Application of computer aided technologies in the clothing and textile companies in Gauteng

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Abstract

The purpose of this study is to establish the extent to which computer aided technologies are applied in the clothing and textile sector in Gauteng. The study was empirical, quantitative and non-experimental research. Data was collected through a cross-sectional survey that was conducted on one sample of clothing and textile companies. The surveyed companies were identified through purposeful sampling. The participating companies were a mixture of small, medium and large companies. The data gathering tool was a self-administered questionnaire. The computer aided technologies investigated are; computer aided design, computer aided manufacturing, computer integrated manufacturing, electronic data interchange, electronic point of sale, and internet. Findings from the analysis show that the applications were not equally popular. The most popular packages were the internet and computer aided design. Electronic point of sale, computer aided manufacturing, and electronic data interchange had a fair number of users. The least popular technology was computer integrated manufacture. These computer applications are not only relevant to the clothing and textile sector. They are equally useful in other sectors. The technologies help reduce the cycle times from design to manufacture and manufacturing companies can accept customer orders closer to due dates.

Keywords

Computer aided technologies, clothing and textile companies, Gauteng, cross sectional survey, competitiveness

1. Background

The Agreement on Textiles and Clothing (ATC), introduced in 1994, heralded the beginning of the formal process for the removal of the Multifibre Agreement (MTA) quotas on textiles and clothing (Naumann, 2006). As a World Trade Organization agreement, it was binding on all its member states (Naumann, 2006). This agreement encouraged member countries to reduce tariffs and South Africa made a commitment to a phased reduction of tariffs over a twelve-year period (Maree, 1995). The reduction of the tariffs exposed the sector to external competition, placing South Africa in a precarious position (Barnes, 2005). The clothing and textile sector began to experience job losses (Table 1).

Table 1. The number of employers and employees in the apparel industry (2003-2013)

Year	National Total	
	Employers	Employees
31 October 2003	1 042	97 960
31 October 2004	1 161	97 954
31 October 2005	1 149	85 854
31 October 2006	1 051	75 929
31 October 2007	1 041	72 919
31 October 2008	1 048	67 737
31 October 2009	1 001	60 253
31 October 2010	933	56 699
31 October 2011	952	58 647
31 October 2012	936	54 737
31 October 2013	865	52 656

Source: Morris & Barnes (2014)

The losses in employees in the clothing and textile sector during the 2003-2013 period were induced largely by the failure of the sector to compete with the international community (Morris & Barnes, 2014). A gloomy picture is also depicted by Baard (2011) in Figure 1. The clothing and textile manufacturing index was generally on the downward trend from 1998-2010 period when it failed to compete against the international markets (Baard, 2011).

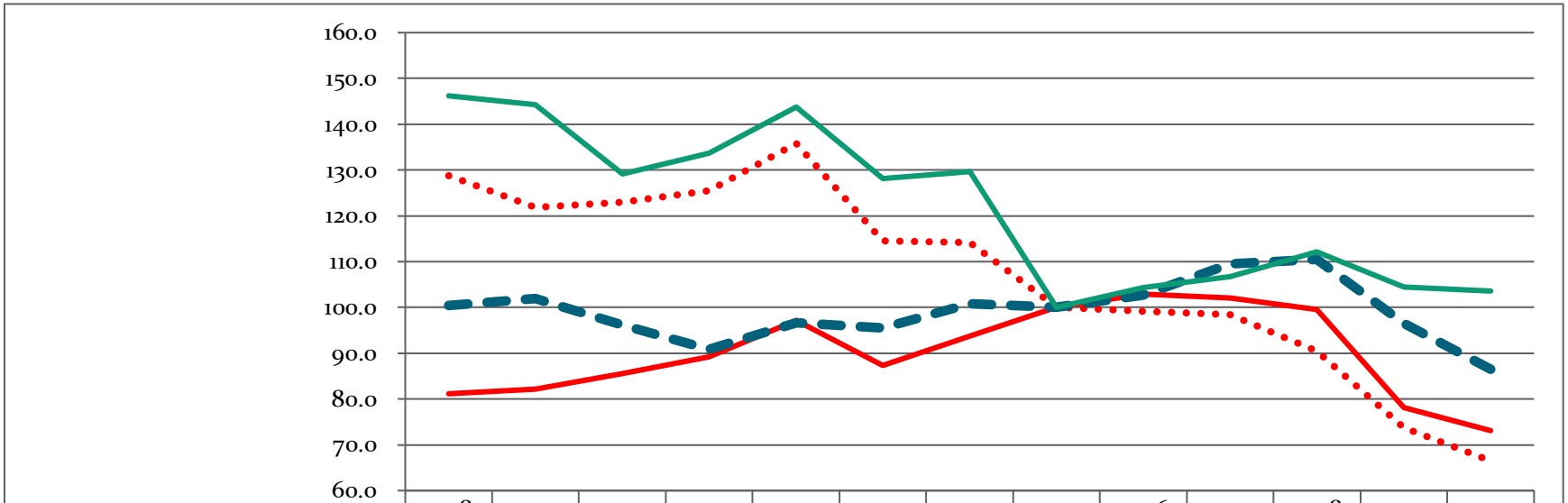
The inability of the South African clothing and textile sector to adjust to the international competition stemmed from a number of causes. The Department of Trade and Industry (DTI) (2009) argued that this scenario was caused by weak supply chain links, lack of competitiveness in technology, lack of innovation and design capacity, and poor skills base.

Lambrechts (2009) states that the clothing and textile industry challenges stemmed from the:

- geographical location – South Africa is a long way away from the markets in the USA and the EU. This restricts South Africa's speed to fulfil customer orders. It also pushes up transportation costs of goods.
- high wages and salaries – data for the early 2000s show South African's labour costs per unit of output were more than double the costs in China and more than treble the costs in countries such as Lesotho and Mozambique (Nattrass & Seekings, 2012).

Vlok (2006) sees the inability of the clothing and textile industry to adjust to the environment of liberalised trade to be associated with:

- inadequate investment and technology;
- poor skills base;
- lack of innovation and design capacity;
- inadequate firm level competitiveness; and
- weak value chains.



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Textiles	128.8	121.9	123.0	125.5	135.8	114.5	114.1	100.0	99.2	98.4	90.5	73.7	66.5
Other textile products	81.1	82.1	85.5	89.2	97.1	87.3	93.7	100.0	102.9	102.1	99.6	78.1	73.1
Wearing apparel	100.4	101.9	96.2	90.9	96.7	95.5	100.8	100.0	102.7	109.5	110.5	96.5	86.5
Knitted, crocheted articles	146.2	144.2	129.2	133.7	143.8	128.2	129.6	100.0	104.3	106.7	112.1	104.4	103.6

Figure 1. South African clothing and textile production index (1998-2010, Index 2005=100)
Source: Baard, 2011

Vlok (2006) further argues that illegally imported and under-invoiced goods worsened the situation. The level of illegal imports was estimated at between 10% and 30% of the total clothing and textile sales (Vlok, 2006). This forced the companies to either close or downsize, resulting in significant job losses (DTI, 2009). The above challenges have cumulatively resulted in the shrinking of the sector. A study done by Morris & Barnes (2014) shows a gradual shrinkage of the sector during the 2003 to 2013 period (see Table 1).

1.1 Purpose of the study

The purpose of this study is to establish the extent to which computer aided technologies are applied in the clothing and textile industry in the Gauteng province of South Africa. The use of modern and capable computer hardware and software can assure competitive advantages, such as high quality, productivity, flexibility and quick response to the requirements of the market (Stjepanovic, 1995). This study seeks to make a contribution to the local clothing and textile industry by providing information to further the discussion surrounding the applications of computers as a potential driver for improving the sectoral performance.

1.2 Research question

The research question that guided this study is stated as:

To what extent are computers aided technologies applied in the clothing and textile sector in Gauteng?

1.3 Scope

The sample frame for this study is micro, small, medium and large clothing and textile companies that are registered with the Registrar of Companies and are involved in manufacturing activities.

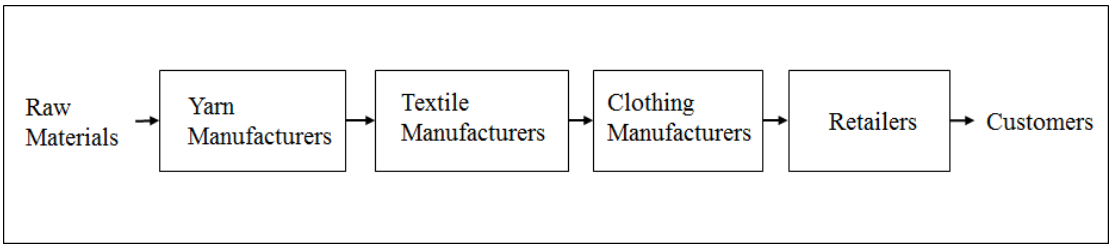


Figure 2. Textile-clothing pipeline
Source: Parker, 2007

The study included companies in Gauteng that produce products varying from the inexpensive mass-produced basics to higher value-added specialised textiles and fashion garments. Raw material suppliers and retailers were excluded (see Figure 2)

2. Literature Review

Given the competitive targets on time and customer satisfaction, computer applications are widely used in clothing and textile value chains. They contribute to improving the performance of both the individual firm and of the supply chain as a whole (Forza et al., 2000). The apparel sector utilizes computer aided technologies to maintain quality, speed up new product development, minimize costs and maximize flexibility to respond to ever changing customer needs (Stepanovic, 1995; Kaystha & Sharan, 2017). Stejpanovic (1995) suggests that computer equipment is widely used for design and production of garments as well as for the assurance of effective information flows.

Some of the computer systems used in the textile and apparel industry include Computer Aided Administration (CAA), Computer Aided Design (CAD), Computer Aided Manufacture (CAM), Computer Integrated Manufacture (CIM) and Electronic Point of Sale (EPOS) (Kaystha & Sharan, 2017). In addition, Stjepanovic (1995) states that garment production processes require the development and application of Computer Aided Process Planning (CAPP),

Computer Aided Quality Control (CAQC), Computer Aided Testing (CAT), Numerical Control (NC), and Manufacturing Resources Planning (MRP II).

In the clothing sector, CAD is used for developing designs, pattern making, pattern grading, marker production and lay planning (Kaysha & Sharan 2017). It also has applications in sketching, 3D modelling, electronic catalogue, sample prints, designing of new base products, fitting of old base products and grading (Forza et al., 2000). Computer-generated human models help to visualize the fitting results of the designed clothes in virtual environment. Due to the consistency of computer programs, patterns are created according to the same rules repeatedly. Moreover, data can be stored and retrieved with ease. In weaving, it is widely used to design the collection and to make sample prints (Forza et al., 2000). CAD is able to offer sample prints that are so accurate as to be almost indistinguishable from the real thing (Forza et al., 2000).

In CAM, computers are used in plotting, spreading, lay planning and cutting, sewing, surface ornamentation, and pressing (Kaystha & Sharan, 2017).

When Computer Aided Design and Computer Aided Manufacturing (CAD/CAM) are integrated, ideas are quickly converted into tangible products and put in the marketplace in a matter of weeks (Groover 2010). Generally, the CAD/CAM systems supporting the garment manufacture processes consist of computer hardware, computer software and communication equipment (Stjepanovic, 1995).

To get the best out of CAD and CAM, there is need to introduce a link. This pivotal link between the two is called process planning (Xu et al, 2010). Process planning deals with the selection of the necessary manufacturing processes and the determination of the sequences required to transform economically and competitively a designer's ideas into a physical product (Xu et al., 2010). There are two approaches in CAPP; variant and generative. The variant approach follows the principle that similar parts require similar plans. This approach is suitable for enterprises that produce standard products. These are products whose demand are relatively stable and predictable, and are manufactured with little variation (Xu et al., 2010). This is consistent with a lean supply chain.

In a generative approach, process plans are generated with little human intervention. New process plans are generated using decision logic and process knowledge (Xu et al., 2010). This is consistent with an agile supply chain. Hence CAPP can adequately cater for both lean and agile supply chains.

Benefits are realized from computer aided technologies when CIM is introduced. Within the manufacturing environment, the CIM system would need to be assessed by all departments concerned. These would include design, production, engineering, management and quality control. The system could also be networked to the retailer to complete the manufacturing cycle (Harlock, 1989).

In the manufacturing environment there is a need to conduct quality inspection to see if the products comply with customer requirements. The inspection process could be done manually or through an automated system and this could be in-process, post-process or offline. Automation of the quality inspection procedure will almost always reduce inspection time per piece, and the automated machines do not experience the fatigue and mental errors suffered by human inspectors (Groover, 2010). Hence the adoption of automated quality inspection improves productivity, and inspection consistency. This in turn makes the company competitive.

On the other hand communication among companies in a supply chain is significantly improved with the introduction of Electronic Data Interchange (EDI). EDI can be defined as the inter-organizational exchange of business documentation in structured, machine-processable form (Vijayasarathy & Tyler, 1997). The traditional documents of doing business such as purchase orders, invoices, shipping notices, order confirmations, and payment receipts are transmitted electronically over networks, rather than using mail, facsimile, couriers or other conventional modes (Vijayasarathy & Tyler, 1997). EDI is probably the best known IT application for inter-firm integration (Mason-Jones & Towll, 1997; Forza et al., 2000). It offers greatly improved information flows and is an extremely important aspect within leading organizations in the fight to decrease lead times (Mason-Jones & Towill, 1997). EDI helps to integrate the vendor base directly with the rest of the supply chain by passing down planning information and pull signals (Naylor et al, 1999).The EDI linkage connects the vendor to the point of sale location, and enables the vendor to access the sales trends as well as the inventory position of a particular stores. Once the inventory reaches a certain level, products are replenished from the inventory maintained by the vendor (Naylor et al., 1999).

The conduct of business is also improved through the introduction of EPOS scanners. An EPOS is a computerized system that speeds up sales transactions and monitors stock levels (Kaystha & Sharan, 2017). It is the collection, in real-time at the point of sale and storage in a computer file, of sales and other related data by means of electronic devices (Lynch, 1990). The most common input devices are the bench scanners, scales, key pads and hand-held wands (Lynch, 1990). These data input devices interact with a price look-up file which holds the complete list of items stocked by the retailer and their current selling prices (Lynch, 1990). The customer receives a printed record of what and how many items were purchased, the total amount of money paid for the items, how the money was paid, and the date, time and place of the transaction (Lynch, 1990).

Another platform that allows seamless sharing between entities in the value chain is the internet (Duffy et al., 2004). There is a higher chance of success in integrated product development teams when management values information sharing between the design and marketing, and the design and manufacturing of a manufacturing enterprise (Duffy et al., 2004). When internet systems are applied in clothing and textile sector they allow the buyers and consumers to review garment style, appearance, fit and suitability (Kaystha & Sharan, 2017). Internet also enables online marketing (Duffy et al., 2004).

The literature reviewed showed that there are a number of computer aided technologies that manufacturing entities (including clothing and textile companies) can exploit. These technologies improve productivity, record keeping, quality, consistency in output, flexibility, and information sharing. This in turn positions the focal companies to compete with the local and international community. In this study an investigation was conducted on the clothing and textile sector in Gauteng in order to see the extent to which they use computer aided technologies. The specific technologies analyzed are CAD, CAM, CIM, EDI, EPOS and internet in general.

3. Methodology

The survey was a cross-sectional, quantitative, non-experimental survey that was conducted on one group of clothing and textile companies. The objective was to describe the extent to which computer aided technologies were used in the clothing and textile sector in Gauteng Province of South Africa.

The companies in the sample were micro, small, medium and large companies that manufacture clothing and textile products. The participating companies were categorized (size wise) on the basis of the National Small Business Amendment Act 26 of 2003 of the Republic of South Africa. The act categorizes companies in the manufacturing sector as indicated in Table 2.

Table 2. Company sizes in the manufacturing sector

Sector in accordance with the Standard Industrial Classification	Size of Class	The total full-time equivalent of paid employees	Total annual turnover	Total gross asset value (fixed property excluded)
Manufacturing	Medium	200	R51m	R19m
	Small	50	R13m	R5m
	Very Small	20	R5m	R2m
	Micro	5	R0.20m	R0.10m

Source: The National Small Business Amendment Act 26 of 2003 of the Republic of South Africa

The researchers had no idea of the total population of the clothing and textile companies in Gauteng. Efforts to get the figures from Department of Trade and Industry (DTI) were in vain. This prompted the researchers to use purposeful sampling to choose participants in the study.

The data collection tool was a self-administered and multi-response structured questionnaire. Individuals chosen to respond to the questionnaire were those holding managerial posts. To reduce non-response, companies that failed to return the questionnaires in time were contacted by the researcher on the phone or in person.

4. Findings

The total number of textile and clothing companies that were contacted during the survey was 180. Twenty two (22) of the 180 companies contacted refused to participate in the study. Thus, questionnaires were sent out to the remaining 158 companies. Companies that completed and returned the questionnaire were 122, giving a completion rate of 77%. On conducting a data screening exercise it was found out that 18 respondents did not fill in the questionnaire in full. This left the study with 104 (57.8%) companies and these were used in the data analysis.

The respondents' positions were grouped into ten categories, as shown in Table 3, with results revealing that all respondents held senior positions within their respective companies.

Table 3. Distribution of respondents

Job Title	Frequency	Percent
Founder/owner/member/partner	38	36.54
CEO/ Manging Director	6	5.77
Chairperson/Director	16	15.38
Designer/creator	6	5.77
Operations manager/General manager	8	7.69
Production Manager/Factory Manager/manager	11	10.58
Sales manager/Retail Manager	6	5.77
Administrator/shop manager/Business Dev Manager	11	10.58
Finance manager	1	0.96
Purchasing manager/import manager	1	0.96
Total	**104**	**100**

The ownership structure of the participating companies indicates that 20.2% of participants were sole traders, 10.6% partnerships, 49% close corporations and 18.3% private companies, giving a total of 102 companies. Two companies did not indicate the ownership (see Table 4).

Table 4. Ownership of the clothing and textile business

		Frequency	Valid Percent
Ownership of the Company	Sole trader	21	20.2
	Partnership	11	10.6
	Close corporation	51	49.0
	Private company – subsidiary of South African company	18	17.3
	Private company – subsidiary of foreign company	1	1.0
	Other	2	1.9
	Total	**104**	**100.0**

The ages of the companies were categorized in groups: 24% had been in business for 1-5 years, 28.8% for 6-15 years, 12.5% for 16-25 years, 13.5% for 26-35 years, 1.9% for 36-45 years, 4.8% for 46-55 years, 3.85% for 56-65 years and 1.95% for 76-85 years. There were 76% of the companies that had been in business for more than 5 years and this is long enough for any one company to have put in place adequate management structures.

Collectively the participating companies made clothing and textile products, ranging from yarn, fabrics, clothing and made-up articles. Survey results show that the most popular product category with the participating companies was clothing (78.8%), followed by knit fabrics (15.4%), spun yarn and made up articles (8.7%), woven fabrics and home textiles (7.7%), filament yarn and industrial fabrics (3.8%). Products that were least popular with the participating companies were non-woven fabrics, carpets and rugs. These products were supplied by only 1.9% of the participants.

4.1 Computer applications used in Gauteng clothing and textile sector

The findings in sections 4.1.1 to 4.1.6 show how much of CAD, CAM, CIM, EDI, EPOS and internet are used in the sample of 104 clothing and textile companies that were purposefully chosen from Gauteng.

4.1.1 Computer Aided Design

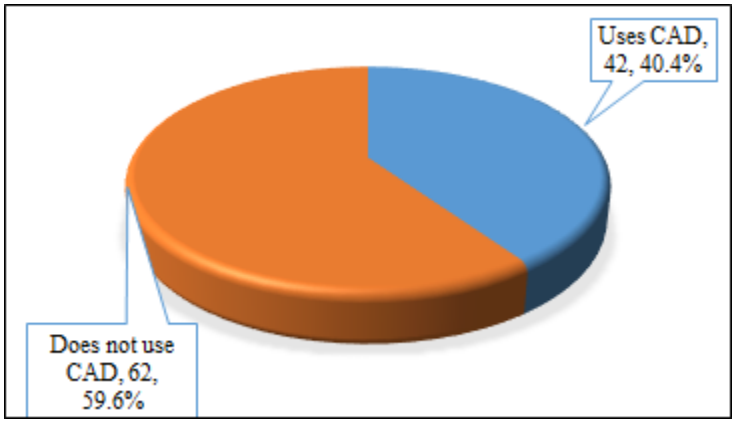


Figure 3. Application of CAD in participating companies

The results in Figure 3 show that 40.4% of the participating companies used CAD in conducting their designs.

4.1.2 Computer Aided Manufacturing

CAM is the effective use of computer technology in manufacturing planning and control (Groover, 2008).

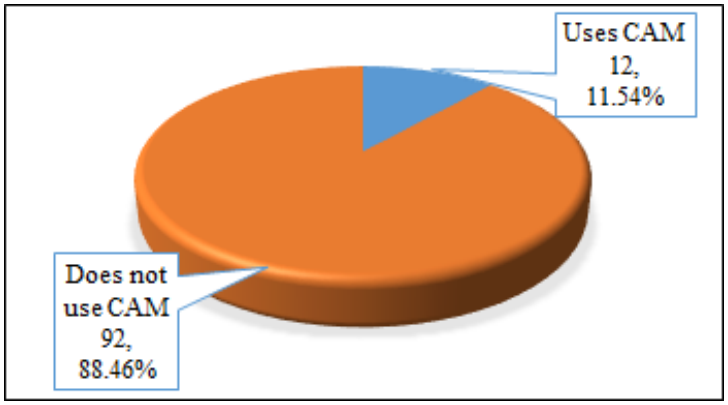


Figure 4. Application of CAM in the participating companies

This study was done to see the extent to which the participating companies used CAM. The results in Figure 4 show that only 11.54% of the companies used the technology.

CAD/CAM is concerned with the engineering functions in both design and manufacturing (Groover, 2008). It denotes an integration of design and manufacturing activities by means of computer systems (Groover, 2008). CAD/CAM equipment reduces the cycle time from design to production (Sen, 2008). These technologies enable the clothing and textile manufacturers to accept retailer orders closer to the fashion season and replenish their stocks frequently during the season (Stjepanovic, 1995; Sen, 2008). Moreover new ideas and trends across the markets can quickly be converted into tangible products (Groover 2010). The CAD and CAM technologies invariably have an impact on both lean and agile supply chain systems.

Information in Figures 3 and 4 leads one to deduce that the efficiency, effectiveness and agility of the local companies is heavily compromised. Few companies are taking advantage of the usefulness of CAD and CAM technologies. There are 42.40 % of the participating companies that used CAD and only 11.54% used CAM. This means that the majority of the companies in the sample have their designs and manufacturing processes performed in silos. This could be one reason why there is a continual loss of jobs in the sector as shown in Table 1.

4.1.3 Computer Integrated Manufacturing

The ideal CIM system applies computer and communication technology to all of the operational functions and information processing functions in manufacturing from order receipt through design and production to product shipment (Groover, 2008). The CIM concept enables the incorporation of a firm's operations related to production in an integrated computer system (Groover, 2008). In the integrated computer system, the output of one activity serves as the input to the next activity, through the chain of events that starts with the sales order and culminates with shipment of the product (Groover, 2008). Full implementation of CIM results in the automation of the information flow through every aspect of the company's organisation.

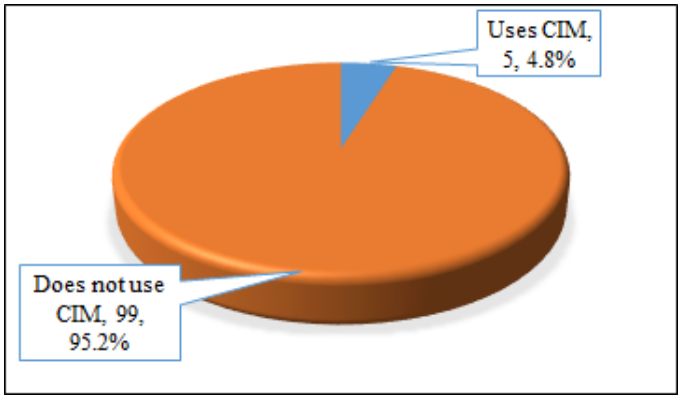


Figure 5. Application of CIM in the participating companies

In this study, CIM was the least popular technology to be used by the participating companies (see Figure 5). Only 4.8% of the responding companies used the technology. This is bound to impact on the ability of the companies to timeously harness new trends across the markets and convert them into tangible products. The results also explain the poor performance of the sector as observed by Morris & Barnes (2014) in Table 1.

4.1.4 Electronic Data Interchange

EDI offers greatly improved information flows and is an extremely important technology that helps to decrease delivery lead-times (Mason-Jones & Towill, 1997).

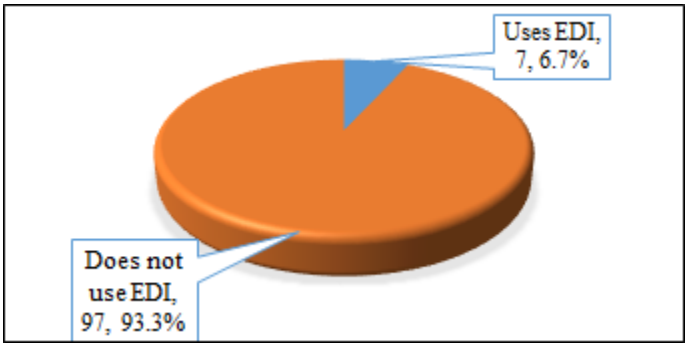


Figure 6. Application of EDI in the participating companies

It facilitates automatic re-ordering and allows the manufacturer to manage its retailers' inventories (Sen, 2008). EDI use expedites inter-organisational transactions, reduces transmission costs, reduces inventory costs, improves the accuracy of the information exchange, reduces paper flow, eliminates labour intensive tasks, and increases market share (Vijayasarathy & Tyler, 1997). This ultimately leads to the competitiveness of the companies involved. Results in Figure 6 show that only 6.7% of the companies used EDI. This is probably part of the evidence in Vlok's (2006) explanation of the inability of the South African clothing and textile industry to adjust to the environment of liberalised trade. The improved inter-organisational transactions would benefit a lot those companies that make innovative

products and require agile supply chains. On the other hand it would benefit companies that make functional products. According to Naylor et al (1999) such companies do well when they adopt lean supply chains where competitiveness is gained through waste reduction.

4.1.5 Electronic Point of Sale

The EPOS scanners at checkout counters read the bar code attached to each item and record the merchandise sales by its price, style, colour and size (Sen, 2008). The information is recorded as and when transactions happen (Pycraft et al., 2010).

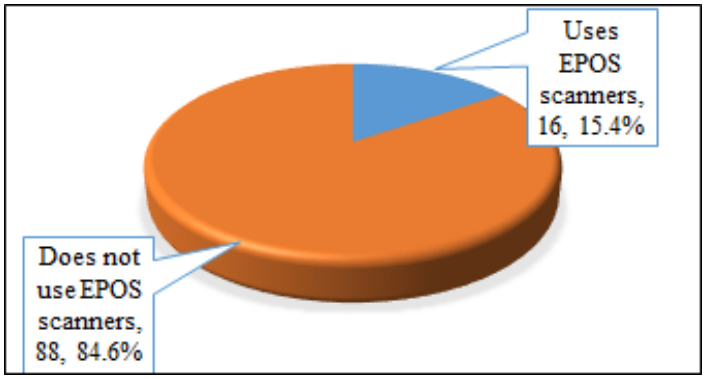


Figure 7. Use of EPOS scanners in the participating companies

Figure 7 shows that only 15.4% of the participating companies use EPOS. The rest (84.6%) are losing an opportunity to improve competitiveness through implementation of EPOS. Lynch (1990) states that EPOS improves check-out throughput, shelf-filling, stocktaking and more consistent and accurate handling of pricing and price changes. It also improves efficient use of shelf space and removes the need for individual product price labelling (Lynch, 1990).

4.1.6 Internet

The most significant technology to impact on operations management in the last few years has been the internet (Pycraft et al., 2010). It is a network of networks and is used to link computer networks with other computer networks (Pycraft et al., 2010).

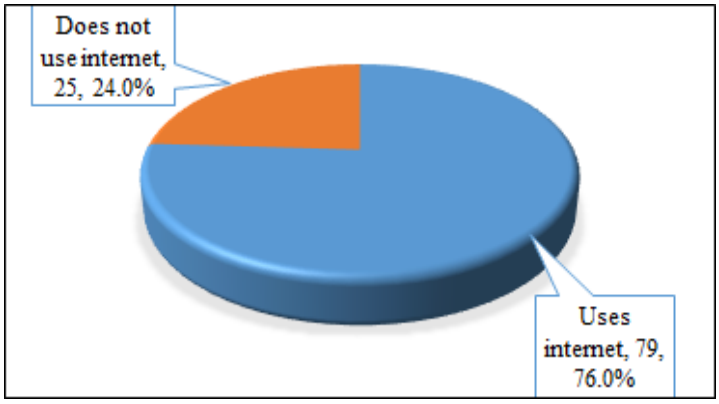


Figure 8. Use of internet by the participating companies

In this study, 76% of the participants used internet (see Figure 8). This is a significant improvement in usage over the other technologies investigated. Internet gives companies a platform to access information on developments in the clothing and textile sector worldwide thereby positioning them to be competitive.

4.2 The level of automation in the manufacturing plant

The study was done to understand the level of automation in the clothing and textile industry in the sample. The results showed that 58.7% of the participating companies were not or were slightly automated, while 29.8% were moderately automated and 11.6% were mostly or fully automated (see Table 5).

Table 5. The level of automation in the manufacturing plant

	Frequency	Valid Percent
Not at all automated/Slightly automated	61	58.7
Moderately automated	31	29.8
Mostly automated/fully automated	12	11.6

Findings in sections 4.1 to 4.6 show that there is low uptake of computer-aided technologies. This confirms the low level of automation found in this section. Similar to technologies in sections 4.1 to 4.6, automation is important to both lean and agile supply chains. It has, on one hand, the impact of improving response, and on the other hand, it reduces cycle time. In addition, Groover (2010) recognises the following benefits derived from automation:

- low amount of labour;
- low product cost, because cost of fixed equipment is spread over many units;
- high production rate;
- minimal work in progress and production lead time;
- minimal use of factory floor space.

5. Conclusion

This study investigated the application of computer aided technologies in clothing and textile companies in Gauteng, South Africa. The technologies analysed are CAD, CAM, CIM, EDI, EPOS and the internet.

The results were generated from 104 clothing and textile companies that were chosen purposefully. Hence the results cannot be generalized to the clothing and textile population in Gauteng.

The surveyed companies showed a low uptake of computer aided technologies. This could be a partial explanation to the poor competitiveness of the clothing and textile companies in South Africa as observed by Morris & Barnes (2014).

Outputs from this research are of value to academia and policy makers. The results stimulate the academia to do a more comprehensive study in order to get a country wide understanding of the computer aided technology usage in the sector. To the policy makers the findings point to the intervention that can be introduced to save the sector from collapse. Moreover the results help the clothing and textile companies see the need to invest in computer aided technologies. Findings from this study have also generated a platform for informative debates within the clothing and textile sector with focus on the relationship between computer-aided technologies and performance.

6. Recommendations

1. The results obtained from this study are based on one sample whose elements were selected purposefully. Generalisation cannot occur because random selection of elements was not done. To get a general view of the usage of computer aided technology in the clothing and textile at district, provincial or national level, it is necessary to involve the entire population of clothing and textile companies. This will allow the researcher to select the participants randomly, analyse the data and eventually generalise the findings.
2. There is need to conduct a study that focuses on clothing and textile companies' understandings of the influence of computer aided technologies on company competitiveness. This will aid stakeholders in realising the extent to which these companies understand the importance of the technologies and will help render appropriate interventions where necessary.
3. Although this study was conducted in the clothing and textile industry, similar studies could be applied in other sectors.

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8. Biographies

Forbes Chiromo is currently a full time lecturer in Mechanical and Industrial Engineering Technology at the University of Johannesburg. He holds a Masters in Manufacturing Systems Engineering from The Queen's University of Belfast, Northern Ireland. At the time of writing this paper, Forbes had submitted his PhD thesis for marking. The research was on supply chain management. Forbes has taught courses in applied mechanics, mechanics of machines, theory of machines, quality assurance, operations management, production technology, systems dynamics, logistics engineering and information systems. Prior to joining the University of Johannesburg he worked at Harare Institute of Technology and Scientific and Industrial and Research Centre (SIRDC) in Zimbabwe. His research interest is in operations management.

Andre Leon Nel (MIEEE) has BSc (Eng), MEng and DEng degrees. He is currently the Executive Director: Operations at the University of Johannesburg and is interested in research into areas related to low image processing, operations research and engineering management.