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Exploring the Implementation of 3-Dimensional (3D) Technologies in Clothing Manufacturing Industries in Zimbabwe

Dzikite C.
Lecturer, Department of Clothing and Textiles Technology,
Chinhoyi University of Science and Technology, Zimbabwe
Muza D.
Fashion Designer, Department of Clothing and Textiles Technology,
Chinhoyi University of Science and Technology, Zimbabwe
Dandira T.
Lecturer, Department of Clothing and Textiles Technology,
Chinhoyi University of Science and Technology, Zimbabwe

Abstract:
With an era of fast fashion evolving, the clothing manufacturing industry in Zimbabwe is facing great challenges to design and produce fashion products within a short time to meet customers' demands. 3D software technologies have been identified as tools that can make it possible to design and present products virtually without physical samples. The purpose of this qualitative case study was to explore the extent to which clothing manufacturers in Zimbabwe have implemented 3D technology in the manufacturing system. In-depth interviews and observations were used to elicit data from production managers of forty clothing manufacturing companies. Data was presented in narrative form and analysed thematically. The study established that out of the companies that were studied thirty-two companies did not use any form of new technologies like 3D nor 2D in their manufacturing while six of the companies used 2D technologies and two companies employed 3D technologies within their organizations based outside Zimbabwe. The manufacturing practices of the companies tend to differ depending on the type of technology used. The study concluded that clothing manufacturing industries in Zimbabwe had implemented 3D technologies in their manufacturing to a very limited extent. The high cost of purchasing and managing 3D technological equipment was concluded as one of the major barrier that limited majority of the companies in Zimbabwe from implementing 3D technologies. Lack of experts and technicians to maintain the 3D technologies were found to be another challenge in the process of implementing 3D technology in the clothing manufacturing companies. From the findings of the study, it was recommended that the government of Zimbabwe should support the local clothing industries with loans and consider waving import tax for technological equipments so as to enable companies to purchase the technologies needed for manufacturing. Clothing manufacturing companies in Zimbabwe should have a co-operate plan to train experts regionally or even internationally who can operate the CAD systems that are of importance to the clothing manufacturing systems. Universities of science and technologies should train professionals who are innovative to meet current development and technological needs of the clothing industry.

Keywords: *3D technology; product development; clothing manufacturing industry; fast fashion; virtual fitting.*

1. Introduction

In this millennium era, fashion trends change rapidly making styles and design short-lived. Fashion consumers have become more demanding and always looking for new styles in the retail shops more frequently. This means that clothing manufacturers have to look for innovative ways to deliver new fashion product more frequently (Puri, 2013). As noted by Burns and Bryant (2007), 'an era of fast fashion has evolved that is characterised by the fast pace of the fashion industry and its desire to satisfy the constant demands of the savvy consumers. It has been observed that customers are ever looking for a variety of fashion products within a very short time. This high demand ends up affecting the lead time from concept to consumers. This is presenting great pressure on the Clothing and garment manufacturers to carry out the manufacturing process in lesser lead time (Kumar, 2012). The Clothing and garment manufacturing process comprises a number of stages such as design development, product development, laying and cutting, sewing, finishing, packing and dispatch. In the past decades, most companies globally have been manufacturing their fashion products forecasting on two seasons that is spring/summer and autumn/winter. This was done so as to allow time to evaluate the garment as it passes through

the various stages before reaching the final customer. However, the contemporary customers demand the latest fashion frequently. To satisfy this demand, Barnes and Lea-Greenwood (2006) reported that companies have increased seasons significantly and some are reported to work towards more than ten seasons a year. Furthermore, it is stated by these authors that some of these companies can design, produce and dispatch a garment to retail shops in less than three weeks. This implies that the supply chain is now driven more by customer.

It is noted by Goesth (2013) that product development is the most crucial stage of the clothing and garment manufacturing process. Jefferson, Power, Jess and Rowe (2012) also affirm that the 'time taken for product development can be as high as seventy percent in a typical garment lifecycle, whilst the actual manufacture only corresponds to thirty percent'. This is because in this stage all aspects of market research, idea generation, development of a range, technical specifications, pattern development and manufacture of a prototype which will be approved for fit and style using a live model are done (Jefferson, etal, 2012). If any modifications to the prototype sample are needed, appropriate changes will be made resulting in pattern adjustment as well. All these stages results in a very long process that incurs cost as well for after every adjustment that is made, the pattern pieces has to be re-worked again and again. This is done to ensure the garment comes out perfectly in terms of colour, design, fabric, colour and fit. Again these stages are necessary to ascertain that a few errors would be made in the actual mass production stage.

With increasing competition, Varukolu, (2007) advises that quick response is the main key factor to succeed in fashion business in this fast fashion period. Clothing manufacturers that need to remain competitive have to invest in different technological software solutions to shorten the product development process. By accepting technology, manufacturers can exceed their competitors by cost cutting and increasing profits (Kumar, 2008). It has been established by Kozar, Rudolf, Cupar, Jevsnik and Stjepanovic (2014) that 'the implementation of 3D CAD systems for garment pattern design has decreased the production of real garments' prototypes by twenty percent'. Thus, 3D technology is a type of software that enables companies to work their designs and approve them digitally with minimum sample making. In developed countries, the use of 3D software packages has become the order of the day. It has been acknowledged by Adwoa-Oppong, Biney-Aidoo & Biney-Adowa and Antiaye (2013) that countries like China, United States of America and France have developed their economies through the textiles and clothing fashion industries through the use of 3D software packages which are faster. This is how their clothing fashion designs get into the retail shops much faster than in the past, enabling companies to capture continuing sales and compete in the global fashion industry. These giant clothing manufacturing industries use more of 3D software packages than human labour and clothes are produced faster and with less rejects.

The African clothing manufacturing sector is characterized by significant variations in the adoption of emerging technologies, ranging from very low use of mainly basic technologies to run office applications to intensive use encompassing completely integrated systems and high end computer aided design facilities (Adowa-Oppong, etal, 2013). Owing to the nature of clothing manufacturing, which is labour intensive and makes heavy use of sewing machines, the use of technologies is mostly limited to the administrative functions of companies. It was noted that although a number of commercial clothing CAD software packages are now providing 3D modules such as 3D Runway by Optitex, V-stitcher by Browzwear of Gerber technology or Modrias 3D Fit by Lectra, the African clothing fashion industry somehow hesitates to adopt these 3D features in the design and product development process(Mbaiwa, 2013).

The Clothing manufacturing industry in Zimbabwe used to contribute a high percentage of the country's total gross domestic product but facing many challenges. The clothing sector in Zimbabwe comprises of registered companies who are members of the Zimbabwe Clothing Council (Youmans, 2012). While the Zimbabwe economy is seen to be recovering from economic hardship, only a small number of clothing manufacturers, less than ten percent, manufacture for export despite the growing regional market and inroads in past years into new markets mainly in Europe(Youmans,2012). Clothing manufacturing industries that continue to excel globally and regionally in today's competitive business understand the importance of 3D technologies in their manufacturing. Continual utilization of a lengthy product development process will make it difficult for companies to catch up with the fast-selling innovative fashion products. It is with these observations that the researchers were motivated to investigate the extent to which clothing garment manufacturing industries in Zimbabwe have implemented 3D technologies. There is so far no study that has been undertaken taken on 3D technologies in Clothing manufacturing industries in Zimbabwe.

1.1. Statement of the Problem

Over the last few years the global clothing market has undergone significant change, forcing clothing manufacturers, more than ever before, to focus on customer needs and upon their own internal efficiency in order to continue to compete effectively. While the Zimbabwe economy is seen to be recovering from economic hardship, only a small number of clothing companies, less than 10%, manufacture for export despite the growing regional market and inroads in past years into new markets in Europe (Youmans, 2012). The Zimbabwe clothing industry is perceived by fashion consumers to be small, stagnant if not deteriorating. There have been complaints from the consumers regarding the clothing manufacturer's service and product delivery not tallying with the consumer needs. As a result the clothing manufacturing companies have experienced stiff competition from the cheap fashion imports from other international clothing companies that are utilizing a variety of emerging technologies to capture continuous sales wherever they are needed(Youmans, 2014). Hence the needs to establish the extent to which local manufacturing industries in Zimbabwe have implementation 3D technologies. The study was therefore guided by the following research questions:

- To what extent had Zimbabwe clothing manufacturing industries implemented 3D technologies in the garment manufacturing process?
- What challenges were faced by Zimbabwe clothing manufacturing industries in implementing 3D technologies?

1.2. Limitations of the Study

The research was delimited to Clothing manufacturing industries in Zimbabwe hence the results may not be statistical generalized. This study was however, intended not to prove but to improve the situation of clothing manufacturing in Zimbabwe.

1.3. Theoretical Framework

This study was guided by one theory that has emerged to improve response time of supply chains and their management called Just in Time (JIT). JIT is a method of production and inventory cost control based on delivery of parts and supplies at the precise time they are needed in the production process, (Kumar. 2008; Goesth, 2013). This entails that the focus is on minimizing waste and improving quality thereby advocating for a lean approach to production through the use of advanced and emerging tools to achieve the goal. The overriding aim is to improve the time to reach the market and satisfy customer requirements, and increase profitability (Jones, 2006). According to Fabian and Morgenstern (2009) good supply chain management and communication is the key to this success, and dedicated information technology systems like the use of 3D technologies are imperative to provide the required information. In addition, through the use of 3D technologies companies can get the right products to the right customers at the right time. To note as well design decisions regarding garments, such as design features and fabric choices undertaken within the design and product development can impact on the supply chain responsiveness and costs (Khan, Christopher and Burns, 2008). Changing customer needs can be met quickly through getting the right information at the right time by using fast and emerging technologies. This gives the company a good competitive advantage

2. Related Literature

2.1. The Clothing Manufacturing Industry in Zimbabwe

The Clothing manufacturing industry in Zimbabwe is involved in the designing and manufacturing of clothing and other accessories and then providing them to the consumers. The clothing manufacturing industry is a big part of the clothing and textiles sector. The industry is involved in producing men's wear, ladies' wear, corporate wear, school wear and work wear. It is also involved in producing clothing for the infants. The clothing manufacturing sector currently produces an estimated 18, 7 million garments a year, against a peak of 135 million garments in the 1990s. According to Youmans (2014) the sector had one hundred and five companies that were operating formally as in 2014. Capacity utilization was around 50 percent but experiencing stiff competition from imports. Despite advances in technology, still this industry is labor intensive. Most of the clothing manufacturers are performing only the role of entrepreneurial by providing the functions such as buying raw materials, designing cloths and preparing samples, arranging for the production and distribution of the clothing and then marketing of the finished goods.

2.2. Importance of 3D Technologies for Clothing Manufacturing

The Clothing manufacturing industry has been attracted to use 3D technologies in clothing product development process to strengthen the collaboration along the supply chain and shorten the product time to market. As described by Lim (2013), 3D technologies are software packages that can allow one to make construction with three dimension that is width, length and height. Vilumsone and Dabolina (2013) indicate that the use of 3D technologies in the different processes of the clothing manufacturing industry is necessary to reduce the costs of a product and raise competitiveness. Worth of noting is the idea that 3D technologies reduce design and pattern development time and the number of physical samples required. Thus, according to Vilumsone and Dabolina (2013) this shortens lead times for manufacture of new products. This explains that 3D designing systems excludes the time taken for manual preparation of patterns and creation of layouts. With 3D software, it is possible to create computer aided garment constructions, gradations and then create a virtual first pattern of the model. As elaborated by Sul and Kang (2004), data can be captured through 3D body scanners and imported into the 3D software to recreate an exact shape of a human being. Fabric properties of mass, thickness, bend, and stretch, are then associated with fabric images to reproduce a realistic visualization of a garment, and fit can be analysed through pressure and tension mapping. Furthermore, images that enhances the visual display, such as trims and seam details, enables the designers the opportunity to assess proportions and aesthetics prior to a tangible prototype being produced. Razdomahins (2007) acknowledges that 3D technologies provide the possibility to avoid small operations and manual work, to raise precision, productivity and organize information flow in a collaborative and transitional environment.

2.3. 3D Technologies in the Clothing Industry

For the past three decades, 3D technology use in the fashion industry was limited to a few adventurous manufacturers, and was largely dismissed by the apparel sector. Today, pressure in the clothing market to produce more collections under shorter lead times has led to a veritable 3D revolution affecting the clothing industry as a whole (Mattila, 2013). In the last few years ago, 3D technology has gained acceptance as both a design, product development in the clothing industry and is also recognized for its effectiveness in streamlining product development, and is applied throughout the supply chain. The 3D CAD systems link with available 2D pattern CAD systems. Vilumsone and Dabolina (2013) categorized 3D software systems in to three types. Though this software can be categorized into types depending on the different processes done, the software packages can be integrated to cover all the processes from designing to product management.

The first type of 3D technology involves garment designing system that allows one to create the shape of a garment, identify dividing lines, and create patterns in a 3D environment following a layout in a plane (Vilumsone and Dabolina, 2013). The Assol 3D software

is one example of a clothing design system. This is in cooperation with Auto Desk and was created on the basis of AutoCAD. It is stated that the module provides the parametric designing of garment templates, parametric gradation of templates, and digitized mannequins for 3D designing of limited assortment (Park& Lee, 2011). The system allows building the cloths in 3D space with completely controlling the appearance of the virtual product, degree of the fit and shape of the model line.

Another example of the 3D software system that can be used for designing is the V-Stitcher by Browzwear (Lim, 2013). V-Stitcher is 3D garment visualization and drapes simulation software from Browzwear and was developed in Israel. It can use one's mass, weight and fabric type as input to generate a realistic image of how the design will look like. Gerber of United States of America has merged this software with its pattern design, grading and marker making software AccuMark, and now available on the market as AccuMark V-Stitcher (Rosenberg, 2013). V-Stitcher has the capability of producing virtual prototypes from 2-dimensional (2D) pattern pieces and then assembling them directly on a virtual mannequin. V-stitcher was created for pattern makers that need to design and create patterns for new garments while the V- styler had been created for fashion designers who want to work on the design and colour of the clothing (Mattila,2013).

Furthermore, Bernina My Label that was developed in Switzerland could be used as a designing software system that feature twenty intergrated different styles based on parametrical mannequin (Vilumsone and Dabolina, 2013). The styles can be changed for individual measurements. It can be used to make slight design details such as making skirt longer, widening a collar. The garment can be virtually embellished with stitches, embroidery and buttons to vary the style properties. The model can be dressed and undressed as many times until the desired reflection is achieved. The advantage of this type of software package is that it can be saved; emailed and printed hence design can be bought and sent to different manufacturers.

The second type as proposed by Vilumsone and Dabolina (2013) encompasses the garment imitation systems that allow one to perform a virtual fitting, evaluate the external appearance and proportions of the garment. This means the garment is created in 3D by joining patterns constructed in a plane, creating an imitation of the garment with the intention to ascertain the conformity of the outer appearance to the expectations. An example of such software is Lectra Modaris 3D Fit software. It combines the accuracy of CAD with virtual product visualization, providing the best visual simulation capabilities available for virtual prototyping. As commented by (Lectra, 2014) Modaris 3D Fit is unmatched in its ability to control garment fit, validate styles designs and specifications, and accelerate approvals for entire collections. It constitutes a major CAD breakthrough and enables simulations and validations of styles, fabrics, motifs and color ranges. It allows pattern designers to check garment fit in various fabrics and sizes. It provides virtual review of prototypes between brand and subcontractors (Rosenberg, 2013). Modaris 3D Fit combines with product life cycle management hence this integrated software can cover the entire value chain from design to manufacturer to managing the collections lifecycle. According to Lectra, (2014), the software package facilitates the importation of pattern files and the digitalization of paper patterns. It also enables users to perform basic modifications, high quality grading in all sizes and pre-production preparations.

Still in this category 3D Runway by Optitex has been noted as another software that can perform a virtual fitting for apparel that suit any model as well as pattern designs options (Park & Lee,2011). Optitex has been recognized as a leading provider of 3D Virtual Prototyping & 2D CAD/CAM software solutions for the apparel. 3D virtual tools provided by Optitex enable the user to lower costs, quicken time to market, and become more competitive. Optitex offers a number of products that can be used during the various stages of pattern making, grading and marking (Baur, 2013). It is recognized as a powerful pattern design system which has many versions, makes very easy to create new styles, or use existing patterns to design patterns. OptiTex also feature 3D Runway garment simulation software package. This software package can support both 2D-to-3D simulation and 3D-to-2D simulation unwrapping. The 3D Runway software can allow designers to create a virtual runway show letting the designer analyses fabric behavior while a model is making her strides on the catwalk. The use of Optitex 3D Runway suite of tools makes virtual to become real.

TUKA3D was also identified as another 2D-to-3D simulation software suite that accepts 2D pattern pieces drafted separately to produce digital garment prototypes (Volino and Thalmann, 2006). It was developed by Tukatech in USA. It can generate animation and a virtual catwalk of dressed models to facilitate evaluation of fit and style. In addition, it is equipped with a physical tension-mapping tool for the purpose of evaluating the looseness and tightness of virtual clothing on the mannequin. It supports online virtual fit sessions across the globe among the partners using the same systems and facilities to make dynamic storyboards for presentations purposes.

The 3D CAD system Staprim from Russia is designed for the loose fitted garments such as coats, jackets, dresses and uniforms for mass production as well as individual product design (Sayem, 2013). The patterns of cloths are created automatically by laying out the surface of the constructed model from three photos on a plane. The process from the idea to the layout is computerized by merging the 3D CAD system Staprim with traditional 2D CAD. This system is very suitable for creating different uniforms, since it has a unique option of creating well set construction for different individual figures, but only at the basic level not for special feature designing.

The last type includes those that are used for imitation of the garments' appearance. The system allows changing the 3D sketchor photograph to evaluate the appearance of the garments' model with visually different types of textile materials. Vidya by Assyst is such one type of 3D draping software which can be used in the clothing industry for product-development and virtual. According to Baur (2013), Vidya enables the real-time simulation of garments, simulation of material properties and virtual fitting of 2D garment patterns on a 3D body model. It works on the basis of 2D to 3D design principle. The apparel appearance imitation systems are suitable mainly for making catalogues and specialist communication to verify the visual conformity of the textiles with the particular model. To create the reality of the apparel perception shading of a photograph is spread over the fabric in the image in a way that the direction of the pattern conforms with the pattern direction of the fragment defined with the help of a net structure.

Wu, Mok, Kwok, Fan and Xin (2011) studied the reliability and usability of 3D technology in garment fit evaluation. This study tested the effectiveness of using 3D scans of clothed participants in the fit analysis process and pointed out that 3D scan was of potential to substitute live fit models. Bye and McKinney (2010) further investigated the reliability of 3D scan model as a fit analysis tool by comparing it with a live model and found that though fit can be virtually tested with 3D scans though there are some concerns about its accuracy in some specific locations. It has been noted from this section that all the different types of 3D software were developed outside Africa; hence it is imperative to examine the extent to which Zimbabwe clothing manufacturing companies have implemented such high technological software for their manufacturing systems.

3. Methodology

3.1. The Design

Given the qualitative stance that was adopted in the study and the nature of the research questions, the researcher utilised a descriptive case study design as the most appropriate research design for the study. As defined by Yin (2012) a descriptive case study strives to describe, analyse and interpret a particular phenomenon with a view to produce knowledge which might inform the Clothing Manufacturing companies in Zimbabwe on the role of 3D technologies in garment manufacturing. The researchers were assigned to different cases so as to study the implementation of 3D technologies in the clothing manufacturing industries without imposing preconceived notions. The cases provided rich, contextual insights into the dynamics of issues related to use of 3D technologies in clothing manufacturing industries.

3.2. Sample and Sampling Techniques

The clothing manufacturing industry in Zimbabwe is a big part of the clothing and textiles sector. According to Youmans (2014) the sector had 105 companies operating formally. A sample of forty companies was purposively selected. The companies were selected from five major cities of Zimbabwe. The companies that were selected were involved in producing men and women's formal wear, casual wear, corporate wear, school wear, work wear, lingerie and underwear.

3.3. Instruments

The researcher utilized a combination of data collecting methods namely in-depth interviews and observations. These were used in order to collect information to determine facts and to collect views, opinions and perceptions from the targeted sample.

3.4. Data Presentation and Analysis

Data from the study was presented in narrative form and inductively analysed to discover important themes and inter-relationships.

4. Findings and Discussions

The discussion covered the findings of the two main research questions. These findings were interpreted using data collected through in-depth interviews and observations.

4.1. The Extent to Which Zimbabwe Clothing Manufacturing Industries Had Implemented 3D Technologies

The first research question sought to examine the extent to which Zimbabwe clothing manufacturing industries have implemented 3D technologies in the manufacturing of clothing fashion. Interviews were conducted with the design and production managers of forty clothing manufacturing companies that were selected as the sample. The results were analysed under the following themes: characteristics of the companies; type of 3D technology used and manufacturing practices among the companies.

4.2. Characteristics of the Companies Studied

The findings revealed that most of the companies that participated in the study were in operation between five to more than fifty years. The companies ranged from small enterprises to large companies that were registered with the Zimbabwe Clothing manufacturing association. It was obtained that two of the companies were division of multinational organizations that were based overseas. These two companies typically employ approximately seventy to hundred employees here in Zimbabwe. Their products varied from gents and ladies smart and casual wear for various retail shops around Zimbabwe. They had connections regionally. Thirteen companies focused on corporate wear and school wear. Majority of these companies were small enterprises. Four companies focused on children's wear ranging from the newly born to early teens. Nine of the companies ventured on ladies formal, casual and high class fashion while four companies focused on men's formal wear. Three companies specialized into casual wear for all age groups. Four companies specialized into sportswear and lastly one company manufactured lingerie and underwear for different target groups.

4.3. 3D Technologies in the Clothing Manufacturing Companies

It was obtained that among the companies that were studies thirty-two of the companies indicated that that they did not use any form of new technologies like neither 3D nor 2D in their manufacturing. Six of the companies use 2D technologies while two companies indicated that they employ 3D technologies within their organization based outside Zimbabwe.

Among the thirty-two companies that indicated that they did not use any form of new technologies like 3D nor 2D in their manufacturing, it was revealed that the use of technologies like Microsoft office packages were reserved for administrative purposes

only. The findings showed that these companies follow a similar path of manufacturing, irrespective of the type of garments they produce. It was noted that there is nothing like initial designing in all of these companies but product development within the companies start at the pattern making stage for the buyer brings an already made sample into the company as reflected by the excerpt below from one of the participants:

- 'Aaa we do not design here but our buyer looks or even buys a design ,, an already made sample in fact, from other designers locally or even overseas, then we start to manufacture'

This implies that most of these companies make use of already made design from the net and at times subcontract designs from other countries which they use to start the process. From this sample, patterns are then created followed by making another prototype sample which will be used for fit using the targeted clients here in Zimbabwe. Graded samples are then created manually and approved before mass production is authorized. According to the participants, the manufacturing process would take two to three months. This implies that these companies would not stand the stiff competition from the global clothing manufacturing giants that make use of advanced technologies. Most of these companies indicated that they relied on local customers only.

It was evident from the results that six companies were using software such as 2D pattern CAD technology namely Gerber, AutoCAD and Photoshop. It was noted that standard software were being utilised in the form of design and drawing software such Microsoft office packages such as Mac-paint, adobe illustrators and other software such as CorelDraw and vertigraph. Worth of noting was that participants indicated that their designs came from the customers. It was obtained that the designs were developed in the design and development department. A sample garment would then be made and submitted to the customer. The paper patterns would be created, checked and then digitalized on 2D digitalizing table. The data would be input into computer for the patterns to be graded. All the technical specification would be done followed by layout, cutting and finally mass production. It was revealed that a lot of time was saved on pattern making and grading hence these companies reported that they had reduced lead time to six or eight weeks depending on the orders.

It emerged from the findings that two companies that used 3D CAD technology indicated it was slowly emerging as a very useful tool. These two companies indicated that they were divisions of organizations based in Europe and USA hence all their product development processed through 3D technologies was done overseas. It was reported by the participants that the companies were linked to Gerber and Lectra respectively as they both own the 2D version of the systems here in Zimbabwe. One of the production managers expressed that:

- 'Who would assemble and work with such 3D here in Zimbabwe, everything is done outside, our job is to produce only and this is faster and easy for us'.

This excerpt implies that these companies had all their designs sent and the prototype virtually manufactured in the overseas countries. In other words fashion designs originate from these overseas countries. The managers indicated that they at times receive all technical specification online with all grading of the patterns done in the outside countries again .It was indicated that, at times patterns would be graded at the company to cater for different targeted local clients and the garment quickly passed to production. It was however not ascertained from the production manager of these two companies as to the exact procedure that was employed in the 3D virtual development of the sample that occurs overseas as they lacked a thorough understanding of the process. In any case, they indicated that the actual manufacturing process took a very short period like just three to six weeks to deliver their product to the retail shops locally, regionally and to some clients in the overseas countries. These perceived views were in line with Vilumsone and Dabolina (2012)'s observation that the use of 3D technologies in the different processes of the clothing manufacturing industry is necessary to reduce the costs of a product and raise competitiveness. It was found that these two companies have developed a total up-to-date quality control system and procedures comparable to European standards and had the ability to deliver goods and services within the customer's legitimate quality expectation.

4.4. Challenges Faced in Implementing 3D Technologies

The findings revealed that most of the participants indicated that the companies had challenges in fully implementing 3D technologies due to the lack of finances to purchase the equipment. This was in line with Farrell (2007)'study, where it was pointed out that transportation of imported equipment, tariffs charged for electricity added to the cost thereby making such technologies unaffordable to many companies. Instead more than half of the participants indicated that they would opt for 2D technologies in their companies as they indicated that they were user friendly. It was highlighted by the participants that the government was not forth coming in giving the companies loans to boast their operation hence would continue to use the available human labour as the best deal they could get.

Another challenge that emerged from the findings was that of lack of knowledge and technical skills regarding the use of 3D technologies in clothing companies. It was obtained that there was extreme lack of experienced experts who had the practical experience to manage the 3D technologies as one of the participants was quoted saying;

- 'Not even one will be able to use the technology, look right now we even have problems with these patterns grading CAD, and these universities are not producing our experts, hey'.

This revealed that there was a great shortage of quality personnel and technician to maintain the technological software that was required in the clothing manufacturing industries in Zimbabwe. It was even noted that in some small clothing manufacturing enterprises, experienced technical staffs generally knew little of computers. Zhe (2013) even found out that because of the complexity of the original 3D programs, fashion designers who found the technology too difficult resisted adopting it. Zhe indicates that one of the most important 3D garment creation stages is constructing which is the reproduction of a spatial model that is the clothing and

constructing it on a plane. This transformation has to be reflexive when joining the parts of the construction when a garment is originated hence requires an experienced expert.

5. Conclusions

The study concludes that the high cost of purchasing and maintaining both 2D and 3D technological equipment was a barrier that limited majority of the companies in Zimbabwe from implementing the technologies in the manufacturing process. It was also concluded that companies preferred 2D pattern CAD technologies in their manufacturing as there was very little of initial and original designing in Zimbabwe. Lack of qualified technicians and experts to manage the 3D technologies was found to be another challenge in the process of integrating 3D technologies in the clothing manufacturing by companies in Zimbabwe.

6. Recommendations

From the findings of the study, the researchers recommend the following; the government of Zimbabwe should support the local clothing industries with loans so as to enable them to purchase equipment and technology. The government should consider waving import tax for technological equipments for companies. The study recommends that high costs of acquiring equipment could be reduced by adopting measures such as locally assembling software to avoid over reliance on costly imported software. The government should investments in custom-made technological materials that are relevant for the Zimbabwean economy. Clothing manufacturing companies should have a co-operate plan to train experts regionally or even internationally who can operate the CAD systems that are of importance to the clothing manufacturing systems. Universities of science and technologies should train professionals who are innovative to meet current development and technological needs of the clothing industry. In order to promote CAD applications in the clothing and textiles industry, software companies, clothing companies and universities should work together to solve the problems affecting the Zimbabwe Clothing manufacturing industry.

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