Adoption of Apparel CAD Technologies in Nigeria

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Abstract

The integration of Computer-Aided Design (CAD) in apparel design holds the potential to significantly enhance the quality and efficiency of fashion product development. Despite the recognized global advantages of CAD its adoption rate remains low in Nigeria, where traditional manual methods persist. The study was conducted in Southwest and Northern Nigeria to evaluate the awareness, perceptions, and factors influencing the adoption of CAD among fashion designers. The research combined quantitative and qualitative data from designers in Osun, Oyo, and Ogun States. A simple random sampling of 105 designers was done in Osun State, while 20 designers were chosen purposively from Oyo and Ogun States. The majority of the fashion designers were aware of CAD but had never installed or used the software. About half (47.6%) knew that CAD could draft patterns. They perceived that installing CAD would be expensive ($\bar{x}$=2.60) but would make the designs better and more accurate ($\bar{x}$=2.43). Computer literacy and technological know-how ($\bar{x}$=2.58) and management of the package ($\bar{x}$=2.44) affect the adoption of CAD. There is no significant relationship between the level of education and awareness of CAD. Also, there is no significant relationship between the perception of the fashion designers and factors affecting the adoption of CAD (p= 0.034). Stakeholders should provide accessible training, demonstrate CAD's benefits, and foster an understanding of how CAD can complement and enhance designers' skills.

Keywords: Fashion designers; Computer Aided Designs; Perception; Adoption; Awareness

Abbreviations: CAD: Computer-Aided Design; CAM: Computer-Aided Manufacture

Introduction

The fashion industry is one of the biggest and most popular industries experiencing growth and development [1] with the introduction of technology. The fashion market has experienced fast growth, having Computer-Aided Design (CAD) and Computer-Aided Manufacture (CAM) as sources for such fast growth and development [2]. Demands for clothing items increase daily as the human population increases. Manual production of clothing becomes more tedious especially when meeting large quantity demand. CAD has revolutionized the fashion and clothing design industry by streamlining the design process, enhancing creativity, and improving efficiency.

CAD tools in fashion encompass software applications that assist designers in creating, modifying, and visualizing designs digitally. These tools offer a wide range of functionalities, including sketching, pattern making, 3D modelling, and virtual fitting. CAD is a technical drawing of a garment showing details such as seams and stitches. Examples are AutoCAD, 3ds Max and Maya. It saves time, decreases errors, improves accuracy and enhances better quality. The advent of CAD technology has helped global apparel industry development. CAD has a significant impact on the quality, quantity and delivery of fashion products. Designing in clothing construction involving manual illustrations of the new styles, drafting patterns, cutting and construction could be stressful. However, with the development in technology, some easy-to-use software's are available to assist designers by making work better with higher quality.

Clothing plays a significant role in human life, providing protection and serving as a means of expression and social differentiation [3]. Fashion design encompasses the art of creating new apparel, including clothing, shoes, and accessories, which is influenced by cultural and social attitudes [4]. The garment industry has witnessed advancements in techniques, processes, and machinery to meet the increasing demand for clothing items due to population growth [1]. One of the technological developments in the global apparel industry is CAD technology, which has revolutionized the design and production processes

[2]. CAD offers a range of computer-based tools that assist design professionals in various tasks, such as 3D modelling of garment designs, pattern drafting, fabric design, and embroidery [5]. CAD has the potential to streamline design processes, reduce complexity, and improve efficiency [6].

Despite the global development in the use of CAD among fashion designers, there is still a low level of adoption among developing countries in Nigeria. Despite the availability of user-friendly CAD software, manual clothing construction methods (pattern drafting and freehand cutting techniques) are still prevalent, indicating a gap in the adoption of CAD technology [7]. Developing countries need to adopt technology that is sustainable to revamp the textile industry [8]. The use of CAD can make designers competitive, meet customers' demand, boost the economy and increase employment generation in the country. The study will help fashion designers to remain competitive in the business, enhance sustainable production and improve the quality of design while generating more employment. This research aims to investigate the factors influencing the awareness, perception and adoption of CAD among fashion designers in South Western Nigeria.

Literature Review

Use of CAD in the fashion industry

CAD has many uses, one of which is digital pattern making, patterns can be made for garments and any other fashion accessories using CAD with accuracy. Either by using the blocks provided and modifying them on-screen or by photographing an existing pattern with a good digital camera and on-screen digitizing pattern lines. Fuchs et al., [9] discussed the basic structure of CAD systems to include a front end, back end, geometry kernel and processing unit that enable design engineers to visualize, modify, and specify designs. CAD is used in computerized embroidery. The software is created to design objects to get real or virtual image drawings. The image drawn entails information like processes and measurements. CAD can be used in making standard embroidery designs. Bidwell (2009) opined that there are a lot of software that can be used in designing and editing embroidery patterns and images.

Embroidery CAD software transforms the computer graphic images into stitches and the embroidery is done by the machine. CAD embroidery ensures accurate works with good quality and standard designs. Manual embroidery is labour intensive but with the adoption of CAD, production cost has been reduced in paying labour wages. Designers are allowed to make designs by sketching on the computer and scanning images using fashion design and styling software. The software contains template commands that allow fast ways of designing clothes, they also help in the creation of ideas, pictures and other forms of textile design. Designers now use 2D and 3D software to make virtual designs of garments and clothing. The major benefit of CAD software in designing is the speed at which designs are made. Providing CAD software on systems in fashion studios is necessary for effective learning and teaching of fashion design.

In the 1970s, the first sectors that benefitted from CAD technology in the fashion designing industry were pattern grading and marker making. Block pattern is the basis of pattern-making using CAD software. Basic blocs are scanned and inputted into the system using a digitalizer or scanner, they are then converted to coordinate data. Pattern production, changing of style and revisions are done using CAD software. In the fashion industry, using CAD for cutting involves the use of a laser cutter. The laser cutter uses a laser beam to cut fabrics and patterns. Fabric is spread on the pallet and moved into the cutting zone to cut. After cutting, the pallet moves to the other side of the cutting zone where the cut parts are removed. Patterns with larger and longer sizes are divided by the computer.

The use of micro-electronic control units which helps standard industrial sewing machines to be able to handle hard task, are attached to such machines. They are attached to manufacturing machines and are controlled by computers. Thereby forming an integrated system of CAD and CAM. Manufacturing machines use computers to assist designers in eliminating errors, achieving consistency and reducing costs. In knitting, there are electronic machines that use computers in the selection of pins for knit and tuck, three-way technique, transfer and receive. Electronic motors control pressers and stitch cams, which alternate carriages. The integration of CAD and CAM technology has been of great use to fashion designers and the fashion industry as a whole entity.

Benefits of Computer-Aided Design (CAD) in fashion

Clothing technology, textiles technology, and fashion illustration are CAD-dependent in modern-day fashion design. Fashion design technology is the development of skills to identify and generate ideas and investigate the manufacturing of clothing and accessories. CAD can be sent to the buyer via email or other appropriate electronic media, allowing them to track and manage the designs, while physical samples must be sent via courier, affecting time, protection, and cost [10,11].

Sayem [12] submitted that the innovations in digital fashion can be clustered into four themes - (1) Digital design and e-prototyping, (2) Digital business and promotion, (3) Digital human and metaverse, and (4) Digital apparel and smart e-technology. 3D CAD being one of these innovations can develop new sketches, patterns, and prints more quickly and accurately. It enables multiple modifications of a prototype design. It helps fashion designer explores more colours that can customize a pattern. It can reduce the cost of designing. CAD retrieves patterns anytime and anywhere compared with the manual method of saving patterns on papers, clipboards and albums, with chances of losing such [13]. CAD enables rapid pattern creation and refinement, minimizing errors. Research indicates that CAD-

generated patterns surpass manually-produced ones in terms of quality [14].

It enhances creativity and provides designers with a versatile platform to experiment with various design elements, colors, and patterns, fostering creativity and pushing the boundaries of traditional design. CAD retrieves patterns anytime and anywhere compared with the manual method of saving patterns on papers, clipboards and albums, with chances of losing such [13]. It significantly reduces the time required to create and iterate designs compared to manual methods. Designers can quickly make changes, try different variations, and share digital prototypes with stakeholders. It gives better-fitting garments and minimizes errors during production. With 3D modelling and virtual fitting capabilities, designers can visualize how a garment will look and fit on a virtual model before physically producing it.

This reduces material waste and cost. The utilization of digital technology, encompassing both hardware and software tools, has revolutionized various aspects of fashion design and production. By incorporating interactive features, these tools empower fashion designers and institutions to delve deeper into the scientific underpinnings of cutting-edge fashion trends and offer valuable career guidance. This integration has elevated the creation of motifs and visual patterns, enriching the aesthetic value of fabrics produced in recent times. Moreover, there's a heightened comprehension of techniques like durable press and minimum care, along with advancements in colour applications, digital printing, embroidery, knitting, laser cutting, industrial dyeing, and fabric embellishment.

Challenges in fashion computer-aided design

The following are possible challenges that the use of CAD may pose:

a.   **Learning curve:** Transitioning to CAD tools might require designers to learn new software and techniques, which can be time-consuming and challenging, especially for those accustomed to traditional methods.

b.   **Initial investment:** The cost of acquiring and maintaining CAD software and hardware can be a barrier for individual designers or smaller businesses.

c.   **Lack of physical texture:** While CAD tools allow designers to visualize designs, they may not fully capture the tactile qualities of fabrics and materials, which can be crucial in fashion design.

d.   **Overreliance on digital skills:** As CAD becomes more prevalent, there's a concern that designers might prioritize digital skills over fundamental design principles and drawing techniques.

e.   **Data security:** Sharing digital designs and patterns online can raise concerns about intellectual property theft and unauthorized use of designs.

f.   **Complexity for handmade techniques:** Some intricate handmade techniques might be difficult to replicate accurately using CAD tools, limiting the application for certain design styles.

Perception of fashion designers on the use of computer-aided design

Fashion designers regard Computer-Aided Design (CAD) as an invaluable asset, enhancing their design process, communication, and commitment to sustainability. With ongoing advancements in CAD technology, the synergy between fashion designers and this tool is poised to flourish, spawning fresh avenues for its strategic application. Although CAD is embraced by designers in developed nations as an enhancer of their craft, some creative professionals still harbor reservations about its potential impact on their artistic expression.

Fashion designers believe that CAD is a valuable tool for improving the design process. CAD is seen as a way to improve communication, create more realistic designs, and reduce waste [15]. Fashion design students who used CAD software were more likely to be satisfied with their designs and to feel confident in their ability to communicate their designs to others. Also, CAD software helped students to be more creative and to explore new design possibilities. Fashion designers who used CAD software were more likely to be satisfied with the quality of their designs and to be able to meet customer demands. CAD software helps designers to be more efficient and to save time and money [16].

Research Methodology

The study was carried out in Osun, Oyo and Ogun States of southwestern Nigeria. Thus, fashion designers are prominent in these states with shops and fashion outfits. The population of the study consists of all fashion designers in these states. A simple random sampling technique was used to select 105 fashion designers in Osun State. An additional 20 designers were purposively selected from Oyo and Ogun States. A structured questionnaire and interview schedule were employed as the research instrument to gather data from the respondents. The questionnaire was designed to elicit information about the awareness and perception of fashion designers as well as the factors influencing the adoption of CAD in Osun States, while the interview guide was purposively used for fashion designers in Oyo and Ogun States.

A three-point Likert scale of measurement was utilized to assess the perception of the fashion designers including "Disagree", "Undecided" and "Agree". The responses were used to measure the degree of perception expressed by the respondents for each question. The level of awareness was measured using "Yes," "I don't know," and "No" options. The socio-economic characteristics of the respondents were presented in terms of

frequency and percentage. To examine the factors influencing the adoption of CAD, the options "Always," "Rarely," and "Never" were used. Quantitative and qualitative data were gathered for the study. Data was analyzed using descriptive statistics such as frequencies and percentages. Correlation analysis was performed using SPSS to establish relationships between variables.

Results and Discussions

(Table 1) summarizes the demographic characteristics and business profiles of the selected fashion designers. There is a higher percentage of females (58.1%) involved in fashion design compared with males (42.9%). A significant portion of the selected fashion designers have acquired tertiary education (53.3%), indicating a higher level of education within the industry. The majority of fashion designers were married (61.9%) while 34.3% were single. A large proportion of the establishments (93.3%) operated sole proprietorships. Most fashion establishments (58.1%) operate on a small scale. Regarding income, a significant portion of respondents earn less than N50,000 per month (21.9%), and a notable number earn between N50,000 and N100,000 (33.3%).

Table 1: Socio-demographic and economic characteristics of the respondents.

Variable	Frequency	Percentage%
Gender		
Male	45	42.9
Female	60	57.1
Marital status		
Single	36	34.3
Married	65	61.9
Divorced	2	1.9
Widowed	2	1.9
Level of education		
No formal education	2	1.9
Primary education	6	5.7
Secondary education	41	39
Tertiary education	56	53.3
Form of ownership		
Sole proprietorship	98	93.3
Joint ownership	3	2.9
Limited liability	4	3.9
Scale of operation		
Micro	20	19
Small	61	58.1
Medium	18	17.1
Large	6	5.8
Capital investment		
Less than ₦ 50,000	40	38.1
₦ 50,000 - ₦99,999	22	20.9

₦100,000 and above	43	41
Income per month		
Less than ₦50,000	23	21.9
₦50,000 - ₦99,999	35	33.3
₦100,000 and above	47	44.8

Both males and females support entrepreneurship and economic development in the business of fashion design. Policymakers can direct resources and initiatives to micro and small-scale entrepreneurs in fashion designs to foster business growth and economic development. (Table 2) indicates that 72.4% of the fashion designers surveyed have heard about CAD, while 27.6% are unfamiliar with it. Only 21.9% of all respondents have installed and used CAD software, while 74.3% have never installed or used it. Regarding the usability and efficiency of CAD software, 47.6% of the fashion designers believe that it can be used for pattern drafting, pattern cutting (34.3%) and embroidery (48.6%).

Table 2: Assessment of Awareness of Fashion Designers on Computer-Aided Design.

Awareness	Yes	No	I don't know
	Freq (%)	Freq (%)	Freq (%)
Have you heard about CAD before?	76(72.4)	29(27.6)	0(0)
Have you ever installed/ used CAD software?	23(21.9)	78(74.3)	4(3.8)
Are you aware that CAD can draft patterns?	50(47.6)	21(20.0)	34(32.4)
Are you aware that CAD can cut patterns?	36(34.3)	33(31.4)	36(34.3)
Are you aware that CAD design clothes?	62(59.0)	18(17.1)	25(23.8)
Are you aware that CAD can do embroidery?	51(48.6)	18(17.1)	36 (34.3)
Are you aware that CAD can do 3D modelling?	23 (21.9)	31(29.5)	51(48.6)

In conclusion, the survey reveals that fashion designers have an awareness of CAD technology, but a significant number of them are yet to adopt it in production activities such as pattern drafting, pattern cutting, designing clothes, and embroidery. Additionally, a majority of the designers are unfamiliar with the 3D modelling capabilities of CAD. (Table 3) showed that respondents perceived that installing CAD was expensive (=2.60), but liked to learn more about CAD (=2.57). They submitted that CAD would make the designing process interesting (=2.45), better and more accurate (=2.43). Others believed that they would be spending more on CAD (=2.41). A few respondents are undecided that CAD is not necessary for good designs (=2.00) as well as feeling confident when using CAD to design (=2.00). However, few disagree with the fact that CAD will not make any difference (=2.16) and CAD can kill creativity (=1.83).

Respondents recognized CAD's potential benefits in enhancing design quality but indicated cost concerns associated with CAD adoption. They indicated an interest in enhancing their skills and knowledge related to CAD. From the oral interview, it is clear that respondents are not aware that CAD is a software package and not a big machine that they need to buy. Diyaolu (2018) opined that the automated textile industry is yet to key into CAD installation during the design of products. The study of Dong et al. (2009) supports the proficiency role that technology plays among adopters. (Table 4) presents the assessment of factors influencing the adoption of CAD in fashion establishments. These include computer literacy/ technological know-how (=2.58), consumers' willingness to pay for designers' services (=2.53), constant electricity (=2.55), cost of installation (=2.52) and management and maintenance of the package (=2.44).

Table 3: Perception of the fashion designers on the use of CAD.

Statements	Disagree	Undecided	Agree	Mean
	Freq (%)	Freq (%)	Freq %	
CAD will not make any difference in the designs	64(61.0)	19(18.1)	22(21.0)	1.6
I will be spending more on CAD	19(18.1)	23(21.9)	63(60.0)	2.41
Customers will be satisfied with CAD designs	15(14.3)	40(38.1)	50(47.6)	2.33
Other fashion designers are not using CAD	36(34.3)	33(31.4)	36(34.3)	2
It will take longer to break even using CAD	34(32.4)	28(26.7)	43(41.0)	2.08
CAD is not necessary for good designs	41(39.0)	22(21.0)	42(40.0)	2
Computers will kill creativity	46(43.8)	30(28.6)	29(27.6)	1.83
Customers will prefer manual to CAD designs	34(32.4)	31(29.5)	47(44.8)	2.05
There is constant electricity	27(25.7)	31(29.5)	47(44.8)	2.19
I'll feel confident when using CAD to design	21(20.0)	63(60.0)	21(20.0)	2
I would like to learn more about CAD	13(12.4)	29(27.6)	63(60.0)	2.47
CAD will make the designing process interesting	6(5.7)	45(42.9)	54(51.4)	2.45
CAD can influence designers' skills greatly	16(15.2)	32(30.5)	57(54.3)	2.39
I feel that using CAD will be stressful	45(422.9)	21(20.0)	39(37.1)	1.94
The use of CAD will make people lose their jobs	35(33.3)	30(28.6)	40(38.1)	2.04
I feel CAD will be complex	27(25.7)	23(21.9)	55(52.4)	2.26
Installing CAD will be expensive	8(7.6)	25(23.8)	72(68.6)	2.6
CAD will make the design better and more accurate	3(2.9)	53(50.5)	49(46.7)	2.43

Computer literacy and technological know-how seem to be the most influential factors affecting CAD adoption. From the oral interview, some fashion designers were not computer literate and had not been using any software in their designs. They submitted that the willingness of customers to pay for additional services using CAD software to design limits their adoption of the technique. Similar factors affect the adoption of technology in textile firms in Nigeria [17,18]. Maintenance seems to be a concern for a majority of respondents, with more than half indicating that they always consider it. This reflects the importance of software upkeep and support. User-friendly interfaces, affordable pricing models, energy efficiency, and robust support systems could help address these concerns and improve adoption [19].

(Table 5) shows the relationship between the level of education and awareness of CAD among fashion designers with (p=0.000) given that the p-value is less than 0.05 (alpha value). This implies that the level of education has no relationship with the awareness of participants. The Correlation Coefficient value of -0.451 indicates a moderate negative correlation between the

level of education and awareness. This means that as the level of education increases, the level of awareness tends to decrease

moderately [20,21]. The decrease in awareness with increasing education is not extremely strong and does not imply causation.

Table 4: Assessment of the factors influencing the adoption of CAD.

Factors	Always	Rarely	Never	Mean
	Freq (%)	Freq (%)	Freq (%)	
Computer Literacy/technological know-how	69 (65.7)	28(26.7)	8(7.6)	2.58
Level of education	41(39.0)	42(40.0)	22(21.0)	2.18
Lack of training	55(52.4)	41(39.0)	9(8.6)	2.43
Cost of Installation	64(61.0)	32(30.5)	9(8.6)	2.52
Maintenance of the software	58(55.2)	36(34.3)	11(10.5)	2.44
Constant electricity	61(58.1)	41(39.0)	3(2.9)	2.55
The educational level of customers	45(42.9)	45(42.9)	15(14.3)	2.28
Customer's desire	48(45.7)	41(39.0)	16(15.2)	2.3
Willingness to pay for designers' services	59(56.2)	43(41.0)	3(2.9)	2.53

Table 5: Correlation analysis showing the relationship between the level of education and awareness of CAD among fashion designers.

Variable	Correlation coefficient (r)	Coefficient of determination (r^2)	Percentage contribution	P value
Level of education Awareness	-0.451	0.203	20.3	0

Table 6: Correlation analysis showing the relationship between selected socio-economic factors and perception of fashion designers.

Variable	Correlation coefficient (r)	Coefficient of determination (r^2)	Percentage contribution	P value
Perception Factors	-0.21	0.044	4.4	0.034

While higher education might be associated with lower awareness in this context, it's important to promote education that emphasizes critical thinking, information literacy, and the ability to assess and seek out accurate information. (Table 6) shows that there is no significant relationship between the perception of the fashion designers and factors affecting the adoption of CAD (p= 0.034).

Recommendations

Based on the findings, it can be concluded that a significant number of fashion designers in the study area were females, married, had tertiary education, and operated as sole proprietors. While CAD awareness was high, adoption rates were lower. Most designers operated on a small scale and expressed interest in learning more about CAD. However, concerns were raised about

the cost and complexity of running CAD. Computer literacy and technological know-how seem to be the most influential factors affecting CAD adoption. Also, lack of training and cost of installation were considered barriers to adoption. Respondents' level of education has no relationship with the awareness of CAD and no significant relationship between selected socio-economic factors and designers' perceptions.

The study therefore recommends the following:

a. Policy-makers in fashion should strive to provide equitable access to information regardless of education level. This could involve improving information dissemination methods, utilizing multiple communication channels, and ensuring that awareness is not solely dependent on formal education.

b. Stakeholders can provide accessible training, demonstrate CAD's benefits, and foster an understanding of how CAD can complement and enhance designers' skills.

c. Encourage collaboration between fashion designers, technology experts, and government agencies to foster innovation and integration of CAD in the fashion industry.

d. Further research could delve into the underlying reasons for the observed correlation. Understanding why higher education is associated with lower awareness could provide insights into how education and awareness intersect.

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