Use of Six-sigma Concept in Discrete Manufacturing Industry

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***Abstract*—** Efficiency in manufacturing is critical in raising the value of exports so as to gainfully trade on the regional and international markets. There seems to be increasing popularity of continuous improvement strategies availed to manufacturing entities, but this research study established that there has not been a similar popularity accorded to the Six Sigma methodology. Thus this work was conducted to investigate the applicability, effectiveness, usefulness, application and suitability of the Six Sigma methodology as a competitiveness option for discrete manufacturing entity. Development of Six-sigma center in the country with continuous improvement information would go a long way in benefiting the entire industry

***Keywords*—** discrete manufacturing, six-sigma, , continuous improvement, , efficiency, competitiveness

I. Introduction

The major challenge faced by local manufacturing organizations is the development of credible process and product improvement management systems. While some improvement programs may exist, they are often without a systematic framework upon which they are based [1]. Often they are derived from purely technical considerations without due regard to the 'big picture', the business and operating environments [2]. The industry is therefore characterized by generally low improvement achievements and a good measure of crisis management.

Yet there is need for manufacturing organizations to respond to rapidly changing expectations for them to survive competition in a global marketplace. These include a growing awareness of the connection between quality performance and customer retention, the extent to which quality performance affects safety and the environment, and increasing pressure to achieve high quality in response to market demand, and to contain costs [4]. All this is relevant to manufacturing industry today considering the serious nature of current economic challenges, which include principally low productivity due to the ever rising cost of new capital equipment, spare parts and raw materials that largely have to be imported. Six Sigma methodology is a philosophy whose thrust provides a strategic framework which enables users to respond to these challenges quickly and simply[4]. Six Sigma manages to achieve this because it never loses sight of the fact that improvement is about processes[5]. Six Sigma therefore starts from first principles with a zero-based review of the improvement requirements of each process in its operating context.

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II. Justification

The application of Six Sigma methodology in Zimbabwean industries is still in its infancy stage and very few organizations apply it to aid their continuous improvement initiatives. Yet, Six Sigma is one of the most essential pre-requisites for a successful and highly competitive organization. It therefore means that the adoption of Six Sigma by any organization is a move towards renowned competitive advantage and world class competitive performance [6]. In this research work, Six Sigma is examined in the case study, to see what system of improvement has evolved at the company as a result of its implementation. The impacts came out in different categories and these include impact on cost, delivery, manufacturing, customer, market, profit and impact on other stakeholders like employees and customers.

The research intends to establish the impact and effectiveness of the Six Sigma methodology in repositioning the organization's operational performance.

III. Manufacturing Overview

Manufacturing is defined as a series of interrelated activities and operations involving design, materials selection, planning, production, plant and equipment maintenance, quality assurance and marketing of consumer and durable goods [8].The manufacturing enterprise includes everything that is used, owned or done by a manufacturing business [7]. Business functions such as human resources, marketing, product design, research and development, sales, purchasing, inventory management, logistics, maintenance, finance and accounting management are aspects of a manufacturing enterprise. Different manufacturing enterprises often have different departments, but a majority of enterprises have similar business functions [9]. The diagram below shows the classification of manufacturing processes into two major classes, the discrete and the continuous processes. The bracketed numbers show the sequence in time of development of the processes with the continuous process being the latest process to be developed [8].

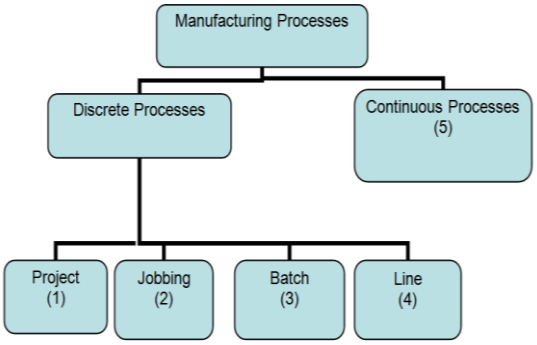

Fig 1. Classification of Manufacturing Processes [8]

Discrete manufacturing processes involve the processing of countable products. Discrete manufacturing can be classified as project, jobbing, batch and line processes[12].This makes the focus of this research on discrete processes a relevant focus, since these are processes that can be improved the most by the use of improvement strategies. In addition to that, they are the processes that constitute most of the manufacturing activities.

IV. SIX SIGMA CONCEPT

Six Sigma is a collection of fact based tools and techniques aimed at helping a business to deliver financial benefits from continuous improvement. It consists of a set of data driven tools and methodologies designed to significantly improve the quality of products and services delivered to customers and it is highly customer driven in that you cannot use the tools without taking the needs and wants of the customer into account. It brings about an analytical and objective, or honest, focus to improving processes [1]. Six Sigma can be used to improve any process, and these can include customer satisfaction, product cycle times, manufacturing, defects reduction, distribution and delivery. Innovation and design remain crucial elements in the mixture of success making ingredients of business [17].

The management can use Six Sigma in two main and related ways. Firstly, as a quality target for the company's processes - Six Sigma sets out a target performance level of less than 3.4 defects per million opportunities (DPMO)[9].

TABLE 1

SIX SIGMA LEVEL NUMBERS[6]

Sigma Level	Defects per Million Opportunities	Yield (%)
6	3.4	99.9997
5	233	99.977
4	6 210	99.379
3	66 807	93.32
2	308 537	69.2
1	690 000	31

In fact the right level of sigma will depend on the process and the economics of achieving higher levels of quality. Secondly, as an aspiration towards a culture and management system like General Electric's where Six Sigma is seen as a mechanism for building a culture of excellence as well as delivery of financial benefits [10]. This second aspiration involves setting up teams to solve specific problems on a project by project basis, and training a very wide group of people so that the whole organization is searching for ways of listening and reacting to the customer, seeking facts to measure current success and focusing on issues that really affect customer satisfaction.

Six Sigma is a methodology that maximizes shareholder value by achieving the fastest rate of improvement in customer satisfaction, cost, quality, process speed, and invested capital [1].

A. Benefits of Six Sigma

The principle of Six Sigma depicts that the activities that cause the customer's critical-to-quality issues and create the longest time delays in any process offer the greatest opportunity for improvement in cost, quality, capital, and lead time [7]. It is further stated that wait time, material and manufacturing overhead and quality costs are the biggest levers of cost reduction, along with labor. The first thing to do is to gather some information on how well your company is performing. The first diagnostic looks at how good the company is at shaping and delivering improvement projects. It looks at basically two aspects [14]:

- How consistently people will give the same results
- The potential size of the improvement opportunity available to the company

B. Six Sigma Culture

Six Sigma culture and infrastructure is the embodiment of principles of transforming goals into action through continuous improvement and innovation, in a form that a company can implement [9]. Anyone who has worked within a Six Sigma driven organization knows that Six Sigma isn't just an "improvement methodology". It is …a system of management to achieve lasting business leadership and top performance applied to benefit the business and its customers, associates, and shareholders. A measure to define the capability of any process. A goal for improvement that reaches near perfection. Six Sigma level numbers often present the capability of a core business process, as measured in defects per million opportunities [7].

The "per million opportunities" aspect of the six sigma metric is critical because it allows to compare the capability of widely different processes. The sigma metric makes sure that simpler processes, which have fewer steps and fewer chances for something to go wrong, are not given an advantage over more complex processes. The culture of a Six Sigma company are summed up as comprising of the following [17]:

-A climate of open mindedness about the future

-No laissez- faire attitude

-Knowing that doing anything more than once to get it right is bad economics. Production line running at half speed or even at 95% of capacity is not only wasteful, but also has a direct impact on the bottom line

-Employee commitment at work and forget social problems
- A conviction in the potential of people is critical for success of Six Sigma
- The drivers of change are the customers and customers come first with loyalty, retention and acquisition imperative
-The Six Sigma focus is on consistency, taste and variation; or consistency, accuracy and precision

C. Critical Success Factors for Six Sigma

Customer centricity - the knowledge of what the customer values most is the start of the value stream analysis. The Six Sigma culture is seeks to delight customers. The quality of a product or service is measured from the customer's perspective, by its contribution to their success. The gap between what customers desire and what is currently delivered are the areas where significant value can be created. Thus Six Sigma is focused on addressing these gaps, increasing operating profit, and becoming part of the DNA of the company and its operations.

TABLE 2

SERVICE AND AFTER SALES SUPPORT PROCESS[16]

Customer comments	**Business implication**	**CTQ requirement**
Too long to get help	High demand on help desk, cost but no revenue generated. Also lost sales & service revenue	Reduce lead time to match customer expectations
Service and after sales support spoils the otherwise excellent Customer experience	Loss of future sales	Improve responsiveness on simple enquiries- back up with help desk when really needed
Long support calls are easier to cope with now that the "0800" number has been put in place	0800 number popular but high cost to Blue	Find a way to make the customer contribute to the support costs
Would be good to be able to ask for advice on other matters as well as help on specific issues	Lost sales opportunities	More than just a help desk – want to provide an advisor

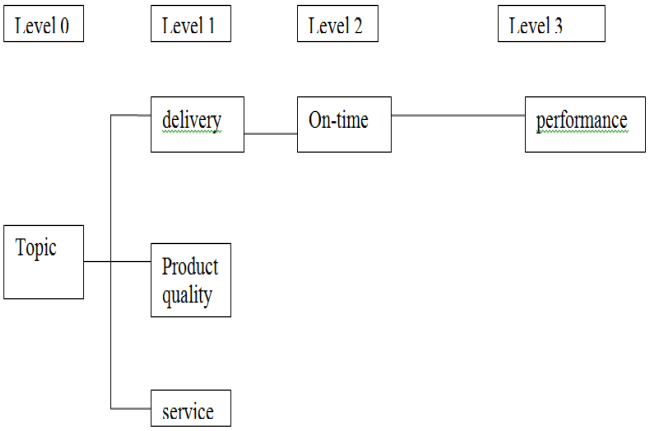

Fig 2.CTQ Measures tree analysis [15]

Six Sigma provides the discipline to help companies go beyond an anecdotal understanding of customer wants and needs to specific requirements-driven process metrics. This changes behavior from fire-fighting to disciplined improvement based on customer satisfaction. Every defect in a process not only reduces quality but creates a time delay, generates an additional cost, and produces an associated loss of operating profit. The actual cost of defects depends, of course, on the process [13].

D. Six Sigma methodology

Six Sigma improves any existing business process by constantly reviewing and retuning the process [11]. To achieve this, Six Sigma uses a methodology known as DMAIC (Define opportunities, Measure performance, Analyze opportunity, Improve performance, Control performance). Six Sigma methodology can also be used to create a brand new business from ground up using DFSS (Design for Six Sigma) principles. Six Sigma strives for perfection. It allows for only 3.4 defects per million opportunities for each product or service transaction. It relies heavily on statistical techniques to reduce defects and measure quality.

Accordingly, the project team will work on a number of different activities to build up the Project Charter and plans [16]given in Table 3.

TABLE 3

PROJECT PLAN- SIX SIGMA PROJECT, DMAIC; SOURCE – BERGER (2003)

Project plan		Jan 13	Feb 13	Feb 13	Feb 13	Feb 13	Mar 13	Mar 13	Mar 13	Mar 13
Activity	Responsible		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	
Define need										
Senior management review										
Select champion/sponsor										
Determine methodology/ approach										
Initial scoping										
ROI										
Authorization										
Select team lead &members										
Identify team training requirements										
Deliver team training										
Team kick-off										
Define phase- target										

Define phase- actual										
Phase- exit										
Measure & Analyse phase- target										
Measure & analyse phase- actual										
Phase – exit										
Improve phase – target										
Improve phase- actual										
Phase – exit										
Control phase – target										
Control phase – actual										
Phase – exit										
Final sign – off										
On – going monitoring										

Project risk analysis - is also carried out identify possible risks and to have a plan for managing the main ones. Sigma projects can fail due to some typical issues like: lack of senior management leadership, lack of acceptance by the business, poorly executed project processes, lack of resources, and lack of focus on project financial benefits.

E. Baseline Performance Measures

One of the key activities in the Measure phase is the documentation of baseline measures. There is need to be clear about the measures, the current baseline and the source of the data. Best practices and benchmarks are invaluable in helping project teams to establish the case for business change. Best practices tend to be descriptions of optimum ways to conduct processes. Best practices can be either within a company or from an external company. Most companies benefit significantly just from applying best practices, already in use in other parts of the company, more widely across the whole organization. Best practices are sometimes seen as lessons learnt from one area of a business that could be applied more widely. Benchmarking gives the processes and measures to compare measured performance across companies and industries. Benchmarks are very useful in showing differing levels of performance [13]. They are always quantitative measures which provide comparative statistics.

Process purpose: to maximize productivity of computer cabinets on product line 1					
GROUPS	CUTOMERS	GROUP 1	GROUP 2	GROUP 3	SUPPLIERS
PROCESS NOTES	Shipping department	Quality assurance	operations	inventory	APR Joiners
Balance inventory costs against availability	Confirm flow & requirements				
Orders controlled by MRP system				Supply cabinets against orders	
Use Just-in-time approach to supply if in stock				Stock issue?	
Confirm all orders using email requesting proof of receipt					Update inventory
Internal inspection on sampling basis of 1:5			⊗	Receive goods	
Alternate between process lines and watch cleaner fluid			Wash & dry cabinets		
Handle with care – watch for paint gap problem			Paint & fit cabinets		
Final QA should focus on customer visible problems		Quality?			
Target is 100% acceptance within the timeframe required	Confirm receipt	⊗			

Fig 3.Process map example- Source [1]

F. Solution Options and Solution Filter

The preferred solution can be determined through application of a two - stage solution filter framework, and a first level evaluation approach based on VSAFE criteria can be applied. The VSAFE criteria possesses the following components [7]:

-**V** for value – looks at the expected impact on the bottom line. Will the solution deliver clear financial benefits in excess of implementation costs?

-**S** for suitable – examines how this idea contributes to the company's business strategy and business imperatives. Does the proposed solution fit with our business imperatives?

-**A** for acceptable – the team should take a time to think about how acceptable the stakeholders will find the idea. Will stakeholders agree with this solution option?

-**F** for feasible – checks that the idea is feasible given time and other constraints. Is it feasible to implement this solution in our organization?

-**E** for enduring – the team needs to check the likely endurance of the proposed solution. Is the proposed solution option likely to be sustainable?

G. The DMAIC Process – Control

The objectives of the Control phase are to implement the new processes in all areas of the organization and to put in place robust plans to ensure that the improvement is sustained and financial benefits are delivered. The pilot and improve phase proved that the new processes will work and can be implemented in all the planned areas. The main task of the Control phase is to "sell" the wider implementation to a wider group of stakeholders and users. It is particularly important to have clear response plans for dealing with the inevitable "teething problems" that can be expected from the wider implementation of new processes [14].

The outputs of the control phase are:

On-going process management
Process improvements and control
Standards and procedures for new processes
Response plans
User training in new processes
Lessons learned
Team rewards
The Control phase checklist

At the end of the Control phase, the project team will be disbanded or moved to other to other tasks. The basis of the handover is a clear set of control measures and alarm levels for the new process owner(s). The alarm levels are designed to signal when things are going upside upper or lower tolerance limits. It should also set out what actions the process owner should instigate if these alarms are reached.

I. Design for Six Sigma - DFSS

There will be times when continuous improvement through the DMAIC process will not be enough to raise sigma levels to required standards [12]. What will be needed is a radically new process. Design for Six Sigma (DFSS) is the Six Sigma method for radical process innovation. DMAIC is a method for projects that are aimed at an incremental improvement in performance, but DFSS is a method that is used when incremental improvement is not enough or there is no existing process to improve. DFSS is used for radical or new process innovation.

J. Successfully Managing Six Sigma Change to Deliver

Six Sigma success requires intelligent management of change and an absolute focus on the delivery of financial benefits. For effective implementation of Six Sigma. Common impediments to the Implementation of Six Sigma include [9]:

–*Maturity*- trying to copy too closely the approach of other exemplars, by not discerning enough or being sold a mechanistic process developed by someone who knew only part of the story.

–*Six Sigma* - is a statistical term- it is out of sharing and collaboration that most innovation emerges. If one has to progress, s/he needs to go out there and share. If one wants to die through stagnation, then keep it to yourself.

Six Sigma is the pulling together of the many different types of tools, techniques and thinking of many "small, medium and large giants" [15]. It is an approach that any organization can use.

V. Case Study

The case study was done for Wills Ware Pottery to assess the impact of Six Sigma methodology in ceramic industry. The organization has a manufacturing plant and a network of sales branches. The main product lines are tableware, insulators and ornaments. Its five major categories of customers are: retailers, hotels and restaurants, badged ware, giftware and industrial.

Tableware products fall under household consumer goods and these are normally distributed through wholesale chains. The ceramic company imports 80% of their raw materials in value terms, such as *glazes, on-glazes* and *stains*, whilst in volume terms, 80% of raw materials are local and these are *clays, feldspar, silica* and other materials.

The organization had a local market share of 55% in the year 2009, 43% in 2010, 38% in 2011, 30% in 2012 and 38% in 2013 coming down from about 70% market share in the year 2002. Imported ceramic ware into the country constituted above 50% market share in 2009 whilst the other small players in the ceramic industry had a combined market share of about 15%.

The competitive imported Asian products have taken many markets by storm, gaining significant market shares where local products had previously dominated, and these include the South African, Zambian and Botswana markets. These developments necessitate the adoption of Six Sigma methodology to grow its local market share to a target of 45% by end of year 2013, from a market share of around 38% as at the beginning of the year. Six Sigma methodology was considered the appropriate tool for the ceramic firm, as it seeks to improve various facets of the operations like cost, customer satisfaction and retention, defects reduction, delivery performance improvement and manufacturing performance improvement initiatives.

A.Major processes

The four major manufacturing processes involved are ***bisquit making, glazing (***glost making**),** ***decorating*** (deco making) and ***hand painting*****:** The defects that occur under every one of these processes present opportunities for improvement which were to be addressed by the Six Sigma in form of product and process improvement.

Bisquit making- major defects are: under-fire, over-fire, edge chip, bottom chip, centre crack, loose handle, and thermal shock. Edge chip, bottom chip, under-fire, over-fire and thermal shock can all emanate from human error during execution of the firing operations and defective equipment.

Glost making- the major defects identified were crawling, lumps, knocked glaze and dirt. Crawling and knocked glaze emanate from defects like improper density, incurred during glaze preparation prior to spraying the bisquit product. This afforded opportunities for improvement. Lumps and dirt resulted from errors incurred during the spraying operations and the root cause analysis availed improvement opportunities.

Deco making- the major defects were identified as dunting, underfire, dirt, stuck, water defect, and cutline. Dunting, underfire and stuck defects arise from defective equipment during firing operation or due to operator error during the firing process. Dirt, water defect and cutline arise from errors incurred during the decal applying operational phase. These defects presented the organization with a multitude of opportunities for improvement.

Hand painting- this process presented defects in the form of dirt, crawling and knocked glaze. The occurrence of these defects is as alluded to earlier.

It was established, that due to the manual nature and individual skills dependency nature of hand painting, the volume of hand painted products was very low, and this constituted about five percent (5%) of the total production volume, while decorated ware constituted around 20% and plain gloss constituted the remaining 75% of production. It was also established that rejects at bisquit level, could all be one hundred percent recycled into the production process, whilst rejects at gloss , hand painted and deco levels cannot be recycled and can only be destroyed or relegated to seconds for sale in the Seconds Shop.

Green make tableware and mug handles are manufactured through the casting process outlined in Figure 4 below:

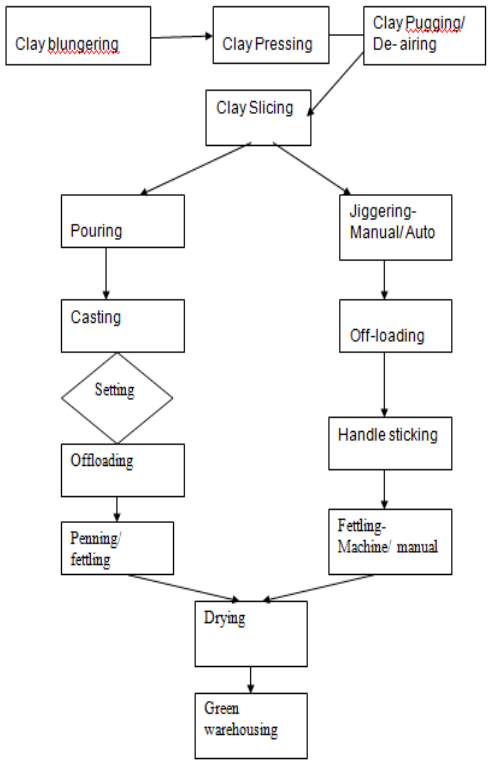

Fig 4.Handle making process

Ceramic products are made up of clay, flint /quartz and feldspar. It has also become possible to make almost any body sufficiently plastic for shaping, either by using bentonite in small quantity instead of using a large amount of ordinary clay, or by using organic binders. Depending on the particular compositions of feldspar, clay and flint in a particular ceramic body, the application or use of a ceramic body can fall into any category that includes: dental porcelain, hard porcelain, Pariton body, floor tiles, translucent porcelain, electrified porcelain, wall tiles and tableware as in Fig 5 below.

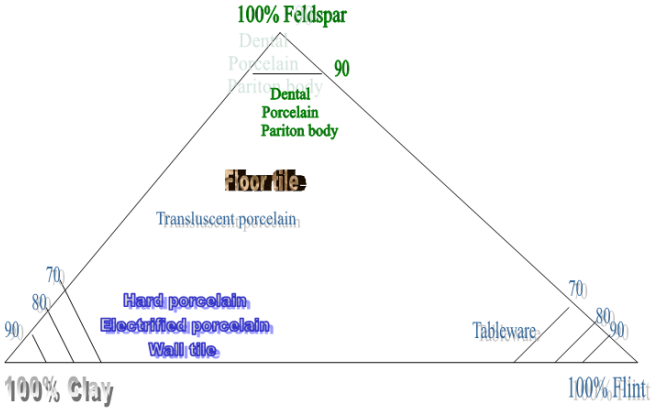

Fig 5. Ceramic body composition [8]

The theory on ceramic materials forms the basis for clay body preparations within the local ceramic industry [8].The two categories of tableware products are domestic ware and hotel ware. In terms of volume in Zimbabwe, i.e. pieces, it is estimated that domestic ware accounts for 87% of the market and hotel-ware about 13%.

In terms of value, the hotel ware share is higher as hotel pieces, especially designed hard wearing pieces, would cost more to manufacture and consequently have a higher sales value. Domestic ware comprises all tableware, serving and kitchen ware used in domestic households. Hotel ware comprises all tableware used in hotels, fast foods outlets, restaurants, canteens, airlines, trains and functions. Fig 6 below shows a sample range of hotel ware products. While Fig 7 gives the sample of mug ware products.

Fig 6. Hotel ware products

Fig 7.Mug ware products

Below is a schematic diagram of the ceramic tableware manufacturing process for the plant in Fig 8.

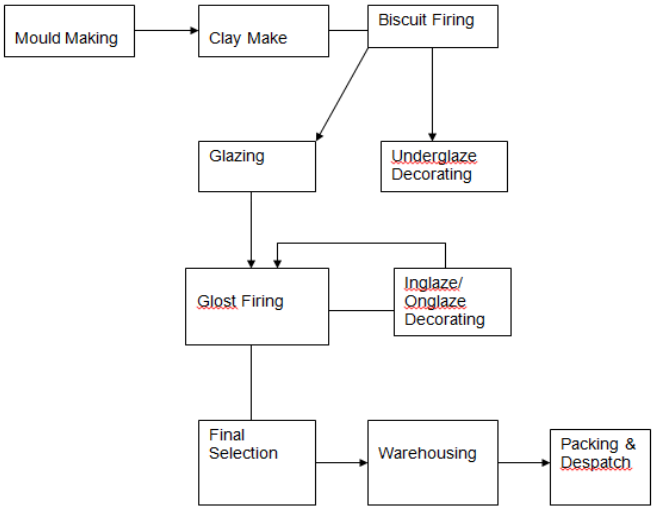

Fig 8.Ceramic tableware manufacturing process overview

Raw materials and other material inputs- Clay bodies (9-15% of production costs): The main raw materials (kaolin, ball clay and silica) to make the ceramic body are all available locally at what is considered an attractive price. High quality clays that may be required to manufacture superior porcelain or china are not available locally, but there is an abundance of clays suitable for the manufacture of earthenware products.

Glazes, stains and transfers (7- 18% of production costs):Glazes and stains are available from SA. Materials for the manufacture of decal transfers are imported, but transfers themselves are produced locally.

Packaging (3- 8% of production costs): Packaged dinner and tea sets intended for resale in the mass market stores require to be packed in sturdy card board boxes suitable for prominent display on the store shelves. This packaging requirement applies products for local market.

Energy (8- 12% of production costs):Energy is required for the kilns, manufacturing, drying, glazing, decorating and handling equipment. Energy for the kilns will be in the form of electricity, Liquid Petroleum Gas (LPG) or coal, or solar energy, or a combination of these resources

Effort was made to get feedback on the usefulness, effectiveness, suitability and applicability of the Six Sigma methodology. All managers and supervisors were encouraged to note on the issues of Six Sigma usefulness, effectiveness and applicability as a competitive advantage package. Observations were made on the processes, products and examination of secondary data was carried out by the researcher for a period exceeding two months. The general responses were jotted down and later ssessed to derive broad opinion polls of the workers on Six Sigma methodology application.

The manufacturing margins improvement model used for identifying products and processes that needed investigation exhibited the following structure. The identifications were spearheaded by the finance department and the products or processes were ranked according to existing margins and potential for improvement.

The major steps in using the model below in Figure 9 included the following steps:

- Identifying the products and cost centers that needed investigations
- Ranking the products or cost centers according to existing margins and potential for improvement

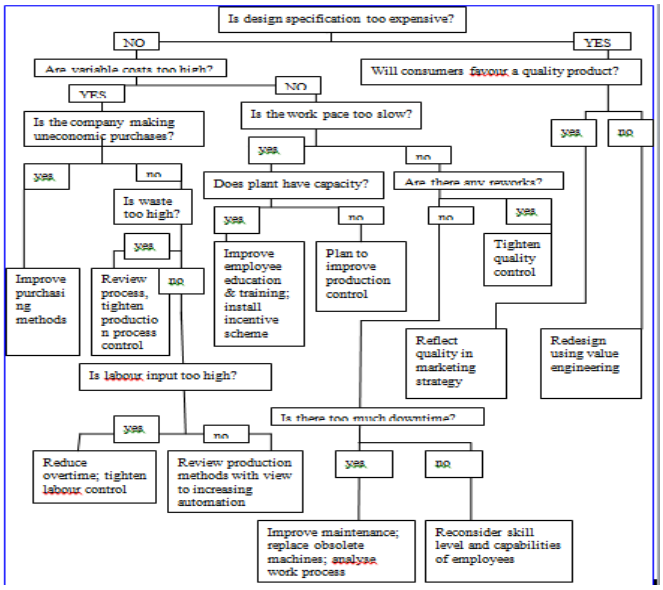

Fig 9.Model for manufacturing margins improvement

During this part of the project, employees, supervisors and management staff along with some customers were interviewed to establish opinions on usefulness, effectiveness, feasibility, suitability and applicability of Six Sigma.

VI. Research Findings

On analyzing the customers and employees' responses to interview questions to find out if the responses supported the idea that the Six Sigma methodology is a useful, practical, original and applicable methodology for competitive advantage for discrete manufacturing enterprise.

A. Data profiling and analysis for customers

i. Information about the Company

The questions sought to establish how customers managed to create the relationship with the company and how they got to know about the organization being capable of meeting their needs. The results show that thirty one percent (31%) of the customers who transacted with the company got to know about the company, through word of mouth of other customers who were satisfied by the product range and service delivery. The contribution shows that satisfied customers market on behalf of the organization. Forty five percent (45%) and twenty four percent (24%) of the respondents disclosed that they got to know about the company through personal visits by employees of the company and through the press and other advertisements respectively

TABLE 4
COMPANY INFORMATION

Adverts	Sales Personnel	Custo mers	Other
24%	45%	31%	0%

ii. Delivery lead time

Twenty two percent (22%) of the customers indicated that delivery lead time is excellent and most of these customers fall into the top twenty (20) customers of the organization, which may mean that they are given top delivery priority. Forty seven percent (47%) indicated that delivery lead time is generally good and they are satisfied with the current performance levels which range between 4 and 6 weeks, compared to the over 10 weeks delivery lead times that were being experienced. Thirty one percent (31%) of the customers cited that delivery lead times are reasonable, but sometimes they suffer delays, since there is reoccurrence of some complaints like receiving broken ware from supplier and receiving incomplete orders, which come late on delivery.

TABLE 5
DELIVERY LEAD TIME

Excellent	Good	Reasonable	Poor	Awful
22%	47%	31%	0%	0%

ii. Product Quality

All the respondents were satisfied with the product quality with nine percent (9%) indicating that the product range and quality is excellent. Seventy three percent (73%) of respondents indicated that the product quality is good whilst eighteen percent (18%) of the respondents concurred that the product quality was satisfactory. Most of the respondents indicated that the products are durable, aesthetic and quite fashionable in line with international trends.

TABLE 6
PRODUCT QUALITY

Excellent	Good	Satisfactory	Poor	Awful
9%	73%	18%	0%	0%

iii. Service Quality

Close to ninety `one percent (91%) of customers indicated that they are satisfied with the quality of service they receive. In their comments, most of them mentioned that even if they are satisfied with the quality of service they receive, however sometimes product breakages and shortages on delivered products occur, and this causes dissatisfaction within customers. Nine percent (9%) of the customers indicated that service quality is not good since there is reoccurrence of some complaints like receiving broken ware from supplier and receiving incomplete orders, which come late on delivery.

TABLE 7
SERVICE QUALITY

Excellent	Good	Reasonable	Poor	Awful
9%	60%	22%	9%	0%

iv. Product pricing

Off all respondents, close to 9% indicated that the product prices were high and these were mainly customers from the low income bracket. Fifty six percent (56%) of respondents indicated that product prices were acceptable and eleven percent (11%) indicated that the prices were low.

TABLE 8
PRODUCT PRICES

Low	Acceptable	High	Unbearably High
24%	56%	11%	9%

v. Employee Performance

Twenty nine percent (29%) of customers disagree that employees are properly trained because they claim they are not given enough attention especially with regards to complaints aimed at elimination/reduction of ware breakages and shortages. Thirty eight percent (38%) of customers tend to agree that employees of are properly trained and these customers who confirmed this are mostly hoteliers and well established retail customers whose

strong links with the organization date back for five years or more. Thirty three percent (33%) of respondents were found to be in agreement that the employees are properly trained.

TABLE 9

STAFF TRAINING

Strongly Agree	Agree	Disagree
33%	38%	29%

vi. Tenure with the organization

The question sought to test customer loyalty for the organization and to evaluate how loyal customers benefit the organization. From the above analysis the number of years that customers have spent with the organization reflect loyalty and a long relationship that has been established. Thirty six percent (36%) of the customers have maintained a relationship with the organization for at least 10 years. Thirty three percent (33%) maintained their business with the organization for a period between three and ten years and below.

TABLE 10

TENURE

Three Years and below	Between three Years and ten years	Ten years and above
25%	42%	33%

vii. Frequency of transacting with the organization

The question sought to find out how often customers make transactions with the organization. If they frequently conduct transactions with the organization, then this qualifies that customer satisfaction is a critical factor for the company's growth and survival. Twenty five percent (25%) of customers indicated that they transact with the company once in a while. Forty two percent (42%) mentioned that they transact with the organization on regular basis and fifteen percent (15%) indicated that they frequently transact with the organization.

TABLE 11

TRANSACTING FREQUENCY

Once in a while	Regularly	Frequently
25%	42%	33%

viii. Factors considered by customers in their dealings with the company

Thirty one percent (31%) of the customers feel that product quality is the most important factor in the ceramic tableware sector. However customers also ranked product prices as the other most important factor. Eighteen percent (18%) of customers indicated that delivery/service quality is the third most important factor with a lot of them commenting that delivery efficiency and customer care, including complaints handling are critical factors. Sixteen percent (16%) and four percent (4%) of customers indicated that distribution efficiency and responsiveness rank fourth and fifth respectively in terms of importance and they commented that these are not very critical factors.

TABLE 12

IMPORTANT FACTORS

Product Quality	Product Price	Delivery Service Quality	Distribution efficiency	Responsiveness
31%	31%	18%	16%	4%

B.Six sigma implementation effect on human resource

The organization came up with team orientation and people management as a strategy of team building and rewarding excellent employees. These teams include Six Sigma project teams, problem solving teams, quality improvement teams and management teams. The Human Resources manual showed that, in a move to reduce costs and unnecessary expansion, the company implemented a turnaround strategy and streamlined manning levels. The histogram below illustrates how the organization has attempted to reduce their costs through streamlining

Fig 10.Manning levels over the years (2009 to 2013)
Source: Human Resources Manual – 2013

C. Effect of Six Sigma on performance

The performance emanating from the application of Six Sigma methodology was verified basing on specific performance metrics as stated below and validated by the researcher through examination of real time operational outputs as workers executed their duties and verification of operational records.

Market share - rose to 38% as at end of 2012 from 30% at the end of 2011 as a result . As at March 2013 the market share was determined to be at 42%, which is a positive stride towards their target.

Gross profit margin - was at 70% as at March 2013 as compared to below 45% in 2012.

Return on profit - was averaging 16% as at March 2013 compared to an average of 12% in 2012.

Record productivity level - of 800 pieces per employee per

month was being achieved as at March 2013 compared to previous record level achieved in 2012 of 500 pieces per employee per month, and still using the same equipment and technology.

Customer order delivery cycle times - as at March 2013 were that 37% of orders were delivered within 4 weeks,34% within 5 weeks, 25% within 6 weeks and 4% within 7 weeks, as compared to the delivery cycles that ranged from 6 to 14 weeks as at March 2012, with around 50% of orders being delivered within 10 weeks.

VII. Research Discussion

For the ceramic tableware industry, the key survival strategy is innovation or continuous improvement, and this is what Six Sigma entails. No tool can succeed in isolation from other tools. Other supporting frameworks like Reliability Centered Maintenance (RCM) were necessary, as well as the likes of Optimised Production Technology (OPT) and the ISO 9001 Quality Management System which was in existence before the Six Sigma methodology implementation to aid manufacturing efficiency. The factors considered as important by the customer have all improved, and these are product quality, product price and delivery/quality service. This has impacted positively on the customers as their satisfaction levels have been raised.

VIII. Recommendations

A. Six Sigma Experts

Six Sigma methodology implementation requires the availability of Six Sigma Master black belt experts or information centers for information diffusion. Six Sigma information centers for training Six Sigma experts.

B. Implementation Process Standardization

The fact that there are no standard manuals for the implementation of the Six Sigma methodology means that the success of the implementation program depend in part on the skill and knowledge of the Six Sigma centers; and bench marking against other companies that would have successfully implemented the methodology.

C. Audit Trail Procedure

Accredited firms can also utilize the Six Sigma accreditation as a marketing tool and assurance aspect to their customers. Internal audit procedures can also be developed by individual organizations to ensure the internal systems' compliance to the methodology requirements.

D. Six Sigma Methodology Customization

Originality is of strong essence for the effective implementation and application of the Six Sigma methodology. This aspect was strongly recommended to the company for consideration as dissatisfied customers will spread negative sentiments about an organization to the detriment of the organization.

E. Integrated Knowledge Management System

This involves linking the Six Sigma methodology information to all the company's information system. The Six Sigma methodology must define the culture of the organization, it should be the DNA of the organization, meaning that the Six Sigma methodology information is critical in the decision making process. Decision Support System (DSS) of the organization should be guided the Six Sigma methodology as all activities are geared towards customer satisfaction, continuous improvement and financial gains. Thus both the organizations' Decision Support Systems and Executive Information Systems (EIS) should exude strong Six Sigma methodology traits if ever the methodology should remain the DNA of the organization.

IX. Conclusion

The study has revealed that the Six Sigma methodology plays a pivotal role in the organization's survival, growth, professional image building, customer satisfaction, customer retention and loyalty. It was established that there is a direct relationship between the sales volume and the Six Sigma methodology. This suggests that a strategy-oriented organization is better positioned to deal with environmental changes than a non strategy-oriented organization. The findings have also revealed that consumer perceptions on company image vary depending on the implementation of the effective strategies or methodologies.

Observations at the Case Study company revealed that Six Sigma methodology application is still at its infancy, as benchmarking is still being done with South African companies.

The other point that was uncovered was that, like any new approach or system being adopted, the success of the Six Sigma methodology as a real time competitive advantage improvement management system, lies on top management commitment. Top management commitment is key to successful implementation of the methodology as a truly competitive advantage package in the industry's discrete manufacturing sector. Other important requirements for successful Six Sigma application include the availability of resources such as foreign currency, skills such as project management techniques, and time for projects impli3mentation.

With these pre-requisites satisfied, Six Sigma can be effectively used as a competitive advantage option by local discrete manufacturing industries through its provision of a compendium of applicable continuous improvement practices that are readily available from prevailing information sources.

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