Automation of the manufacturing sector in the multi-currency environment: A case study of manufacturing MSEs in Masvingo urban.

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Abstract
The purpose of this study was to find out how the Zimbabwean manufacturing companies had improved their manufacturing methods after the recession of 1997 to 2008. The major issue was whether they had invested in new technology in order to improve their benefits. The study covered the period of 2009 to 2012 after the introduction of multicurrency. Masvingo town was taken as a case study. The DeLone and McLean (D and M) information systems success model was used as the theoretical framework. The study employed the descriptive survey design and an open ended questionnaire was used to solicit information on the automation of the manufacturing sector in Masvingo urban. The study findings showed that the automated departments were not connected into integrated systems. Of the fifteen companies only two had employee training facilities on automation. As a result they had problem with human errors during production and lacked adequate skilled manpower. The automation level was still very low with only one company at level five (fully automated). Some of the benefits outlined in the D and M success model were still to be realized. The study recommended that the government investment policies be changed in order to promote automation in the manufacturing sector and boost the export sector.

Background to the study
Production is the key to economic improvement especially when an economy is moving from a down swing (Dumbu and Chadamoyo 2012). The Zimbabwean situation from 1997-2009 was characterized by a decline in manufacturing (Dumbu and Chabaya 2012). This study intended to find out how the Zimbabwean companies had improved their production technology after the recession period of 1997 to 2008. Multi-currency was introduced in 2009 after the economy had gone down and inflation was the highest in the world. Automation was a necessity to boost the export sector which was once vibrant.

The Zimbabwean manufacturing sector had 1260 manufacturing companies in 1980 (Kanyenze 2006). The sector consisted of the subsectors including among others, food, beverages, textiles, clothing, wood, paper, chemicals, non-metals, metals and transport as the main segments. However, the sector had experienced unprecedented problems in the last two decades. A decline in the growth in output was experienced as it went down from -0.8% in 1997 to -12.3% in 2008. The number of companies fell to 912 in 2012 (Zimbabwe National Statistics Agency 2012).
The employment rate declined from 7.1% in 1997 to -3.1% in 2004. In 2008 the manufactured exports stood at 15.3% going down from 37% in 2000 (Dumbu and Chadamoyo 2012). The clothing subsector had 250 companies in 1999 and of these 30 closed down by 2005 and in the same period, the textile had 90 companies that reduced to 80 by 2005 (Kanyenze, 2006). According to the Confederation of Zimbabwe Industries (CZI) November 2011 publication,

manufacturing companies operating at 100% capacity were: 3% in 2005, 0% in 2006 to 2009, 4% in 2010 and 7% in 2011.In this sector, the volume of production was going down since 1990 as shown by figures from Zimbabwe National Statistics Agency (2011). For example, using 1990 as base year the levels of production were: 108% in 1997, 93% in 2000, 58% in 2004, 47.8% in 2007, 35.4% in 2008 and 2009 and 42.4% in 2010. This showed that the introduction of multicurrency had some impact on raising production levels for the two years (2009 and 2010).

Companies hadto cut back on capital expenditure despite the compelling need to invest in production technology that enabled companies to pinpoint salient characteristics that impacted on system usage, user satisfaction and overall company benefits.The exchange rate was high and the fact that thecomputerized machinesand the spares were bought from abroad contributed to the high prices. From 1997, the industry was not getting foreign exchange on the formal market; hence companies were surviving on buying expensive foreign exchange on the parallel market. A number of companies had closed shop as already indicated above. The remaining ones were virtually operating on a survival mode. This development was had an impact on the system quality and service quality as well as the company's net benefits.

The other challenge the manufacturing industry facedwas the loss of technically qualified and experienced manpower. The levels of employment for the textile and clothing industries shrunk from 24 000 and 27 000 in 1990 to 11 522 and 17 300 in 2005 (Kanyenze 2006). Qualified computer professionals left the country and it wasvery difficult to attract them back. The countrycould not compete with some of itsneighbouring countries in terms of salaries because its currency was absolutely vulnerable and as a result its professionals went for greener pastures abroad.The skills lost were essential for the effective management and continuous improvement of automated functions in the companies. Technologically Zimbabwe had fallen behind (UNDP 2008) and this had affected the product quality leading to a decline in exports.

Kaplinsky (1995) argued that the relative importance of education to flexible production depended upon the sort of organizational techniques which were introduced. He noted that in Zimbabwe some companies made considerable progress with a largely unskilled labour force and in most adopting companies. The degree of success seemed to be closely correlated with in-plant investment training. In Zimbabwesuch systems as Accounting Information Systems, Human Resources Information Systems and the Internet are common in most of the companies.The actual level of automation was affected owing to lack of working capital and unfavourable terms of financial support. Machine breakdowns became a common feature and retooling (Dumbu and Musingafi 2012) was difficult for the companies. Without current technology in place, the cost of production remained high resulting in low levels of capacity and inferior product that were internationally uncompetitive (CZI Publication 2011).

The introduction of multi-currency in 2009 has seen a turn-around for the Zimbabwean economy. The capacity utilization in the manufacturing sector was recorded at 60% in 2002, declined to 10% in 2008 and rose to 57.2% in 2011 (CZI, 2011). This position was confirmed by The Business Connect (24 May 2012) which carried out a survey of 120 companies from the manufacturing sector that showed capacity utilization rate varying from 30% to 74%.

Between 1997 and 2008 Zimbabwe's information technology sector, that was expected to boost production in the manufacturing sector, was at cross-roads where it faced possible collapse due

to the acute shortage of foreign currency and the excessive loss of skilled manpower spawned by the acute economic recession. This sector, touted as the fastest growing sector prior to 1997 hadbeen weighed down by the excessive costs of importing products into the country against the background of shrinking disposable incomes. This came at a time when the once robust agriculture-driven economy had virtually given up on securing offshore lines of credit (Dumbu and Musingafi 2010) due to the worsening country risk profile. However Information Communication Technology (ICT) investment levels rose rapidly in the communication sector. The Zimbabwe tele-density rose to 78.8% during 2012 first quarter from 67.5% in May 2011. In the manufacturing sector, the investment was at a slower pace. For example, Schweppes Zimbabwe Ltd installed state-of-the–art bottling line machine worthy US$15m, making Zimbabwe the latest of fifth country on the continent to boast such technology (www.znccharare.co.zw 2012).

In Africa, arguments as to whether the continent should acquire the new technologies assumed robust dimension. The major issues centredon the question of priorities and the following issues had been raised: Is it appropriate for African leaders to ignore the basic needs of their people and hop onto the bandwagon of the new technologies? Will acquisition of new technologies transform African economies, lead to greater food production and improved quality of life, health and housing, overcome poverty and illiteracy, and end internecine civil strife? Indeed, can Africa thus afford not to adopt new IS? These questions still have to be answered and this could explain why studies on automation levels of the production sector are very rare in Africa.

In Africa, there is insufficient evidence to suggest a direct link between automation and development. Recent studies have found a positive correlation between investment in IS and economic growth in developed countries, but evidence for developing countries is not as extensive(Ngwenyama et al, 2006). However, the potential for automation to transform the productive capacities of developing nations had been noted (Crafts, 2003; Chen and Zhu, 2004). Although the Zimbabwean manufacturing sector experienced minimum automation, it is high time that the level of automation be determined. Without such studies in place, there will be little or no understanding of the relationships between systems quality, information quality service quality and net benefits in the manufacturing sector.

The importance of automation on economic growth in developed countries was cited by the Organisation for Economic Co-operation and Development (OECD 2003). It pointed out that information system(IS) investment led to availability of capital stock leading to the raise of labour productivity. In Finland, Ireland and South Korea a labour productivity growth of 1% was recorded in the 1995-2001 period. OECD also recorded improved company performance through network effects, low transaction costs and rapid innovation.

Statement of the Problem

The success of automation in the Zimbabwean manufacturing sector has not been measured hence its impact on the economy is not known. This was the problem that this study attempted to address.

Research questions:
This study was guided the following questions:

- What were the automation levels in the Masvingo manufacturing sector?

- What problems were the companies experiencing as a result of automation?
- What were the automation benefits?

Theoretical Framework

Models were developed in the developed countries. These were tested in both developed and developing countries. Testing in the developing countries was done in the Asian countries that automated their manufacturing sector.Theoretical models were developed to explain factors that contribute to the impact of IS on individual users and companies. One of the early models, focusing on how the system and information qualities impact on users and the organization, was developed by DeLone and McLean (1992). This has been referred to as the D&M Information System (IS) Success Model.

In the D&M- IS success model, systems quality measured technical success; information quality measured semantic success; and user, user satisfaction, individual impacts, and organizational impacts measured effectiveness success. The six dimensions of success were proposed to be interrelated rather than independent. This had important implications for the measurement, analysis and reporting of IS success in empirical studies. The model suggested that IS was first created, containing various features. Users and managers experienced these features by using the system and were either satisfied or dissatisfied with the system. The use of the system and its information products then impacted or influenced the individual user in the conduct of his /her work and these individuals impacted collectively intocompanybenefits.
Taking into account many proposals from researchers, DeLone and McLean reviewed empirical studies that had been carried out between 1992 and 2002 and came up with an updated model shown below.

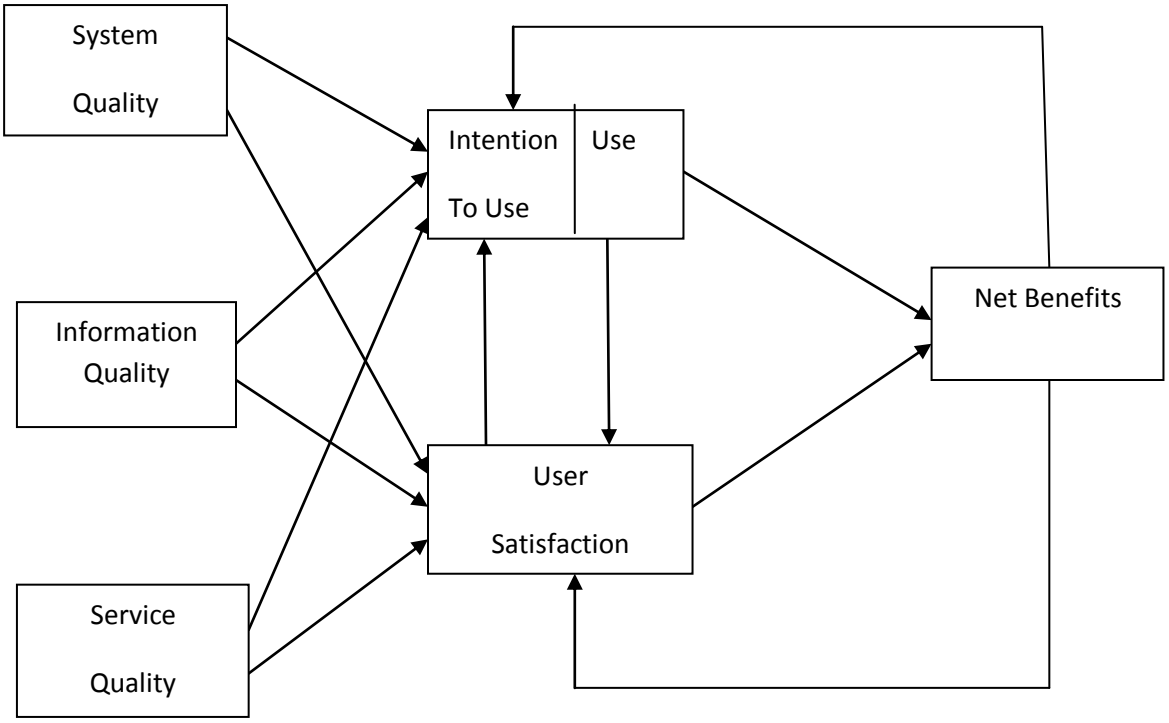

Figure 4.1 Updated DeLone and McLean IS success model (2003)

The model was tested in the industrial sector including the manufacturing companies. The model showed how IS resulted into company benefits.In the updated D&M model the dimensions of success included the following constructs:

- System quality – The desirable characteristics of information system included ease of use, system flexibility and reliability and ease of learning.
- Information quality – The desirable characteristics included system outputs like management reports, relevance, understandability, accuracy, conciseness, completeness, timeliness and usability.
- Service quality – The quality of support that system users received from IS department and IT support personnel, for example, responsiveness, accuracy, reliability, technical competence and empathy of the staff.
- System use – The degree and manner in which staff and customers utilized the capabilities of an information system, for example, amount of use, frequency of use, nature of use, extent of use and purpose of use.
- User satisfaction – Users' level of satisfaction with reports, Web sites and support services.
- Net benefits – The extent to which IS are contributing to the success of individuals, groups, organizations, industries and nations, for example, improved decision-making, improved productivity, increased sales, cost reductions, improved profits, creation of jobs and economic development. For example, Brynjolfson et al (2002) had used production economics to measure positive impact of IS investments on firm-level productivity.

Hua-Yang Lin (2005) presented a paper on re-specification of the DeLone and McLean IS success model and empirically examined it in the enterprise resource planning (ERP) context. Five IS success constructs and a balanced scorecard were used to predict ERP systems success. The theoretical model was tested using a survey of 257 companies that had already implemented ERP systems in Taiwan. Structural equation modeling (LISREL) was used to validate the research model. Results of the study were consistent with the IS success factors for explaining ERP systems success. System quality and information quality were found to have a significant effect on system use and user satisfaction. System use and user satisfaction were associated with individual impact. Individual impact had a significant effect on four balanced scorecard perspectives.

Tsai and Chien (2005) updated DeLone and McLean IS success model in the ERP implementation environment in high tech manufacturing companies in Taiwan. The purpose of their study was to re-specify and extend the updated DeLone and McLean model (2003). The relationship among the success measures was empirically tested. Structural modeling techniques were applied to data collected from the questionnaires answered by 204 respondents of ERP systems. Three companies were used. Tape-recorded interviews were also used for data collection. Questionnaires were sent to 600 end users and the response rate was 38%. The research found that system and service qualities played a more important role than the information quality in terms of influencing ERP benefit of use and user satisfaction.

Jen-Her Wu and Yu-Min Wang (2006) carried out a study to re-specify the DeLone and McLean model in Taiwan. They raised an important issue of establishing a measurement model that could

be used to evaluate knowledge management system (KMS) success and suggested ways to improve its usage.

Chien and Tsaur (2007) proposed a partial extension and re-specification of the DeLone and MacLean model of ISsuccess to ERP systems. The purpose of the research was to re-examine the updated DeLone and McLean model. The updated DeLone and McLean model was applied to collect data from the questionnaires answered by 204 users of ERPsystems at three high-tech companies in Taiwan. The study suggested that system quality, service quality, and information quality were mostimportant successful factors.However, the insufficiency of this model was confirmed by Petter et al (2008). There were insufficient studies at the company level to evaluate the strength of most of the relationships. They pointed out that most studies focused onbenefits on an individualand there was little understanding of the impact of information system at the company level**.**Thisgap still needs to be closely looked at.

Research Methodology

Research design

A research design is the blueprint that enables the investigator to come up with solutions to problems and guides in the various stages of the research. Cooper and Schindler (2003) argue that research design is an activity and time based plan always based on the research question and guides the selection of sources and types of information. The study used the descriptive survey research design as it was helpful in indicating trends in attitudes and behaviours and enabled generalisation of the findings of the research. The design was chosen as it saves time, expenses and allows valid quality information to be yielded at the same time guarding against researcher bias because participants completed identically worded self report measures.

Population

A population is defined as a complete set of individuals, cases or objects with some common observable characteristics (Dumbu and Matanda, 2010). It must contain an up-to-date list of all those that comprise the target population. The population of the study comprised of all registered MSEs with the Masvingo City Council. There are 65 MSEs in Rujeko and 71 in Mucheke light industry all in various business sectors according to the Shops and Licencing Act Masvingo City Council 2012. This accounts to a total of 136 registered firms with the city council. Of the total only 27 (20%) of the registered firms are in to the manufacturing business. Therefore the study only considered the 20% as the case study.

Sample and sampling procedure

Sampling design refers to a research plan that indicates how cases are to be selected to participate in the study. The rule of thumb in sampling is that one need to have at least 30 participants for a smaller population (Dumbu and Matanda, 2010) but for larger populations a sample of 10% is representative. From the target population of 27 a sample size of 55% was taken giving a respondent base of 15 respondents consisting of managers/ owners of the manufacturing MSEs. This sample is considered representative, comprehensive and economic in the study. To draw the sample a simple random sampling of the MSEs sector was employed.

Instruments

Questionnaires with open-ended items were used to collect data. According to Cooper and Emory (2008), the questionnaire is conveniently used because it is cheaper, easier and quicker to administer. It is also highly convenient for the respondents as they could complete them on their own spare time when their workloads are manageable. The questionnaire was self administered**.**

Data analysis

Responses from open-ended questionnaire items were recorded and coded according to themes that emerged. Data was then analysed according to the emerged themes and findings and conclusions were arrived at.

Results and discussions

Questionnaires were sent to fifteen (15) manufacturing MSE companies and all responded giving a response rate of 100%. Their response is discussed below.

Company subsectors

Of the fifteen companies, nine were in the transport business while three were in the clothing, two in textiles and the paper and food subsectors had one each as shown figure 6.1 below.

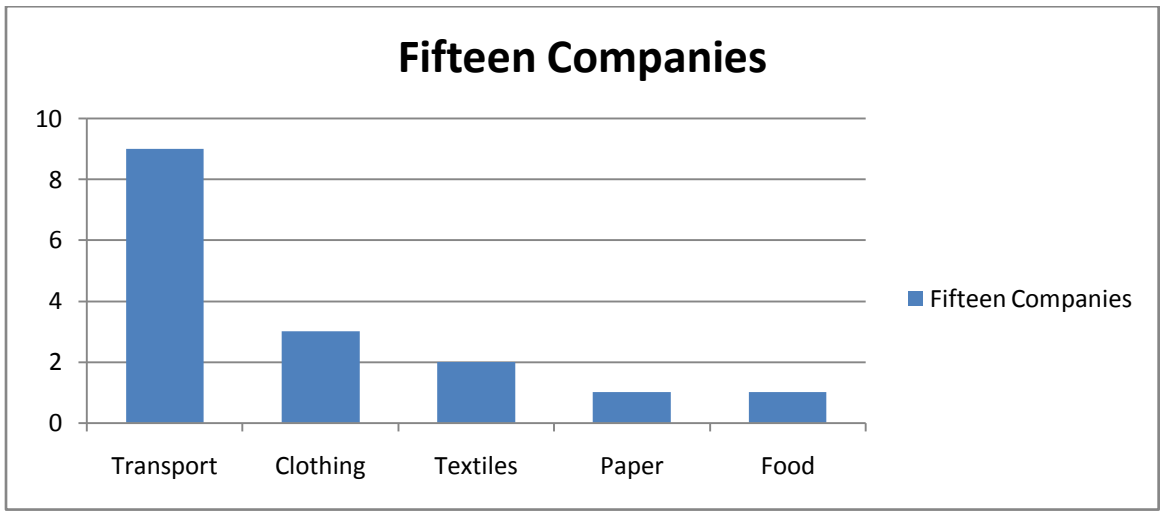

Figure 6.1 Company Subsectors

Automated departments

As shown in figure 6.2 below six companies had automated their production departments and five had automated decision making processes. Two each had IS systems running for finance and marketing and sales. Only one company had both decision making process and human resources systems automated. No company had its systems integrated and this had an impact on the production.This also posed a limit on testing the D and M IS Success model that requires integrated systems. Palaniswamy and Frank (2000) showed that incompatibility among integrated systems resulted in poor manufacturing performance. Whereas an integrated system

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like the ERP, has benefits such as quicker information responsetime, improved on-time delivery, lowerinventory levels, better resource management,and improved interaction with customers andsuppliers (Duplaga and Astani2003).

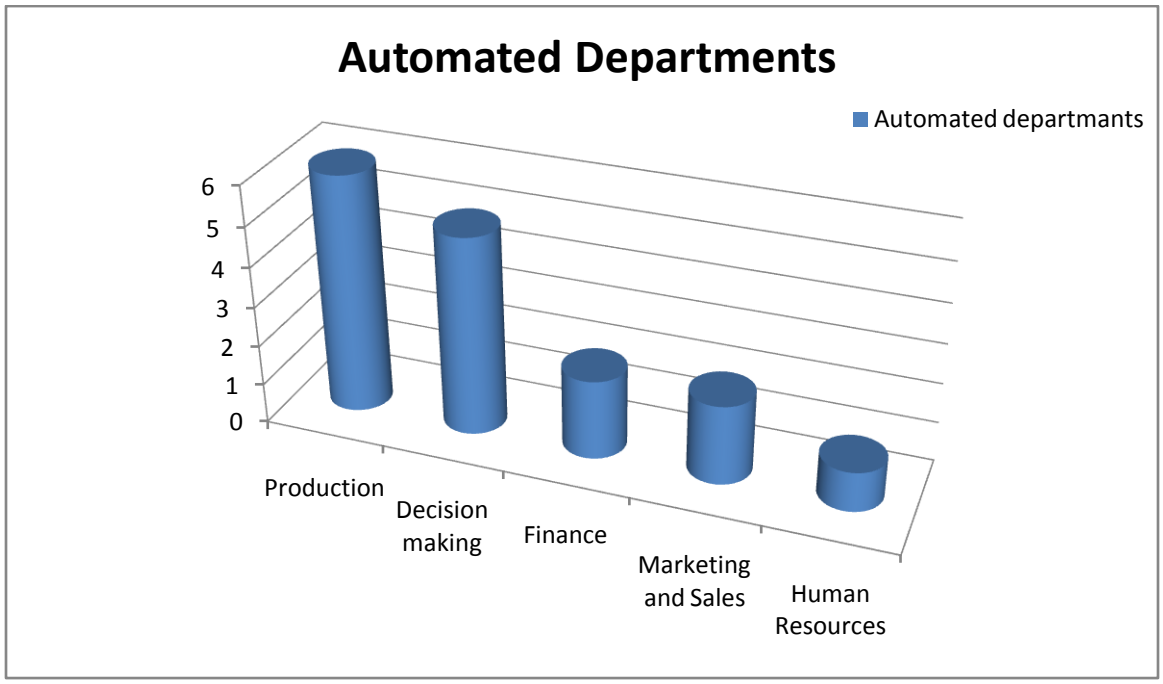

Figure 6. 2 Automated Departments

Automation training

Of the fifteen companies only three trained the employees on automation. One held partial training and the rest had no training facility for their employees.

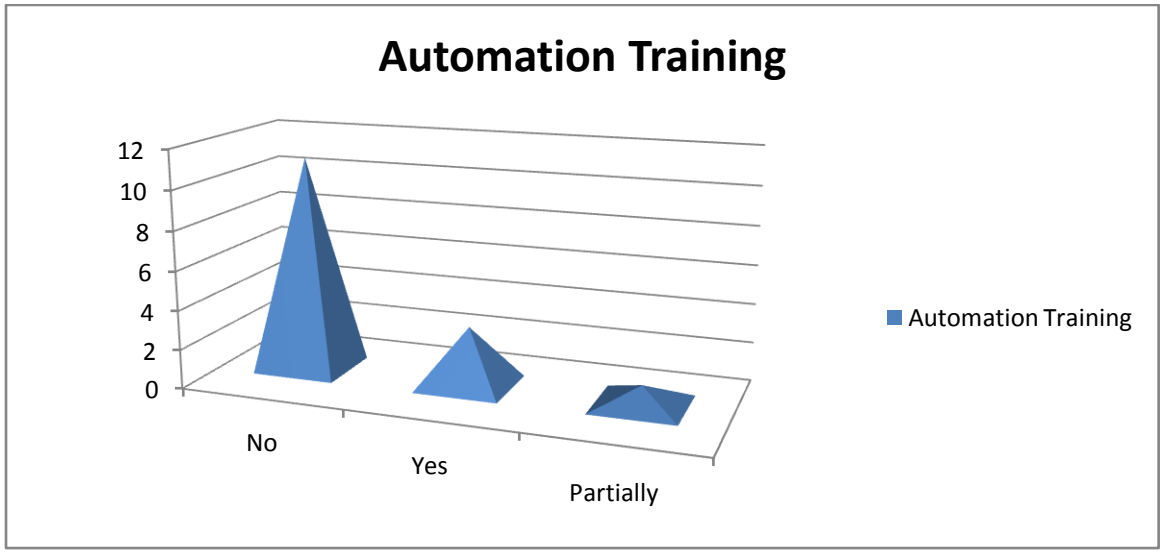

Figure 6. 3 Automation Training

The above finding confirmed Kaplinsky (1995) argument that the relative importance of education to flexible production depended upon the sort of organizational techniques which were introduced. He noted that in Zimbabwe some companies made considerable progress with a largely unskilled labour force and in most adopting companies. With today's technology the country is lagging behind by employing this technique as few of them were able to do own training. The result was that the country has very little to export.

Automation problems

Five companies did not have enough skilled labour force and this confirmed thechallenge that the manufacturing industry losttechnically qualified and experienced manpower (Kanynze 2006). Four companies indicated that they had electricity problems. This was common as pointed out byOdedra et al. (1993)in the study of Sub-Saharan nations. They said that one of the factors contributing to underutilization was inadequateinfrastructure support prerequisites such as reliablepower supply.Threecompanies faced maintenance problems and two experienced human errors a clear sign that service quality and systems quality explained in the D and M IS Success model did not exist. Figure 6.4 shows a full picture. No company indicated that it had a problem with rapid change of technology.Without current technology in place, the cost of production remained high, resulting into low levels of capacity and inferior product that were internationally uncompetitive (CZI Publication 2011).

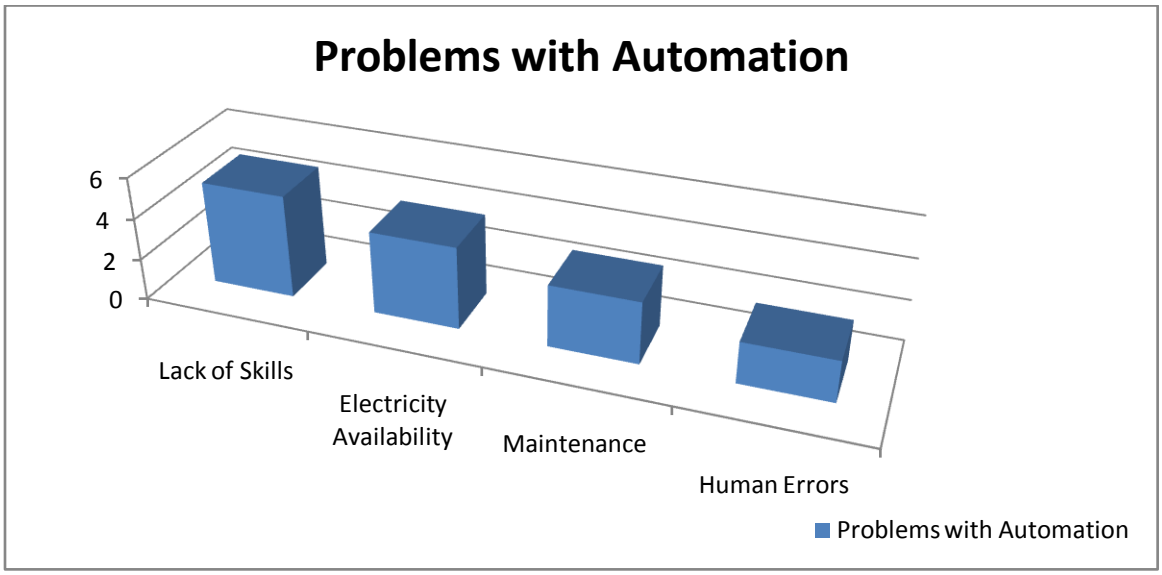

Figure 6.4 Automation Problems

Gupta (1994) noted that, to the contrary, automation had frequently resulted in complex and fragmented environments that proved detrimental to cost reduction and quality enhancement efforts. The lack of a strong measurable relationship between information systems and shop floor productivity had led top management and manufacturing personnel to view such systems as cost centers that had a negative impact on bottom-line results. Automation had created serious bottlenecks in designing flexible environments and reducing the lead time to deliver quality products to the market place.Haran and Lee (2011) noted a serious problem in the lack of expert knowledge in the field for both managerial and technical staff.

Obijiofor and Inayatullah (2003) summed up the African situation by saying that ignorance about the importance of and need for IS which made even those rich enough to acquire them apathetic to IS. General poverty led to the perception of computers as luxury acquisitions and poor maintenance and repair culture in which spare parts and technical experts from the manufacturers were imported whenever the technologies break down. This led to waste of resources, time and money. The companies had poor infrastructural support basecoupled with inefficient electricity and telephone systems.The other problems were the unavailability of experienced and talented software personnel, management personnel trained in modern business management, a small and parochial private sector, a small and weak middle class with very low purchasing power, lack of appreciation of the power of information by the state, failure to treat information as a critical element in any major economic objective and uninformed resistance in government circles against investing in automation.

Datta and Mbarika (2006) supported above argument by saying,in Sub-Saharan Africa, governments invested considerable sums towards buyinginformation infrastructure, with little understanding of itsproper use. As a result, the acquired informationinfrastructure remained seriously underdeveloped,falling short of any productive potential.

Automation levels

Five companies were at level 2 automation. This meant that the employee had to decide and act with the support of the information system and six were at level 3 where the system suggested a decision to be approved by the employee before the machine acted. Two were at level four where the system was monitored by the employee before any production was made. Only one company was at level five which meant that it was fully automated.This was a textile company and its production system was fully automated. No human interaction was required in the production. Considering this sample to be representative, it meant that about 7% of the Zimbabwean manufacturing industrywas fully automated.The impact of IS as described by the D and M IS Success model is still to be experienced in Zimbabwe. Technologically Zimbabwe had fallen behind (UNDP 2008) and this had affected the product quality leading to a decline in exports. Figure 6.5 below shows the company responses.

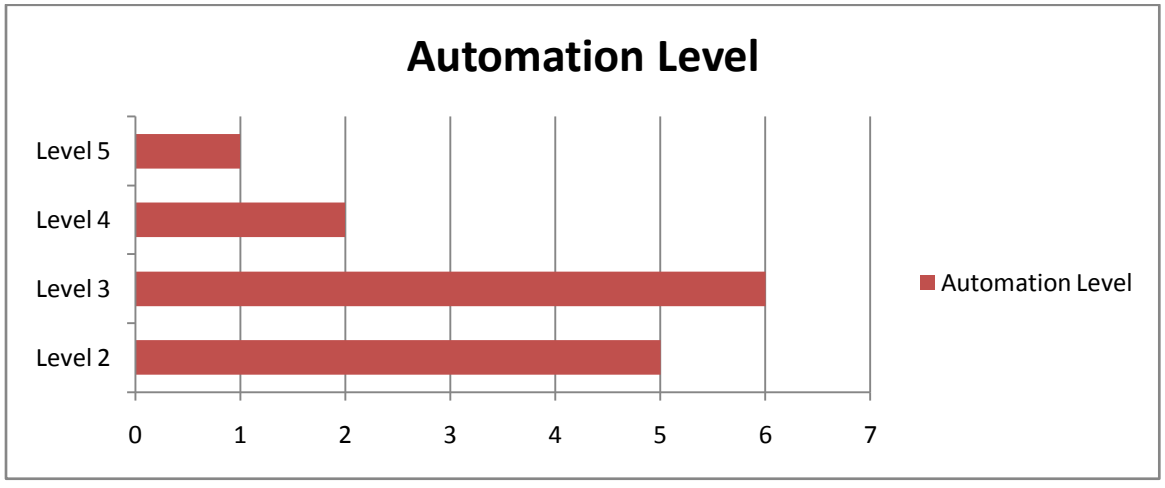

Figure 5 Automation levels

Automation benefits

Seven companies indicated that automation brought about time-saving in their production.Six had improved service quality and this confirmed the D and M IS Success model.Chien andTsaur (2007) study's suggested that system quality, service quality, and information quality were mostimportant successful factors.Yet most of the Zimbabweancompanieswere still operating on a survival modeand this had an impact on the system quality and service quality as well as the company's net benefits. Two companies experienced cost savings. One had its employees benefitting and this confirmed Hua-Yang Lin (2005)'s findings that a system was associated with individual impact. Figure 6.6 below shows the responses.

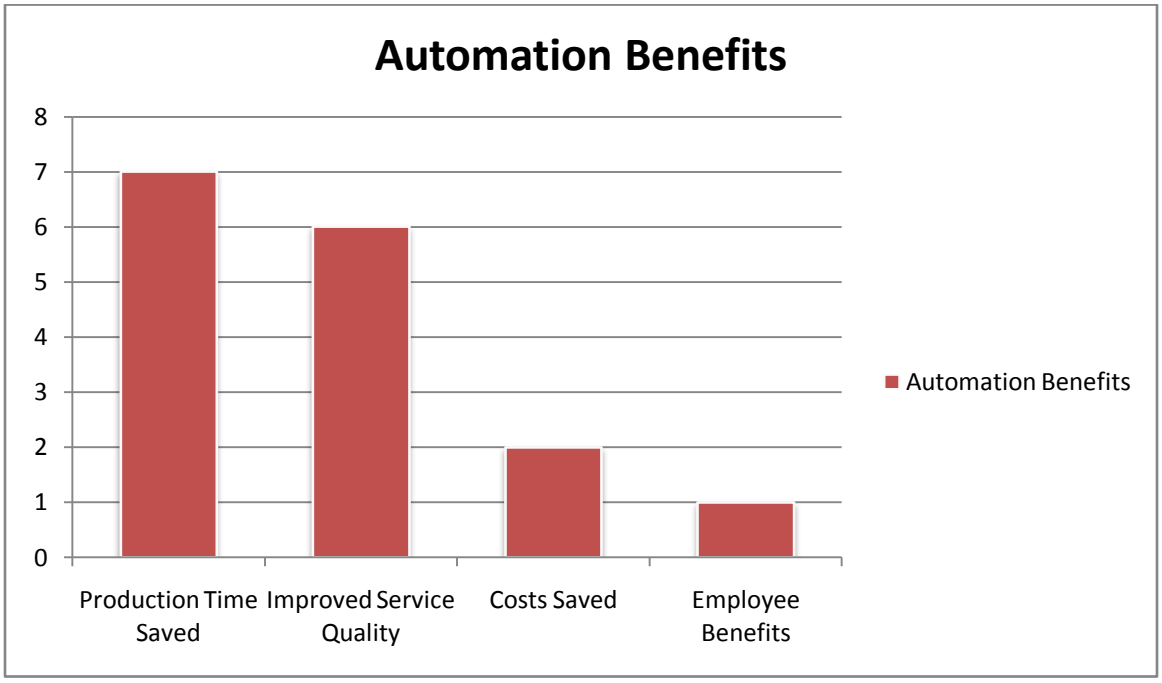

Figure 6 Automation Benefits

However the following benefits were not mentioned: increased production, improved product quality, increased market share, improved machine usage, promotion of user satisfaction and company benefits. This restricted a full application of the D and M IS Success model.

Conclusions and Recommendations

The following recommendations were drawn from the study:

- The government policy, in developing national capabilities should not be highly protective but move slowly in liberalization but retaining policies favouring local production. Brazil and India pursued this successfully (Kraemer and Dedrick2001). This could result in dropping of prices and greater selection of hardware and software and promote automation in the manufacturing sector.
- The government should introduce market-oriented reforms and promote investment in the manufacturing sector. The country's policy of company indeginisation seems to scare the

potential investors away. The policy stipulates that Zimbabweans must acquire 51% of any foreign company shares.

- The government should consider liberalising foreign investment laws and lowering of trade barriers on parts and equipment leading to investment in the manufacturing sector.

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