontrollable environmental factors.

Keywords: Small and Medium Enterprises (SMEs), Standard Industrial Classification Code. (SIC), Oxygen and Acetylene gas welding, Manual Metal Arc Welding (MMA), Metal Inert Gas Welding. (MIG), Tungsten Inert Gas Welding. (TIG)

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* Corresponding author. *E-mail address:* makorea2009@gmail.com

1. Introduction

The development of the welding process is linked to the progression of manufacturing processes in marine engineering and the ancient methods of metal working. Welding practicability became a reality due to the changes in metallurgy, the development of electricity and the industrial gases (Mutch, 1998). The fusion welding of metals is the joining process of metals using gas or electric arc and these technics were developed towards the end of the nineteenth century and had very different trajectories of adoption and diffusion. Gas welding was developed from the discovery of techniques for making oxygen and then acetylene and combination of these two enabled the development of cutting and welding technology.

One of the factors that hampered the use and development of electric arc welding was the low penetration of electricity into many workplaces and many factories were slow to adapt the new production techniques. The use of these new production techniques to repair warships and the construction of an all welded steel structure for a factory served as precursors of the shift towards the use of welding as a manufacturing rather than a repair technology. Drastic changes were ushered with the end of the Second World War and this brought about major expansion of new industries replacing antiquated processes (Mutch, 1998). Technological innovation use is known for the fact that it produces better products at lower costs and technological innovativeness produces greater benefits downstream for both existing and new customers (Utterback, 1994). Welding is a manufacturing process used in a large number of industrial sectors and it is estimated that in Europe more than two million jobs are related with welding technology. Rosado et al. (2008, p.1) have pointed out that "Welding has an economic impact as it is used in the production sector which generates an added value of approximately 1600 billion euros, per year, in Europe. It is estimated that approximately 5% of this value, equating to 8 billion euros is related with joining technology".

2. Joining processes

Welding can be perceived as an obvious industrial process by the laymen, but in actual fact it is a complex process with many parameters determining the end product. Shipbuilding is one of the first industries to adopt the welding technology (Mutch 1998); "the welding costs play a crucial role in decision making. While many variables affect this cost, including equipment, consumables, and energy, the most significant one is labour, which can represent 80 per cent of the overall manufacturing cost" (Dinovitzer, 2010).

2.1. Shielded-Metal-Arc Welding (SMAW)

According to Miller Electric Manufacturing Company (2012, p.5)

> *"Shielded Metal Arc Welding (SMAW) or Stick welding is a process which melts and joins metals by heating them with an arc between a coated metal electrode and the work piece. The electrode outer coating, called flux, assists in creating the arc and provides the shielding gas and slag covering to protect the weld from contamination. AWS (American*

Welding Society) A5 specifications set standards for electrodes for SMAW of carbon, stainless, and low-alloy steels; aluminium, copper, and nickel and their alloys; and weld-surfacing. Designations for covered electrodes carry the prefix 'E'. Packaged to AWS specifications, electrodes come in boxes, cans, or other containers, labelled with their AWS specification and trade name, quality- control (heat or lot) number, supplier name, diameter and length, and weight of contents. Specifications require that every electrode be marked for identification near the grip end with its numeric designation".

To select a welding electrode for the SMAW process factors such mechanical properties of the base metal ,metallurgical composition of the base metal, welding position, welding current in relation to the electrode size, joint design and material thickness should be considered in sequential order of importance.

2.2. Gas-Metal-Arc Welding (GMAW) MIG

Miller Electric Manufacturing Company (2012) also defines Gas Metal Arc Welding (GMAW) MIG is a welding process which joins metals by heating the metals to their melting point with an electric arc. The welding process is performed when a solid continuous consumable electrode is fed through a wire feeder either using the push system or the push- pull system and an arc is created between the continuous consumable electrode and the metal being welded. A shielding gas is used to protect weld pool from contamination and the shielding gas used also contribute to the welding process in terms of penetration, bead geometry and weld appearance.

GMAW can be done in three different ways, such as the semiautomatic process where the welding process is controlled by hand ,machine welding where a manipulator is used to carry out the welding process with continuous monitoring from the operator and the automatic welding process which is normally computer controlled.

Flux cored welding wires consist of a steel tube surrounding a core of fluxing ingredients which will provide alloying elements at times or shielding in addition to other shielding gases such as CO_2 or Argon –CO_2 mixtures. Depending on the application the flux cored wires can be self-shielding or a shielding gas has to be used .Some flux -cored wires, form a slag that completely covers the weld-bead face and some metal cored wires produce very little slag.

The primary function of the shielding gases such Argon is to shielded the weld from the surrounding atmosphere; however Helium and Argon mixture maybe used to provide deep penetration and faster deposition rates (Norrish, 2006). One of the weld defects which exhibits weld porosity and low tensile strength can be caused by not protecting the molten weld pool from the atmosphere during the welding process.

2.3. Gas-Tungsten-Arc Welding (GTAW, TIG)

Miller Electric Manufacturing Company (2012, p.5) defines "Gas Tungsten Arc Welding (GTAW) also known as Tungsten Inert Gas (TIG) welding as a process that produces an electric arc between a non-consumable tungsten electrode and the part to be welded. The heat affected zone, the molten metal and the tungsten electrode are shielded from atmospheric contamination by a blanket of non-reactive inert gas such as Argon or Helium". GTAW process joins with or without filler metal and the filler rods can be carbon steel rods, stainless steel rods, aluminium filler rods and additional requirements can be stated in the welding procedure specifications. The tungsten electrodes used in the TIG welding process are supplied with various specifications and some have thorium which provides higher current carrying capacity than pure tungsten and resulting in less contamination of the weld pool, better arc starting and stability.

2.4. Oxygen and Acetylene welding

Gas welding and brazing processes are carried out through the use oxygen and fuel gases such as acetylene or Liquefied Petroleum Gas (LPG). In order to ensure safety and proper handling of compressed oxygen, high pressure cylinders are used to store and transport the gas. Acetylene is also stored and transported in cylinders containing a porous mass, then filled with acetone which absorbs the acetylene for stability. Various types of gas equipment such as high pressure regulators fitted with gauges to show the contents and working line pressure, flashback arrestors, high pressure hoses, check valves are used to enable the welding and brazing processes to be carried out safely (Afrox, 2013).

3. Literature review

In this research paper, the term diffusion is taken as adoption of a product, service or process perceived to be new or innovative and the analogy of a biological organism's life can be applied (Vernon, 1966 in Gueso et al., 2007). Tidd et al. (2001, p. 38) in Smith et al. (2008) defines "Innovation as a process of turning opportunity into new ideas and of putting these into widely used practice". Damanpour (2010) notes that innovation can be defined as an organisational management process which can result in an improved status or dynamic change. Competitiveness can be achieved by cost reduction and pricing competitively and these have strong links with technological innovations.

Kafouros et al. (2008) asserts that one factor which is considered to be important in terms of a company's future performance is innovative technology. Long-term viability and the application of certain core competencies due to investment in innovative technology will result in strategic advantage (Tellis et al., 2009; Roder et al., 2000). Technological innovativeness, which is the degree of newness of technologies embodied in a new product is assumed to be a driver of new product success because new technologies promise higher technical performance, and offer additional functionality and increased benefits to customers (Garcia and Calantone, 2002; Hill and Rothaermel, 2003; Zhou et al., 2005).

Technology affects the way companies do business on the international market on various levels (Sitkin and Bowen, 2010).As noted innovation involves many factors and the company's manufacturing engineering teams must constantly coordinate and facilitate the integration of imported technology in order to develop, adopt, implement and take advantage of new technologies (Singh et al., 2005).

Small to Medium sized enterprises are defined as enterprises which employ fewer than 250 employees, which have an annual turnover not exceeding 50 million euros (European Commision 2003).

3.1. Drivers of innovative technology adoption

Economic growth in Least Developed Countries (LDCs) is currently being driven by SMEs whose funding is largely linked to national governments policy directives. Innovative technology can be viewed as an asset or commodity that can be sold or purchased and a company can achieve growth. Romijn (2001) notes that there high risk in innovative technology due possible leakages to competitors, secondly uncertainty and thirdly there should be economies of scale as new knowledge becomes useful only in large numbers.

It is also critical to acknowledge that family firms have been noted as disadvantaged when it comes to R and D investment due to either their focus on value preservation or lack of resources (Carney and Gedajlovic, 2003). Innovation and entrepreurship have a major contribution towards a company's long term profitability and stability (Hadjimanolis, 2000; Verhees and Menleuberg, 2004). In order to stay ahead of competition, companies need to focus on continuous improvement and pursue the differentiation strategy (Jaselskis et al., 2011). Innovative capacity allows organizations to differentiate themselves from the competition and to create a competitive advantage.

Management thinking and support are essential to the adoption of technological innovation and there is evidence to that effect in the information technology systems adoption (Daniel and Meyers, 2011).

3.2. Market orientation

Jaworski and Kohli (1993) and Narver and Slater (1990) note that several research studies acknowledge the link between market oriented behaviour and company performance. The thrust or emphasis an organisation focuses on in bringing about change can be seen as innovativeness in the market (Carter and Gray, 2007). Management preferences or bias also affects innovation adoption (Sandstrom et al., 2009).

SMEs commonly face a number of environmental factors which can be either controllable or uncontrollable such as legal issues, interest rates fluctuations, supply chain stability, competition, skills and funding. Industry standards and requirements have an impact on adoption of technological innovations and at times this can be imposed on SMEs (Iacovou et al., 1995 as cited in Chong, 2001). Gatignon and Robertson (1985) assert that competitive rivalry does encourage innovative behaviour. The implication of not pursuing technological innovation can result in the firm being perceived non-competitive and poorly positioned (Lee, 1999). The decision to move towards innovative technology can be a result of industry pressure to conform (Robertson and Gatingnon, 1986). Previous research studies have shown that innovative technology adoption process can result from epidemic pressures (Bertschek et al., 2006; Canepa and Stoneman, 2004).

The epidemic model (Ramsey et al., 2008) derives its basis on information and technology spillover acknowledgment by non-users from users. The tendency to adopt innovative technology can be attributed to a number of factors such as the number or levels of adoption and industry specific issues. Some firms or certain enterprises have a low take-up of innovative technology while other firms can easily adopt new technology such as the banking industry. As observed, innovative technology will lead to a multiplicity of results which will be industry specific (Upachalanan, 2000).

3.3. Institutional support

For technological advancement to grow, active government support is critical for the firm which acquires the innovative technology. Importing machinery only without the requisite technical skills and managerial skills and linkages with other firms and institutions, might result in performance deficiency in the company's overall goals. Company specific issues such new skills and technical knowledge often gets in the way of maximum development of imported technology.

One of the key aspects noted is that industry specific issues pertaining to learning needs may require lesser effort such as in apparel manufacturing compared to advanced electronics and mechanical engineering (Lall and Pietrobelllo, 2003). Constraints and restrictions of learning within organisations can be attributed to resistance to change, risk aversion, knowledge deficiency and inability to undertake learning process (Lall and Pietrobelllo, 2003). Romijn (2001) addresses the needed for technological support to industry citing arguments that investment in technological renovation is subject to market widespread failure. Emphasis is also placed on the fact that without curative action, private companies are not obliged to fully invest in technological effort in relation to societal development (Stoneman, 1995 and Dasgupta, 1987; in Romijn, 2001). Proprietary rights risk, uncertainty risk can be viewed as a threat to the incentive to take first mover advantage as new knowledge often becomes substantially useful only in large scale.

WAI SUM SIU (2005) acknowledges the fact that some governments, such as the Hong Kong government has a non- interventionist policy that results in balance of self-regulation and the parent government plays a critical role of infrastructure development and enforcement of legislation. Collaboration has major advantages, as this enables a firm to obtain the necessary skills and resources from a strategic partner. Firms can also spread risk through the reduction of asset commitment and this can translate to organisational flexibility. Schilling (2010, p.210) also noted that "markets characterised with rapid technological change, need innovation as the primary driver of competition".

Technological challenges of small producers are attributed to lack of appropriate means of production in the form of machinery and equipment (Sethuraman, 1977; Harper, 1984). The benefits of technology intensive manufacturing are that process innovations stimulate demand for technology based products thereby quickening the pace of production, employment and exports and entry barriers to competitors are high compared to low-technology activities (Lall and Pietrobello, 2003).

Hamel and Prahalad (1994) define core competencies as harmonised combination of multiple resources and skills that distinguish a firm from its competitors. The term capabilities is used to distinguish elemental skills such as logistics management as noted, they the two terms, core competencies and capabilities can be used interchangeably. In a research study conducted, it was noted that Zimbabwean firms perform slightly better than Kenyan and Tanzanian firms in the clothing and engineering sectors in terms of technological capabilities but ratings are less than international standards and in another World Bank study conducted measuring technical efficiency not capabilities the following values were recorded with similarities with the above research: Zimbabwe (0.52), Kenya (0.41) and Ghana (0.33) (Biggs et al., 1995).

4. Statement of the problem

The study will analyse the adoption state of innovative welding technology in selected SMEs and evaluate capabilities which enable firms to innovate. The research seeks to capture business operational sector and size, technology currently in use, institutional (customer/supplier) relationships, technical knowledge, and skills in use, training, safety standards implementation and quality control awareness. The companies are evaluated on their use of Oxygen and Acetylene gas welding, Manual Metal Arc Welding (MMA), Metal Inert Gas Welding (MIG) and Tungsten Inert Gas Welding (TIG) for maintenance and productive purposes.

4.1. Research objectives

The objectives of this paper are to explore the impact of welding technology innovation on the productivity of Small and Medium Enterprises (SMEs). Both exploratory and descriptive research designs are applied to this study to gain understanding of developments in downstream supporting industry for transformation and value addition to the Agriculture and mining sectors.

Three research questions are proposed to satisfy the objectives outlined above.

RQ1. What is the current state of technology adoption in SMEs in Bulawayo?

RQ2.Which are the internal factors or external factors that influence choice of technology?

RQ3. Do SMEs use institutional support?

There is evidence which supports that investment in innovation can lead to competitive advantage (Roberts, 1999). In this paper we hypothesize that adoption of innovative technology does not lead to competitive advantage.

Hypothesis 1: Adoption of innovative technology does not lead to competitive advantage in SMEs.

Hypothesis 2: Firm innovation strategies are not internally driven.

Hypothesis 3: Institutional support is not critical for growth in SMEs pursuit for innovative technology.

Figure 1 summarizes our hypotheses and the relationships between internal capabilities and performance.

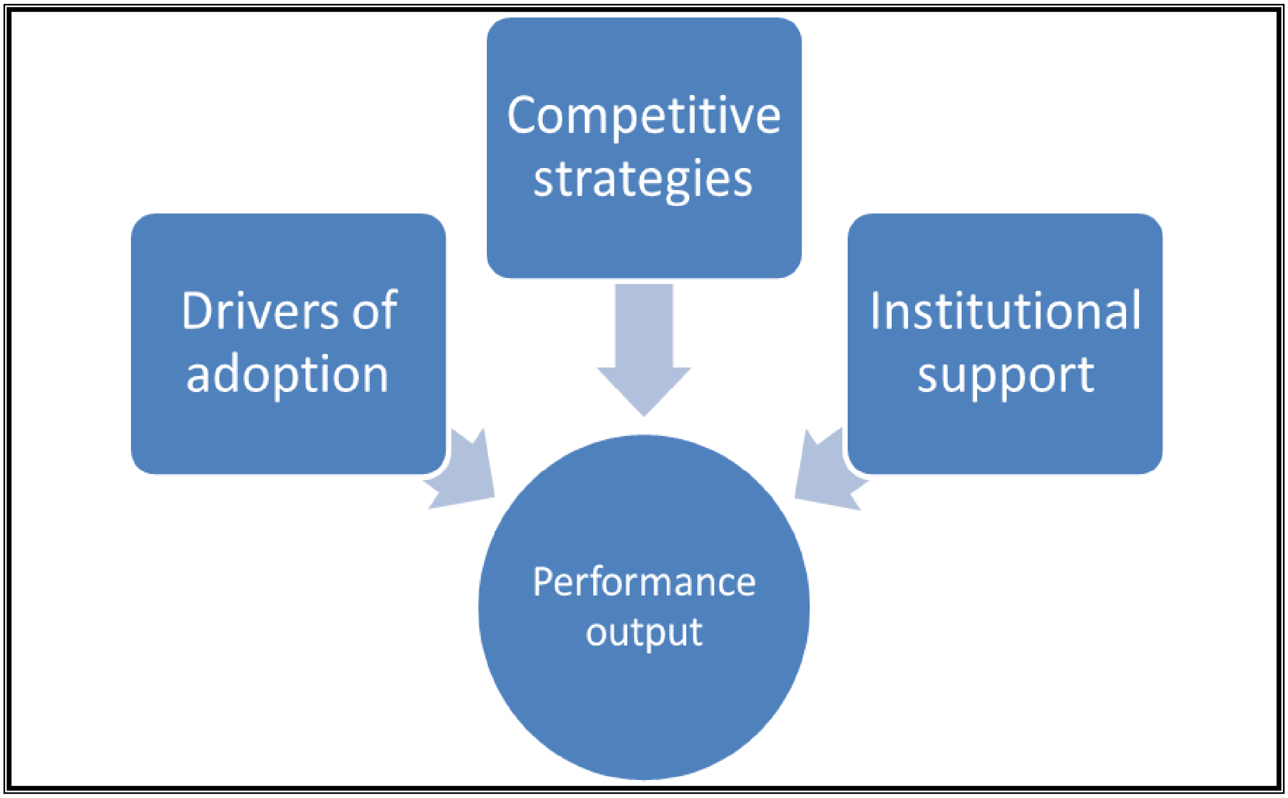

Figure 1. Capabilities framework

5. Research methodology

The research is confined to small enterprises with 10 to 79 employees and medium enterprises with fewer the 250 employees as defined by the European Commission of 1996. In essence it also important to note that SMEs contribution to the development of the economy is quite prevalent in developed nations (Ramsey et al., 2008). A quantitative methodology is used for this exploratory research design which seeks to gain understanding of developments in downstream supporting industry for transformation and value addition to the Agriculture and mining sectors.

The sample included both manufacturing and service industries and these were selected using the SIC four digit codes. The study concentrated on the mechanical engineering, automotive, electrical, clothing industry and civil construction industry. For practical purposes a judgement sample 75 SMEs firms was chosen and data interpretations should take note of those shortcomings. To critically evaluate the appropriate constructs, they were labelled as follows in the measuring instrument: nature of business, staff development, technology awareness and the firm size is also included as a driver (Gray et al., 1999).

The questionnaire also included other demographic/firm characteristic items which were measured using structured responses. To collect data, questionnaires were taken to the selected companies and they were completed in the presence of the researcher. An opportunity to observe welding plant equipment in use and the various types of brand names of welding equipment was carried out during the plant tour. The final total usable responses were 43 per cent (32 questionnaires). Due to the strategic nature of the questions, senior managers were mainly targeted such as Managing Directors, Manufacturing manager /director, Engineering Managers and the owners of emerging small companies or entrepreneurs.

6. Results

6.1. Current state of innovative welding technology adoption (RQ.1)

The data collected was coded and analysed using SPSS (version 16).In relation to innovative welding technology adoption 46% of the companies who responded are analysed in Table 1.

Table 1. Distribution of sample according to industrial classification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Mining equipment fabrication	8	25.0	25.0	25.0
	Agricultural equipment manufacturing	1	3.1	3.1	28.1
	General fabrication	11	34.4	34.4	62.5
	Electrical	1	3.1	3.1	65.6
	Transport	4	12.5	12.5	78.1
	Pharmaceutical	1	3.1	3.1	81.2
	Civil construction	4	12.5	12.5	93.8
	Food processing	2	6.2	6.2	100.0
	Total	32	100.0	100.0	

25% of the respondents are in mining equipment fabrication, 34% in general fabrication 12.5% in transport and also 12.5% in construction industry and 6.2% in food processing.

Table 2 shows that 34.4% of SMEs use oxygen and acetylene gas welding and Manual Metal Arc Welding for fabrication and maintenance of equipment. The most widely used processes are the oxygen and acetylene gas welding, Manual Metal Arc Welding and Gas Metal Arc Welding (MIG) with 47% of the respondents in this category. Also noted is the fact that,18.8% of the SMEs use all the processes stated in the research instrument. 32% of the respondents have 20-39 employees and 28% have 10-19 employees.

Table 2. Distribution of sample according to innovative welding processes being used

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	oxy/acetylene gas, MMAW	11	34.4	34.4	34.4
	oxygen/acetylene gas welding, MAW,GMAW(MIG)	15	46.9	46.9	81.2
	oxy/acetylene, MMAW, GMAW(MIG),GTAW(TIG)	6	18.8	18.8	100.0
	Total	32	100.0	100.0	

6.2. Internal factors or external factors that influence choice of technology (RQ2)

Table 3. Technical support for welding technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very ease	3	9.4	9.4	9.4
	Less ease	9	28.1	28.1	37.5
	Neither ease or difficult	1	3.1	3.1	40.6
	Neither ease or difficult	4	12.5	12.5	53.1
	Difficult	7	21.9	21.9	75.0
	More difficult	7	21.9	21.9	96.9
	Very difficult	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

To assess the provision of support for the various innovative welding processes being used by the various companies the respondents indicated the level of easiness or difficulty on a modified scale. 37% of the respondents indicated that they can easily get support from the companies who sell the innovative welding equipment.

Table 4. Evaluation of technical skills in-house

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes available in house	31	96.9	96.9	96.9
	No	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

The welding costs inherently constitute approximately 80% of the welding costs and 97% of the companies utilise in-house technical skills. 28% of the responding companies are involved in the development of critical skills which act as an enabler in the use of innovative welding technology and they do this through apprentice training programmes.

Table 5. Total quality management issues

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Safety awareness exists in the organization	11	34.4	34.4	34.4
	No safety awareness	12	37.5	37.5	71.9
	ISO certified	3	9.4	9.4	81.2
	Not ISO certified	1	3.1	3.1	84.4
	Other	5	15.6	15.6	100.0
	Total	32	100.0	100.0	

Total quality management is also a key driver for interchangeability of parts and variability of component parts results in non-conformance to manufacturing standards leading to higher costs. In Table 5, 35% of the respondents have safety programmes running within their organisations and only 9% ISO certified. 15.6% of SMEs who fall under the "other" category revealed that they institute the mandatory safety standards through the provision of protective clothing and the do not run any recognised quality programmes within their works.

6.3. SMEs use of institutional support (RQ3)

Table 6. Evaluation on the engagement of partners for assistance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	high collaboration with technical partners	7	21.9	21.9	21.9
	organization does not use technical partners	25	78.1	78.1	100.0
	Total	32	100.0	100.0	

Results for engagement of partners in Table 6 show that 22% of the users of innovative welding technology collaborate with technical partners for assistance to enhance their operational productivity and 78% do not use technical partners.

7. Hypotheses testing

The hypotheses which our study sought to test are as follows:

Hypothesis 1: Adoption of innovative technology does not lead to competitive advantage in SMEs

Hypothesis 2: Firm innovation strategies are not internally driven

Hypothesis 3: Institutional support is not critical for growth in SMEs pursuit for innovative technology

We use a significance level (α) of 0.05 for all our analyses. Any p –value that is less than this significance level indicates that the variables are probably correlated in the population from which our sample is drawn. Fisher (2010, p.404) indicates that "The value of the Pearson Chi-square is an aggregate measure based on the differences between the count and expected count for cells and the larger the difference between them, the bigger will be the value of chi-square and more evidence there is for association between variables".

Hypothesis 1: Adoption of innovative technology does not lead to competitive advantage in SMEs

Table 7. Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14.489[a]	14	.414
Likelihood Ratio	18.248	14	.196
Linear-by-Linear Association	6.196	1	.013
N of Valid Cases	32		

a. 23 cells (95.8%) have expected count less than 5. The minimum expected count is .19

Table 8. Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Interval by Interval	Pearson's R	-.447	.126	-2.738	.010[c]
Ordinal by Ordinal	Spearman Correlation	-.457	.132	-2.817	.008[c]
N of Valid Cases		32			

a. Not assuming the null hypothesis, b. Using the asymptotic standard error assuming the null hypothesis, c. Based on normal approximation

The correlation between industrial classification and innovative welding processes is negative –o.447 and this correlation are in the low to moderate range and the results indicate that the two variables are independent. An assumption cannot be made here, pertaining to the fact that the type of industry has a relationship with the type if innovative welding technology they will adopt, hence as noted, competitive pressure that firms face within their particular industry has influence on the company's decision to adopt innovative technology (Robertson and Gatignon, 1986; Iacovou et al., 1995).

Hypothesis 2: Firm innovation strategies are not internally driven

7.1. Innovative welding processes and technical skills

Table 9. Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Interval by Interval	Pearson's R	.039	.038	.216	.830[c]
Ordinal by Ordinal	Spearman Correlation	.053	.050	.289	.774[c]
N of Valid Cases		32			

a. Not assuming the null hypothesis, b. Using the asymptotic standard error assuming the null hypothesis, c. Based on normal approximation

The results indicate that the adoption of innovative technology is more externally driven than internally driven which also concurs with previous research studies that have shown that innovative technology adoption process can result from epidemic pressures (Bertschek et al., 2006; Canepa and Stoneman, 2004).

Hypothesis 3: Institutional support is not critical for growth in SMEs pursuit for innovative technology

7.2. Industrial classification and partners for assistance

The correlation between Industrial classification and partners for assistance is 0.359 with approximate significance of 0.044. The correlation shows that 36% of SMEs in various industries use outside partners for assistance and support. For an economy with GDP growth rates of 4.4% in 2012, and 5% in 2013 estimates (National Budget Statement, 2013), the government support is relatively important and there is need to grow the sector by offering more support. This is supported by Romijn (2001) who addresses the needed for technological support to industry citing arguments that investment in technological upgrading is necessary due to market widespread failure. Emphasis is also placed on the fact that without curative action, private companies are not obliged to fully invest in technological effort in relation to societal development (Stoneman, 1995 and Dasgupta, 1987; in Romijn, 2001).

Table 10. Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Interval by Interval	Pearson's R	.359	.124	2.107	.044[c]
Ordinal by Ordinal	Spearman Correlation	.371	.145	2.191	.036[c]
N of Valid Cases		32			

a. Not assuming the null hypothesis, b. Using the asymptotic standard error assuming the null hypothesis

8. Discussion

The findings on the non-significance of the influence of technological innovativeness can be as a result internal organisational factors and external environmental factors such as legislation (Tatikonda and Rosenthal, 2000). Technological innovativeness can positively and also negatively affect the profitability of an organisation, but one other key factor which has been noted is its ability to increase customer value (Kock et al., 2011).

The research has shown that management in SMEs do not leverage on the use of innovative welding technology unless it's already widely used in various industries. The diffusion rate is basically governed by industry dynamics controlled by industry standards such as ISO9000 standards and ISO 14000 standards. With a mean (5.84) standard deviation (0.723), most industries use oxygen and acetylene gas welding, Manual Metal Arc Welding and Gas Metal Arc Welding (MIG) processes for manufacturing and maintenance purposes. For technical support, the mean (4.823) and standard deviation (2.02778) most companies neither, find it easy to or difficult to get technical support for the welding processes they are currently using.

Due to complex requirements associated with the use of innovative welding technology, companies develop and use in-house skills as indicated by mean (3.09) and standard deviation of (1.376). Innovative technology contributes towards customer benefits through quality management systems which also look at manufacturing processes, however innovative welding technology does dos not impact performance.

9. Limitations, future directions and conclusions

This research study has several implications for future research. The future research has to focus on both cross-sectional studies and longitudinal studies to gather relevant data on the impact of innovative welding technology. The issue about non-significant impact of innovative welding technology on performance as noted by previous studies (Tatikonda and Rosenthal, 2000) needs further investigations. The effects of change brought about by innovative technology seem to have benefits if they are broadly diffused as technical aspects are generally guided by standards.

The limitations of this research are mainly the methods used to collect data, perharps in future a longitudinal study will be ideal and there is also need to focus on the final product produced by the innovative welding technology.

9.1. Management implications

The strategic nature of the decision to invest in innovative welding technology rests on management. Highly innovative welding technologies can have a long term impact on the firm growth strategies.

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