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Complexity in Modern Automobile Technology: A Challenge to Mechanics Operating in Micro and Small Enterprises in Kenya

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Abstract: *Micro and Small Enterprises in Kenya have restricted levels of technology, inappropriate technology and inadequate institutional capacity to support adaptation and absorption of modern technological skills. Technological inventions, innovations and developments in electronics, hydraulics and pneumatics have revolutionalized the automobile industry. In light of the these developments, the informal sector mechanics must be equipped with appropriate technical skills in order to have a competitive edge as far as servicing or repairing modern vehicles is concerned. This study aimed to determine factors that influence technology adoption among automobile mechanics in micro and small enterprises in Nakuru town; Kenya. The objectives of the study were to establish the role of: complexity relative advantage, compatibility and Observability in the adoption of technology. The research used a descriptive cross sectional survey design and employed both probability and non-probability sampling techniques to collect quantitative and qualitative data. After a detailed binary logistic regression analysis using SPSS, the study found that, adoption of various modern motor vehicle technologies is influenced by perceived attitude of the mechanics in terms of: complexity, relative advantage, compatibility and observability of a particular innovation. The study recommended that the government should emphasize and invest in intellectual capital by way of developing relevant training curriculum for the mechanics based on industry and environmental needs. This study is significant as its findings, if implemented; can jump-start the informal mechanics towards achieving quality, competitiveness and both human and environmental safety.*

Key words: *Complexity, Micro and Small Enterprises, Technology adoption*

I. Introduction

1.1 Background Information

The development of the informal sector has long been regarded as crucial for economic development in both developed and developing nations as it plays an important role in job creation, poverty alleviation and in the utilization of local resources. A study conducted by Bureau and Fendt (2013), indicated that; micro and small enterprises (MSEs) represent 99% of an estimated 19.3 million enterprises in the European Union (EU), and; provide around 65 million jobs, representing two-thirds of all employment. In Latin-America, the vast majority (approximately 80-90%) of companies are micro enterprises. While in Brazil the economy expanded by only 2% in 2011, MSEs grew by 8.5%. In Colombia, MSEs accounted for 39% of all jobs and 67% of industrial jobs. Moreover, MSE membership in Colombia's chambers of commerce rose from an average of 22% in 2009 to 93% in 2012. In Japan, 81% of all employment is in MSEs where the average enterprise employs nine staff as opposed to four in the EU. In the Organization for Economic Cooperation and Development (OECD) countries, MSEs represent over 96% of enterprises in most countries and generate over half of private sector employment (Bureau & Fendt, 2013).

According to Kenya National Alliance of Street Vendors and Informal Traders (KENASVIT, 2011) the Micro and Small Enterprises (MSE) sector is the source of income for over 8 million people, who represent the majority of working Kenyans. In Kenya, sector is dominated by Micro Small and Medium-sized enterprises (MMSEs) involved in various activities such as woodwork, metal work, leatherwork, textile, handicraft, service industry, retail trade and motor vehicle repair among others. These enterprises in Kenya represent a vital part of the economy, being the source of various economic contributions through; the generation of income via exporting, providing new job opportunities, introducing innovations, stimulating competition, and engine for employment. In spite of their importance, this sector faces many challenges, such as lack of access to credit, poor infrastructure, use of inappropriate technology and lack of intellectual capital among others. Intellectual capital appears as the most important and vital component of a knowledge-based economy (Karanja, Gakure, Were, Ngugi & Kibiru 2012).

However, in the present economy, small and medium enterprises are facing tremendous challenges and threats to survive in a competitive environment. As a matter of fact, SMEs are faced with the threat of failure

with past statistics indicating that three out five fail within the first few months (Bowen, Morara & Mureithi, 2013).The impact of intellectual capital on the general performance of the Small and medium enterprises has become a very important issue now than ever, this is due to the level of globalization of whose outcomes are privatization and deregulation of markets, aggressive competition and the ever-rising expectations of customers. These dynamic changes are very much pronounced in the automobile industry where liberalization and globalization has resulted into an influx of various makes and models of motor vehicles all competing for the same market. In addition, these modern vehicles incorporate complex electronic components that require only skilled and knowledgeable mechanics to diagnose service and or repair (KEMRA, 2014). As a result of this, there is need for businesses to be at their best in order to be relevant in the environment. There is no known comprehensive study which has been conducted in Kenya to establish factors that determine automobile technology adoption among mechanics operating in the micro and small enterprises.

1.2 The Automobile Repair Sub-sector

In Kenya, repairs to motor vehicles are undertaken in either of two places: dealer (formal) garages and *Jua Kali* (informal) garages. Mechanics in the informal sector perform the bulk of the repairs yet most of them do not have the right equipment and many have had no formal education in repairs of motor vehicles. With changes in motor vehicle technology, the mechanics have not kept up with the changes and this has had a negative impact on the quality of the repairs they undertake on motor vehicles. This calls for development of new policies and incentives for the informal sector that can take care of and respond to technological changes. Majority of the Jua Kali garages are found in urban centers (Wanyeki, 2014). This is because in urban centers is where most motorists are found and also where supporting businesses (spare part shops, petrol stations, etc.) are found. Those garages located in the outskirts of town are to be found in the densely populated estates and this is because the high rate of unemployment in such estates forces many people to start Jua Kali businesses including garages. A majority of the Jua Kali garages are located in temporary workshops. This could be attributed to the ownership of the plots within town in that most Jua Kali garages rent the places they are using and therefore cannot make permanent improvements on the plots (Wanyeki, 2014).

According to Kenya Motor vehicle repair association (KEMRA) (2014), most garage owners/managers have had some form of formal education. This is because the nature of activities in garages requires some technical understanding and so it is imperative that the owners/managers have some basic education. In contrast, the majority do not have professional qualifications. This seems to be because those with formal training normally secure jobs in the formal sector and it is only after retirement from the formal sector that some venture into the Jua Kali sector. Also there is perception by some of the owners/managers (and even some members of the public) that the curricula in technical training institutions are outdated, and hence not relevant to the job market. Most garages handle less than five cars a day. This is due to their capacity in manpower and space. Plot owners don't restrict the numbers or kinds of tenants in their plots so long as one can find space and is ready to pay rent. This makes most garages to be congested and restricts the number of cars at any given time and also the number of mechanics. Majority of the Jua Kali garages perform both minor services and major services. This is because the services involve routine maintenance and schedule services which in most cases are done upon the requests of customers. There is nothing much that requires specialized personnel and equipment and anybody with basic automotive knowledge can do. It involves visual checks, adjustments and component replacement (i.e. changing oil, fuel and oil filter, spark plugs, brake pads and shoes). Mechanics in the informal sector perform the bulk of the repairs yet most of them do not have the right equipment and many have had no formal education in repairs of motor vehicles. In the automotive industry, the repair of motor vehicles is one activity that the Jua Kali sector has come up as an alternative to the formal (dealer) sector.

Technological inventions, innovations and developments in electronics, hydraulics and pneumatics have revolutionalized the automobile industry. In light of the these developments, the informal sector mechanics must be equipped with appropriate technical skills in order to have a competitive edge as far as servicing or repairing modern vehicles is concerned (WB, 2013). Low costs of training (apprenticeship) in this sector attract potential mechanics. However the quality of services offered in this sector is much lower than those offered in more formal settings (Kipkurui, Kithyo, Okemwa & Korir, 2004). This may be attributed to lack of proper tools and equipment and also lack of capacity to adopt modern technology. In spite of these developments, there is no known study that has been undertaken to provide some insight as to the slow pace of technology adoption among the informal mechanics. Yet, the mechanics have not kept up with the changes and this has had a negative impact on the quality of the repairs they undertake on motor vehicles.

1.3 The Problem

A summary report of the US National Highway Traffic Safety Administration (2013) task force that studied consumer losses in auto repair and maintenance found that consumers lose about $20 billion annually due to improper or unnecessary repair and maintenance practices. The losses consist of wasted repair

expenditures, wasted fuel, avoidable accidents and pollution, and reduced car life occasioned by improper diagnosis and repair of modern automobiles. Another study conducted by Morgan (2013) during the month of November 2013 on world traffic deaths by region revealed the following number of deaths due to motor vehicle accidents: South-East Asia 335,000, Western Pacific 334,000, Africa 194,000, Middle East 123,000 South America 94,000, Europe 92,000 and North America 52,000. Most of these accidents were caused by driver error or mechanical failure. Mechanical failure are, in turn, caused by lack of repair knowledge, failure in understanding or using vehicle manufacturer's manuals and a slow rate of modern vehicle technology adoption. According to Kenya Motor Repairs Association (2014), most mechanics in Kenya have not acquainted themselves to modern vehicle technology and thus costing motorists unnecessary expenses and at times total failure of major vehicle systems or components. Adoption of modern automobile technology will ensure accurate and reliable diagnoses, repair and or service of vehicles, thus lowering maintenance costs as in fuel consumption and less frequent repairs, maximum safety and a cleaner environment. It is critical for the informal mechanics to adopt modern auto technology in order to alleviate the possible challenges. The motor vehicle repair and service industry is thriving and it is not uncommon to find a six-acre yard (e.g., Kigandaini in Thika town) with several small open-air garages in towns across Kenya (Kinyanjui, 2010). With increasing technical sophistication, the human resource in this requires continuous development of technical and interpersonal skills necessary for them to remain relevant in their practice or otherwise "perish" Barber (2013).

1.4 Purpose of the Study

The general purpose of this study was to assess the determinants of technology adoption among automobile mechanics in micro and small enterprises in Kenya. Specifically, this study sought to establish the role of complexity on the adoption of technology within the informal automobile mechanics in Kenya. This study is important in a number of ways: first, the study ventures into a field critical to the development of human resources. In particular, this study focused on the development of informal automobile mechanics operating MSEs, whose role has been underestimated both at the local and national level, resulting in little effort being directed at developing and exploiting the inherent potential. Further, the globalized economy is seriously campaigning for greener energy solutions. Therefore, minimization of harmful carbon emissions exhausted from the increasing number of automobiles is crucial. This can be achieved only if the mechanics adopt technologies that can enable them to; effectively and efficiently service and repair vehicles as per the manufacturers' standards. This will also lead to fuel efficiency in a country like Kenya where fuel prices are considerably very high. Also identifying the technological challenges facing informal mechanics may be meaningful in terms of the types of intervention (finance, training, management, and technology) donors from the developed countries may provide. Secondly, much data regarding MSEs is still needed and thus this study generated information on the status of mechanics operating in Nakuru town and Kenya as a whole. The goal here is a move towards liberating mechanics from their socio-cultural, psychological and economic handicaps through developing approaches that enhance adoption of modern technology. Finally, the study is justified on the grounds that the information availed will assist the Kenya government and other stakeholders in policy formulation and in the development of appropriate approaches for future interventions, so as to effectively cater for entrepreneurs in MSE sector. It is hoped that this study adds to the available body of knowledge and increase the understanding of how to best empower mechanics in the informal sector, so that they in turn can contribute more meaningfully to economic development.

1.5 Research Hypotheses

In accordance with the previously stated objectives and consistent with related literature, this study tested the following hypotheses:

i) H_0: Relative advantage does not influence the adoption of modern automobile technology among the informal mechanics.
ii) H_0: Compatibility has no influence on adoption of technology among the informal automobile mechanics.
iii) H_0: Complexity or 'ease to use' does not affect adoption of technology among the informal automobile mechanics.
iv) H_0: Observability does not play any role in the adoption of technology among the informal automobile mechanics.

II. Empirical Literature

2.1 Influence of Complexity in Technology Adoption

Complexity (ease of use or learning) of a technology has a great influence on adoption. Perceived complexity of the technology can lead to increased uncertainty and perceived risk, and these in turn could lead to a resistance to adopt (Fidler & Johnson, 1984). According to Hall & Khan (2002), to explore the complexity of an innovation, it is necessary to understand the contexts in which it occurs. A study conducted by Thomas

(2000). "Contextual factors that sustain innovative pedagogical practice using technology" revealed that ease to use or perceived complexity play a major role in technology adoption. The study applied a logistic regression model with a general objective of determining contextual factors that lead to sustainability of innovations. The study concluded that serviceability of an innovation is positively related to its sustainability. This is corroborated by Ngure (2013) who argues that due to the increasingly labyrinthine nature of the technology that is now incorporated into automobiles, most automobile dealerships and independent workshops nowadays provide sophisticated diagnostic computers to technicians, without which they would be unable to diagnose or repair modern vehicles. Another study by Tan & Leo (2012) applied a multiple linear regression model to establish factors influencing the adoption of internet banking in Malasia. The study unveiled that among other factors, relative advantage, compatibility and complexity influenced adoption. Identifying and closing skills deficiencies is vital to long-term economic prospects in order to sustain sectors like the informal motor vehicle mechanics that are at risk of disappearing, not being developed or leaving their main tasks to be taken up by formal dealership garages. Experience has shown that lack of skills is the principal factor related to poor quality and productivity and that attitude is often the constraint to turning ideas into products and a successful business (Morgan, 2013). Complexity attribute is related to benefit costs in the innovation for the adopters. Individuals or organizations would likely adopt the innovation if it is easy to understand (Rogers, 2003).

2.2 Perceived complexity in the automobile industry

Nowadays, automobile makers incorporate electronic systems to control vehicle functions. This development has dramatically increased the complexity of the systems found in automobiles (Edmunds, 2011). These complex systems have vastly improved vehicle performance, safety and fuel efficiency, but also increased the likelihood of breakdowns. The more interdependent parts a system has, the higher the probability that the system will fail. However, in modern automobiles the on-board computer has made troubleshooting much easier when something does go wrong. During the 1980s, a universal system was established by the Society of Automotive Engineers (SAE) known as the On-Board Diagnostic system (OBD-II). This system became mandatory in 1996. When something goes wrong in a vehicle fitted with an OBD-II system, a "Check Engine" light flashes on the dashboard. A mechanic can plug into the vehicle computer and retrieve a code. This code is then cross-referenced with a handbook of codes and their meanings, leading the mechanic to an accurate diagnosis of the vehicle's problem. Using OBD-II, diagnostic tools, repairs are reliable since trial-and-error is eliminated. On the other hand, when something does go wrong, the cost of repairing modern vehicles can be more expensive than it was to fix an older models a few decades ago. The more complex modern engines require competent computer literate mechanics to repair. Because of the increased difficulty in managing the number of parts that would require replacement in the event of a crash, the cost of modern cars is more expensive. Other innovations pose unique complications to informal mechanics. For instance most automatic transmission problems can't be fixed by an average mechanic. There are just too many specialized tools and pieces of equipment one will need before attempting any repair. Airbag Systems in modern vehicles are highly complex systems with a number of components that require exact replacement and testing procedures, which require expensive equipment to test, examine, analyze, and repair. In most cases, the repair involves replacement of components. Most of the crash sensors are 'one-time-use' components, and are replaced, as they are not repairable (Lemurzone, 2012).

III. Methodology

3.1 Research Design and Sample Size

This study was a descriptive research specifically deploying cross-sectional survey to gather information from informal automobile mechanics. This type of design utilized different groups of people who differ in the variable of interest, but share other characteristics such as socio-economic status, educational background among others. This methodology was suitable for this study because informal mechanics tend to specialize in different areas like: auto-body, auto electrics, petrol and diesel powered engines though they have common socio-economic characteristics. A sample of 132 mechanics in Nakuru town, randomly drawn; from various areas of specialization as shown in Table 1 were used in this survey.

Table 1: Distribution of the mechanics as per category and sample size

Mechanic category	Category Population (Nh)	Sample size for stratum
Auto body mechanics	73	49
Petrol vehicle mechanics	28	19
Diesel vehicle mechanics	21	14
Auto electricians	10	7
General vehicle mechanics	65	43
TOTAL	**N=197**	**S=132**

3.2 Data analysis

Binary logistic regression analysis was instrumental in testing of the hypotheses. This study hypothesized that adoption of automobile technology (Y) within the informal automobile mechanics is a function of the adoption perceived attributes, as presented in equation 3.3:

Adoption (Y) = f (X_1, X_2, X_3, X_4) **(1)**

In the equation, Y is a binary response adoption: Y_i is 1 if a technology has been adopted, Y_i is 0 if a technology has not been adopted, and; X = (x_1, x_2, $x_3$and x_4) are explanatory variables: complexity, relative advantage, compatibility, and observability respectively.

To establish the effect of the hypothesized independent variables on the dependent, the odds ratio (OR), which estimates the change in the odds of membership in the target group for a one unit increase in the predictor was generated. It was calculated using the regression coefficients of the predictors as exponents or exp. SPSS calculated this value of the ln (odds ratio) and presents it as Exp(B) in the results printout in the 'Variables in the Equation.' In addition; to determine which particular independent variables had effects on the dependent variable, the wald statistics significant levels were also generated.

IV. Results And Discussion

A logistic regression analysis using the 'enter' method was conducted to generate relevant statistical information and produced the following tables. A test of the full model is presented in Table 2.

Table 2: Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	35.634	4	.000
	Block	35.634	4	.000
	Model	35.634	4	.000

All variables against a constant only model were statistically significant (Chi-square = 35.634, $p < 0.000$ with df = 11) indicating that the predictors as a set reliably distinguished between adopters and non-adopters and there is adequate fit of data to the model. This means that at least one or all of the predictors is significantly related to the response variable. Results in Table 2 shows that the -2 log likelihood chi-square distribution for the logistic regression has a p value of .000. Hence the study concludes that the four variables are statistically significant. The -2 log likelihood is a measure of how well the model explains the variations in the outcome of interest thus the significance of the variables imply they collectively explain variations in technology adoption among automobile mechanics operating in micro and small enterprises. The Hosmer and Lemeshow test of goodness fit was also generated as shown in Table 3.

Table 3: Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	3.963	6	.682

A non-significance ($p = 0.682$) implies that the model adequately fits the data. Table 4illustrates the summary of the model.

Table 4: Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	105.527	.245	.765

Nagelkerke's R^2 of 0.765 indicates that there exist a moderately strong relationship between prediction and grouping. Overall the success of prediction was 82.7% (93.8% for non-adopters and 48.4% for adopters) as illustrated in Table 5.

Table 5: Classification Table

			Predicted		
			Adoption		
	Observed		0	1	Percentage Correct
Step 1	Adoption	0	90	6	93.8
		1	16	15	48.4
	Overall Percentage				82.7

To establish the effect of the hypothesized independent variables on the dependent, the odds ratio (OR), which estimates the change in the odds of membership in the target group for a one unit increase in the predictor was generated. It was calculated using the regression coefficients of the predictors as exponents or exp. SPSS calculated this value of the ln (odds ratio) and presents it as Exp (B) in the results printout in the **'**Variables in the Equation' as shown in Table 6. In addition; to determine which particular independent variables had effects on the dependent variable, the wald statistics significant levels were also generated.

Table 6: Independent variables

Variables	B	S.E.	Wald	df	Sig.	Exp(B)
Relative advantage	-1.191	.528	5.091	1	.024	.304
Compatibility	2.555	.662	14.905	1	.000	12.868
Complexity	-2.080	.662	9.879	1	.002	.125
Observability	1.535	.621	6.108	1	.013	4.642
Constant	-1.846	.503	13.461	1	.000	.158

The odds ratio for complexity was found to be 0.125 indicating that a one unit increase in complexity will result to a decrease in chances for the mechanics to adopt a technology by 0.125 times holding all other variables constant. A negative b coefficient indicates that as a technology is perceived as more complicated the odds of its adoption increases. The wald statistics criterion demonstrated that complexity made a significant contribution to technology adoption at 0.01 level of significance (p=0.002). Based on the results, the null hypothesis that complexity or 'ease to use' does not affect adoption of technology within the informal automobile mechanics is rejected and the alternative one accepted. Meaning that the more complicated a technology, the less the chances of it being adopted.

As Rogers, Medina, Rivera & Wiley (2005) argued, the skill level of workers and the state of the capital goods sector are two of the important determinants of diffusion of a technology to individual firms, because workers, in this case mechanics and capital goods; in this case modern vehicle diagnostic equipments, are crucial for successful implementation and operation of a new invention. If a successful implementation of a technology requires complex new skills, and if it is time-consuming or costly to acquire the required level of competence, then adoption might be slow. As a consequence, the overall levels of skills available to the enterprise as well as the manner in which the necessary skills are acquired are important determinants of diffusion. If the initial idea is too advanced relative to the understanding capacity of the informal mechanics, then it will take longer for the idea to be implemented.

V. Conclusion

This study found out that complexity or ease to use a particular innovation plays a major role in the adoption of modern vehicle technology. Results indicated that this variable made was significant contribution (p=0.002) at 0.01 level of significance. However, mechanics in micro and small enterprises face the challenge of servicing, diagnosing and repairing modern automobiles due to the dynamic technological innovations in the industry; for example, electronic fuel injection (EFI), automatic transmission systems and water based paints. This study found out for instance, that, most automatic transmission problems can't be fixed by an average mechanic. There are just too many specialized tools and pieces of equipment needed before attempting any repair. In addition, the mechanics cited airbag systems in modern vehicles as highly complex with a number of components requiring an exact replacement and testing procedures which require expensive equipment. To avoid early exit, stagnation or obsolescence and improper diagnosis or repair; the informal sector mechanics need to learn and acquaint themselves in these technologies. Kenya is working towards becoming a middle income economy and eventually a knowledge society by implementing Vision 2030. Kenyan education and training institutions can play a central role in creating a human resource base to enhance science and technology industrialization, and thus aid the development of a knowledge economy. In order to realize a profitable and sustainable informal sector, the Government should commits itself to facilitate the identification, acquisition, transfer, diffusion and application of relevant science, technology and innovation knowledge in all sectors of the economy.

Identifying and closing skills deficiencies is vital to long-term economic prospects in order to sustain sectors like the informal motor vehicle mechanics that are at risk of disappearing, not being developed or leaving their main tasks to be taken up by formal dealership garages. The only prudent option is to achieve a high skill, high knowledge based economy in order to build a significant future in the local and international marketplace. Kenya needs to address the dual challenge of skill deficiencies and skill shortages. Skill deficiencies address future needs. Skill shortages replicate the past and are focused on immediate needs. The government should provide mechanics with appropriate training to improve their knowledge and sensitize them

on the use of modern tools and also assist in the acquisition of modern vehicle diagnostic and repair equipment to ensure efficiency and effectiveness in their work.

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