Developing a conceptual model for restructuring apparel sampling development process using virtual reality technology

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Abstract:

The prototyping process, which is centralized within the apparel product development process, is a time-consuming and costly process for many apparel companies today. By minimizing the sample development time and optimizing the sample development process, apparel companies including buyers and manufacturers will benefit from resource efficiency followed. This paper employed an explanatory and exploratory multiple case study research approach to investigate the current sample development processes in five apparel companies in Egypt to explain the traditional sampling process to show the main process in handling the samples between apparel buyers and suppliers. The study results showed that physical samples couldn't be fully avoided because of the need of buyers to touch the used textile materials. Therefore a new blended model has been developed to enhance speed to market using three dimensional virtual sampling together with physical sampling techniques.

The resulted model which called blended sampling process model (BSPM) is proposed. The solution and the resulting implications for the adjustment of the regarded sampling procedures are explained. A positive effect of adopting virtual technology in sampling process such as reducing the number of samples produced and consequently reducing the cost is expected.

The developed model would act as a guideline for future implementation and would evoke the interest of retailing importers companies and manufacturing export companies to achieve a lean supply chain therefore satisfying their customers.

Introduction

The competitive pressure of globalization is causing textile and garment manufacturers to lower production costs and increase their efficiency. To be able to cope with these changes, measures must be implemented, including the improvement of the internal organization, and the establishment of co-operations with external organizations to create a continuous supply–demand network. The research conducted by McNally et al (2011) claims that speed to market and product quality both enhance product profitability, being the impact of speed to market larger than the one from product quality.

Pressure in the clothing industry to produce more collections under shorter lead times has led to the emergence of 3D technology, a computer technology to assist in the design of a garment product (Liu, Zhang and Yuen, 2010). One of the major challenges in the industry is to ensure that the fit of a garment is as close as possible to its target customer. In most cases, this implies providing a sample, which means patterns need to be made, fabric cut, pieces sewn together and products then shipped to the client for a fit session (Clarke and Wilhelm, 2011).

Now more than ever, garment suppliers must be able to quickly adapt to the retailers' buying requirements (S.F.Qin, 2008). The improvement of pre- production as well as production processes is critical in order to overcome these challenges.

Furthermore, by definition, product development is a very accurate process and 3D design assumes a level of precision that in the early-stages is not available. This CAD tool met this accuracy by exploring processes that can create a better initial framing of the problem, which afterward requires fewer prototypes and as a consequence removes a number of options from the solution space (Fixson and Marion, 2012).

Although the technology for virtual prototyping of garments is available today, it is still unclear whether this is economically viable in the individual case. Holistically viewed, in light of this paradigm, the feasibility of integrating new resources and technologies into existing pre-production systems should be evaluated and tested beforehand (R.Molfino and others, 2009)

The sampling process traditionally involves the use of illustrations, sketches, fabric swatches and photographs by the manufacturers to convey ideas to the purchaser. This progresses to the production of sample garments which are assessed for quality, fit, feel and aesthetics. The purpose of the sample development process is for the retailer to certify that the supplier understands and adheres to the specifications established for a specific product (Park, 2009).

This process which is centralized within the apparel product development process is a time-consuming and costly process for many apparel companies today. By optimizing the sample development process, apparel companies including buyers and manufacturers will benefit from resource efficiency followed. This paper employed an exploratory multiple case study research approach to investigate the current sample development processes in five apparel companies in Egypt, and to suggest process improvement methodology, by using virtual sampling technology besides physical sampling (blended sampling).

Objective

The purpose was to identify the sampling process in the conventional garment sampling process within export-import context, and design a possible theoretical conceptual model for applying a new suggested sampling development process, aiming to improve the performance of this process and reduce the number of produced samples using virtual reality technique.

Research questions:

What is the traditional sampling process in apparel export-import context?

How could we improve the sampling process by integrating 3D visual technology (blended process)?

What is the impact of using this new concept on the sampling process?

Limitations

The paper will focus on the sampling process within apparel import-export context.
We will investigate the process through exploratory case study in five apparel manufacturing companies in Egypt.
The products would include only body-fitted knitted clothing.

Originality/Value

Although all the previous researches had focused on the technical side of product development and how to develop 3D virtual models, no study has been found to show how virtual sampling processes could be integrated in Export-Import context, and what would the expected results be for such initiative. This paper is initiated to close this gap.

Finding a new conceptual sampling model in apparel export-import context capacity is very important not only for apparel manufacturing companies that need to reduce the time invested in sampling process and reduce its cost but also for fashion buyers and retailing companies in getting the best services on time using up to date technology.

Background

3D body scanner

With the aid of 3D body scanners, fit-relevant information for garment design such as 3D body shape, body posture, body cross-sections, and curves and surfaces can be generated (Roedel and Morlok, 2011). In our research work, 3D body scan data are suggested for developing an innovative 3D construction method of body-fitting clothing such as knitted sportswear.

3D design technology and Virtual prototyping

By 1990, 3D design technology was commonly used in aeronautics, furniture, automotive and many other industries—but still not in fashion. The number of apparel companies willing to experiment with 3D fashion technology was few. In addition, because of the complexity of the original 3D programs, fashion designers, who found the technology too difficult, resisted adopting it (Krzywinski,S.;Sigmund, J.2011). Only in the last decade 3D technology made its revolution and gained acceptance as both a design and a merchandising tool in the clothing industry (Zhong, Y.Q., 2011). It is now recognized for its effectiveness in streamlining product development and is applied throughout the supply chain.

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Based on the results of many recent research works such as (Rudolf,A.; Jevšnik, S. Stjepanović, Z. & Pilar, T., 2008), (Rudolf, A.; Jevšnik, S. & Stjepanovič, Z. 2012), (Stjepanović,

Z.; Pilar, T.; Rudolf, A. & Jevšnik, S., 2012), (Ancutienė, K. & Sinkevičiūtė, D., 2011), it can be assured that virtual prototyping is a promising technique that has a potential to replace conventional garments' prototyping. However, it can be successful only when all specific characteristics of the textile materials and accurate virtual body models that simulate the garment fit are fully taken into account.

Maged Kamal. (2014/1), has introduced a successful experiment for producing cycling sportswear by creating automated 2D pattern for body fitting sportswear using 3D Technology (3D design Concept from Lectra), taking into account the used weft knitted material properties. The Bicyclist reported the prototype cycling Bib short fit to be perfect, provided him with a more wearing comfort feeling, as its look and silhouette in relation to his body shape were accurate. He also reported the overall fit to be a 4 on a 5 point scale (where 5 was perfect).

Sampling Process

During the sample development, samples are produced and technical specifications are developed for each product. A critical outcome of this process is to determine the product's manufacturability, costing and fit to fulfill the buyer's requirements, specifications and expectations (Kincade, 2008).

Problems attributed to the sample development process, including high cost of sample making, long development time and lack of understanding of end user's desires, were reported by Adnan (2013) .

As the sample development process involves making physical samples, changes made after the design stage or even in the manufacturing stage of the apparel product development process are often ineffective and costly (Lowson, 2003).

Knox (2002) identified two crucial parameters of the apparel sample development process:

(1) cost of development and,
(2) time of development.

Importance of Samples in export-import context

Sampling is the best way to place an order. Though it is a difficult and time consuming process, it will help the exporter to get the order from the buyer. The purpose of sampling is not only to get bulk order but also to give some additional benefits to the exporters. By doing sampling, the exporter can estimate the yarn consumption for developing the fabric, get a clear idea on costing and manufacturing difficulties, and

optimize the processing parameters for mass production, which help to avoid all kinds of bottle necks.

When working with apparel buyers, suppliers will have to keep on sending samples to them very often. They have to spend too much time/ money on these samples. Still—these samples are inevitably important to develop business. Sometimes, even the buyer is not so confident of some enquiries; if samples are good and attractive at reasonable prices, they will bring orders to suppliers.

Virtual sampling

The approaches for designing virtual garments may be categorized as '2D to 3D' and '3D to 2D'. The former refers to draping flat digital pattern pieces on a virtual mannequin, and the later indicates the development of clothing design on a realistic body and subsequent flattening into 2D pattern pieces. Several computer-aided design (CAD) systems for garment visualization in space have already been introduced into the clothing industry for example:

Gerber Technology has recently introduced 3D Direct™, a user-friendly 3D flattening software package. This software takes a 3D model of a car seat, for example, and allows the user to flatten it automatically into 2D parts which can then be used in the AccuMark or CutWorks software (Gerber's 2D PDS). This can take days even weeks out of their product development cycle. The 3D flattening software minimizes the need to make "full-size physical prototypes" required to create flattened patterns. The software also has a color coded stress visualization feature that allows the designer to view points of stretch and sag (Gerber technology , 2014) .

Lectra has developed a 3D design solution software called DesignConcept 3D (DC3D). The software targets the home furnishing and automobile industries. Realistic virtual prototypes can be generated. The software is able to identify areas of fabric compression and extension to produce a more realistic image.

Modaris 3D Fit, Lectra's virtual fashion prototyping solution enables pattern-makers to control garment fit with expert precision. Validation of styles and specifications is facilitated, and approvals for entire collections are accelerated. This will allow the user to test their garments by virtually sewing them together and trying different fabrics and textile designs without producing a physical prototype (Lectra Systems,2013) .

Lectra's 3D technology was to ease

communication, reduce misunderstanding and errors, and decrease the number of physical samples from two or three to a single prototype. Lectra's virtual fitting room has been developed to be as accurate as a live fit session and practical for both designers and pattern-makers. The ability to work with flat patterns and 3D simulations at the same time contributes to more accurate finished patterns, which preserve style and fit decisions made throughout the development process. "With the 3D solution, we have managed to eliminate various prototyping phases. Now all the departments involved in making a product can work closely together from the first simulation (Lectra Systems,2008) .

 In OptiTex Runway ™, changes can be made to a 3D image, and the style changes can instantly be seen in the 2D environment. The patternmaker can change the styling according to their preferences, for example, adding darts and dropping necklines. With these sophisticated visualization tools, merchandisers and sales personnel can play the "what if game." Styles can be adjusted according to the customer's preferences, viewed and sent directly to the patternmaker via email (Optitex ,2014).

The use of virtual sampling is still unusual in the traditional apparel companies, yet there is a potential for virtual reality to reduce the time and effort exerted in the sampling (prototyping) stage and consequently reducing the order processing lead time and improving the communication effectiveness within the supply chain (Fixson, 2012),

Three dimensional (3D) virtual sampling is visualization of garments and fabric drape on a 3D avatar. Using this technology, users can choose and modify garments, apply fabric properties, and test various garment-design modifications on a 3D fit model, or their personal avatar. 3D virtual sampling could minimize lead times and costs of producing physical prototypes. This Provides flexibility and efficiency for product development among globally distributed teams of designers.

Collaboration in Virtual sampling

Because of ever quicker production cycles, the ability to collaborate and share information is an essential success factor in the fashion industry. Product Data Management (PDM) and Product Lifecycle Management (PLM) solutions are important tools to manage those collaborated processes. PDM/PLM systems enable enterprises to manage and organize data by putting it together in a single environment. Besides stocking all information together, PDM/PLM systems also

coordinate all product aspects during its lifecycle, from the initial concept to its eventual disposal.

According to Maged Kamal, (2014 /2) it is recommended for the export oriented apparel companies to use a new approach of Visual Planning and Control system (VPCS) instead of the conventional one to ~~be~~ solve the common problems facing those companies that use traditional methods in planning and controlling ~~of~~ their processes. Adopting ~~of~~ VPCS could cause a positive effect during planning for sampling process.

Research Methodology

Because of the research questions defined above, the nature of the study is both exploratory and explanatory. In fact, the following part of the paper not only describes the sampling process in the apparel industry, but also proposes a new conceptual model to best use for virtual reality toward enhancing the sampling process between buyers and suppliers

The chosen methodology is multiple case studies. Though there are no precise guidelines as to the number of cases that should be included in this type of study, the widest accepted range falls between two and four as the minimum and 10 and 15 as the maximum (Ghauri and Gronhaug, 2005). We chose five as this number falls into the middle band of the recommended range. So the study involved a sample of 5 companies belonging to apparel manufacturing; the sample of companies from Egypt that export their ready-made body fitting clothing to the American and European market. All the companies produce knitted products and have to run their sampling process many times a year for 70% of their items. Most of the companies included in the sample export their products to western countries, using both retail and wholesale channels.

The prime source of data in this multiple case study was a single, semi-structured interview with a key informant, usually the general managers and department heads, selected with the aim of providing a comprehensive picture of the actual situation. Two principle approaches were followed in the research process. The first involved a series of semi-structured and informal face to face interview approach as this provided us the opportunity to probe beyond initial responses, resolve ambiguities, and even overcome any unwillingness to answer particular questions with factory managers. These interviews were conducted with five senior managers from a range of five apparel companies (A, B, D, E, F), the interview protocol included structured questions

such as:
- Please describe your industry sector and the role of your company in it.
- Please describe the Sampling process in your company.
- Please indicate the type of samples required by buyers, number of samples for each type, and the average time for producing each of them
- What is the average cost for producing a sample?
- Would you use virtual sampling in your business as a supplier? Would it be accepted by your buyers?
- How would you perceive the effect of the introduction of virtual sampling on supply chain performance?

Information obtained from the interviews afforded novel insight into a range of issues relating to their conventional sampling process, and also the main types of samples required by their buyers.

The second approach involved an exploratory case study method analyzing the collected data and investigating a new conceptual model that involves restructuring the old process and develops a new conceptual framework for a new sampling process integrating the virtual tools available in the market nowadays, aiming to enhance the sampling process efficiency.

FINDINGS AND DISCUSSIONS

Organizational Characteristics of Export Firms

(Table1) provides a summary of the organizational characteristics of the export firms studied. It may be observed that the majority of the firms have 10 years or more experience in the ready-made clothing sector.

Table 1: Background information on the companies in the exploratory study

	A	B	C	D	E
Nature of business	manufacturer	manufacturer	manufacturer	manufacturer	manufacturer
Product sector	Knitwear	knitwear	Knitwear	knitwear	Variety
Turnover (USD)	30 million	10 million	7 million	6 million	20 million
Geographic market served	North America and Europe	North America and Europe	Europe	North America	USA, Europe
Number of employees	1300	560	450	380	1000

Nearly 80% of the responding firms have a department, which is responsible for the overseas operations and in 80% of these firms, export departments are responsible for export activities. Marketing departments carry that responsibility in 20% of those firms.

Description of apparel sample development process

From the data collected, we have found that the garment factory proceeds many styles for each buyer, and works with different buyers. It proceeds in average 200 pieces (pcs) monthly/client and the average cost for these samples is about $2000, which means that the average cost for one sample is $100.

The average number of clients per factory is 8 clients, which makes the average total samples of 1600 pcs/month or 19200 pcs / year with a total average cost of $1920000 using DHL or such courier to ship samples at factory cost, which is a lot. Each package costs about $50 - $200 to send.

So one of the aims of this paper is to propose how to reduce the physical samples by integrating virtual technology to reduce this costly process

It is found that a sample development process reaching an approval for production could take eight to twelve weeks using a domestic sample department. On the other hand, it takes approximately 3 weeks to produce the first sample for an overseas manufacturer and approximately 6-8 weeks to completely develop a sample, including communicating back and forth between designers and manufacturer.

The communication during the sample development process includes the flow of information (i.e. flow of ideas, comments, sketches and specifications) and the flow of physical artifacts (i.e. the physical samples). Effective communication facilitates the product development process to produce "right" products according to customers" inquiries

Developing a Conceptual Model of blended sampling

Fig.1 shows the   overall traditional sampling process in the apparel factories and its relation to product development concept starting from idea generation (1 Week) - technical development (2D pattern)- sample production- try on (fit-quality-

style) (2-4 weeks) - technical development (4-6 weeks) - show room – production (Grading variations)- sales man sample production
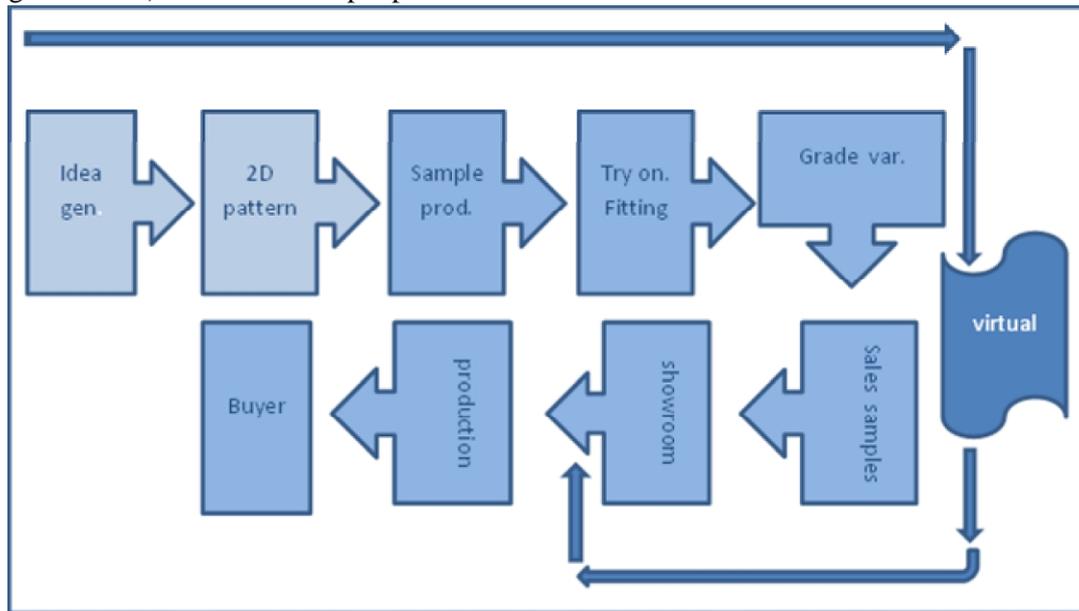

Figure 1. The traditional sampling process and its potential to be made virtual

Now we are going to focus on using virtual technology in reducing product development time with focus on improving the performance of the sampling development process.

Samples 'categories

There are three categories of samples, namely design, sales and production. Design samples test design interpretation and readies the pattern for production. Sales related samples test buyer acceptance. The last type of samples has the purpose of testing application and consistency in production. We have scanned all common types of samples which include nine types (Figure. 4)

Blended sampling

Blended sampling is a new mode of operation that can greatly improve the competitive position of companies adopting it. The key enabling technologies of blended sampling are 3D virtual sampling (VS) and 3D virtual fitting (VF).

This paper identifies the existing apparel sampling processes and briefly describes those physical steps that could be replaced by virtual technology. The paper then discusses the importance of blended sampling and its used applications.

From the point of views of the companies participated in the case study, it will be impossible for the buyers to accept samples 100 % virtual; the reason was that buyers need to touch the materials and see its quality before placing orders. For that reason, we have decided to consider designing this blended sampling model which includes both virtual and physical sampling in the same time.
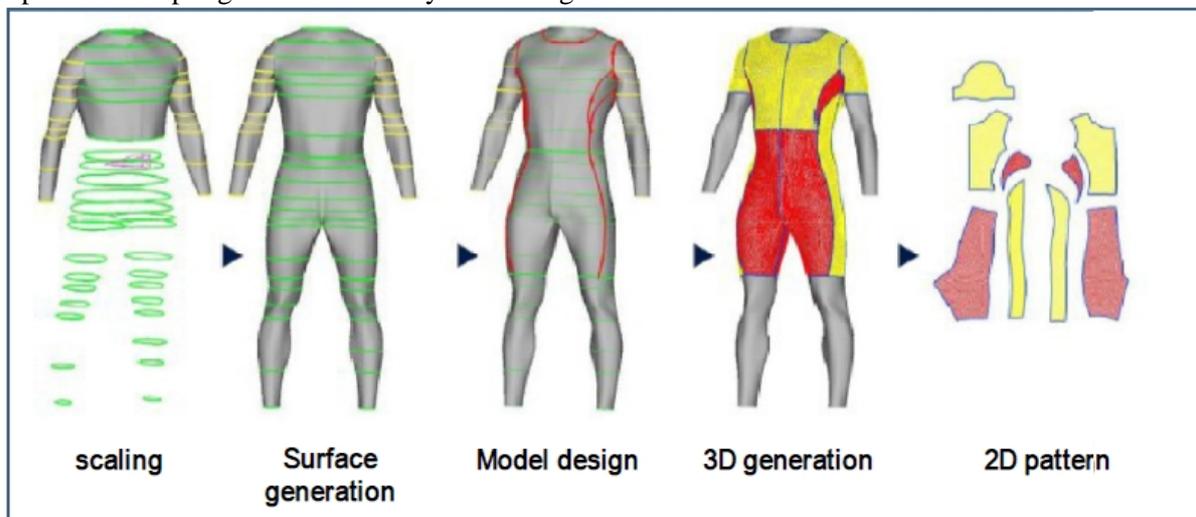

Figure 2. Automatic generation of 3D-surface into 2D-cutting patterns (Maged Kamal,2013).

Using Design concept 3D software, It is possible to import the torso from a body scanner and modify the body measurement according to the required size table, then design the model on the visual torso in 3D , then the program will convert the design directly to 2D pattern after feeding it with the required material properties (Fig.2)

After developing 2D Pattern, we propose using other software such as Modaris 3D Fit from Lectra/ or Optitex to test the fitting of the garment by virtually sewing them together and trying different fabrics and textile designs without producing a physical prototype. It is advised to use compatible file formats to be able to import the images smoothly so in our case we are supposing to use Lectra products as mentioned above (Design Concept 3D and Modaris 3D Fit)

To best use these virtual software to produce virtual well fitted samples and in the same time keep sending minimum physical samples to the buyers to let them feel the material quality, it is suggested to develop a blended Sampling Model (figure 3) , which consists of six main processes:
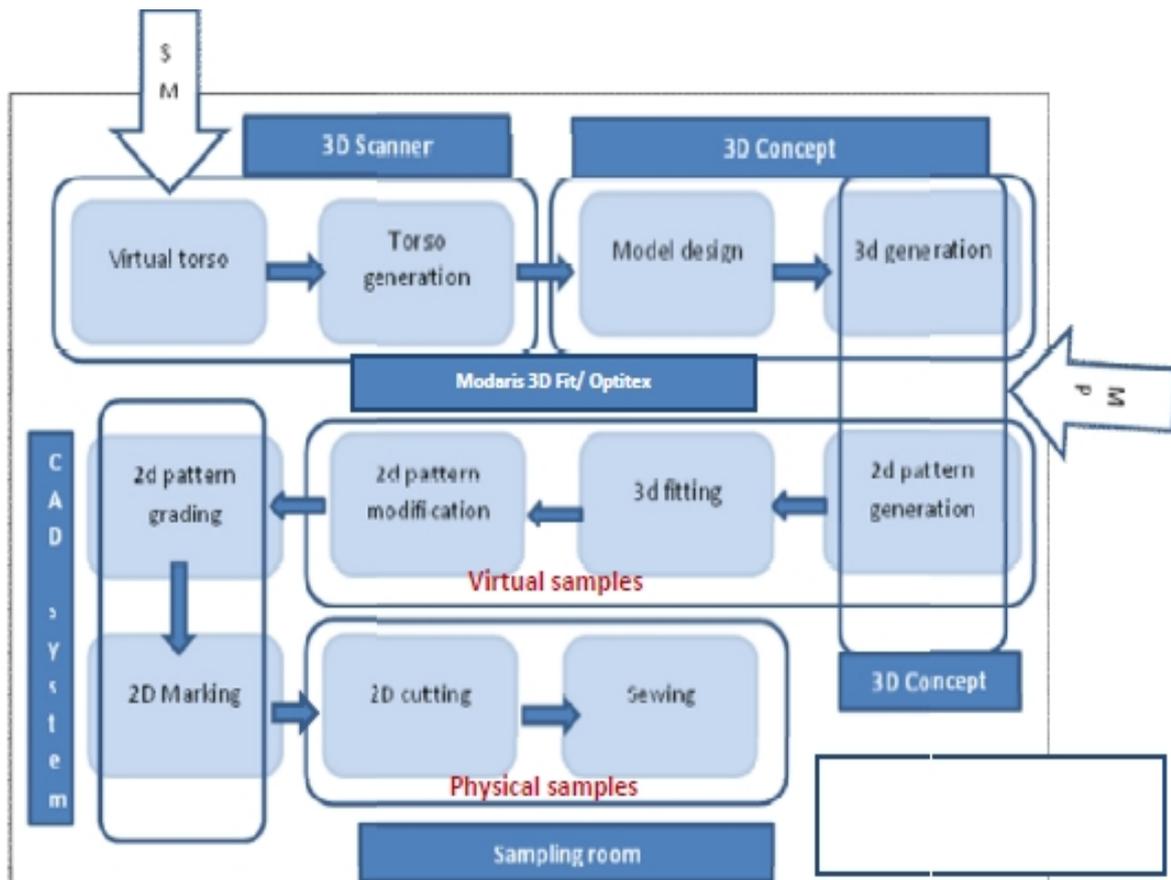

Figure 3: Conceptual Model for blended sampling process (developed by author)

1- Generating ~~of~~ virtual torso (using body scanning, or using ~~of~~ saved torso)
2- Generating three dimensional model (3D Design concept)
3- Automatic generation of 2d pattern considering the used material properties (3D Design concept)
4- Virtual fitting using **2D** software (and the same imported Torso) and modifying 2D pattern accordingly (Modaris 3D Fit/ or Optitex)
5- 2D pattern grading and marker making (CAD system)
6- Fabric cutting and sewing in the sampling room (sampling room)

Using this theoretical model will lead to reduce the number of physical samples from 41 samples in the current process to 24 samples in the proposed process (41%) (please see figure 4), that means saving in the total average cost by the same percent.

The theoretical blended sampling model as well as the expected saving in the number of physical samples that resulted from integrating 3D virtual tools have been sent to the five companies to get their final feedback. The feedback was positive but with only one concern- some buyers might resist this change and insist on getting many physical samples, especially when the sample costs are on the suppliers.
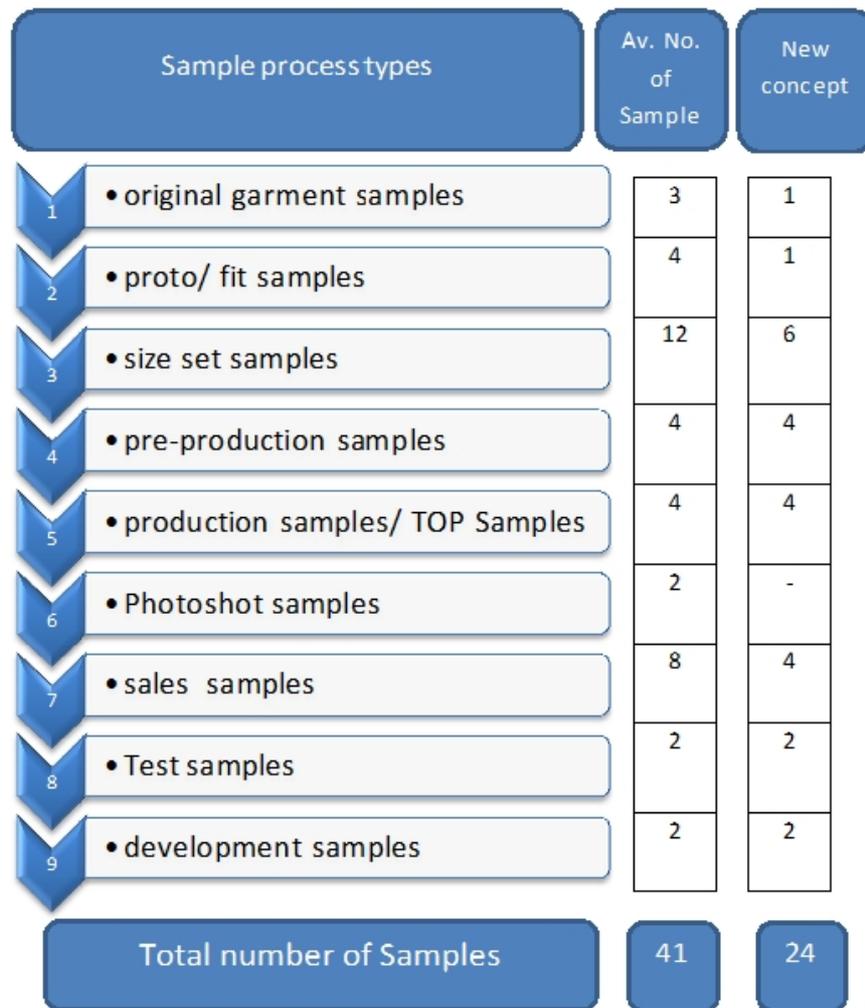
Sample process types	Av. No. of Sample	New concept
• original garment samples	3	1
• proto/ fit samples	4	1
• size set samples	12	6
• pre-production samples	4	4
• production samples/ TOP Samples	4	4
• Photoshot samples	2	-
• sales samples	8	4
• Test samples	2	2
• development samples	2	2
Total number of Samples	**41**	**24**

Figure 4: the average number of physical samples has to be reduced by 41%

Discussions & Conclusions

The paper aims to answer ~~to~~ some research questions regarding the integration of the virtual sampling process in apparel companies aiming to improve the performance and reduce the number of samples that should be handled between buyer and supplier. This paper starts with ~~a~~ analyzing the existing traditional sampling processes and a brief description of those which are currently with a significant economic impact. The paper then reviews the possibilities of reducing the no. of physical samples in the product development phase using 3D virtual technology methods that are available in the market nowadays. Based on the findings in five companies, a new approach has been developed aiming to best use the 3D virtual technology and include virtual software programs to reduce the amount of samples produced and consequently reducing their development time.

The new developed blended sampling process model (BSPM) in apparel export-import context has showed the potential of 3D virtual technology in enhancing the efficiency of the sampling process.

The data for this project was collected from multiple sources of evidence including official documents, interviews, a case study in order to collect real data about product development and sampling process in export-import context.

This study concludes that the use of BSPM could reduce the quantity of the physical samples produced and assist-in the selection of an optimal manufacturing approach. Additionally, using virtual technology makes the previously traditional operations much faster, more accurate and cheaper.

The outcome based on literature review and case studies strongly suggests that blended sampling process model (BSPM) could become part of the product development process in the near future.

Based on the model and its definitions, recommendations were made to apply for current apparel companies conducting similar businesses as the chosen case study companies.

The results showed a reduction in the number of

physical samples by 41% as a direct potential outcome of using 3D virtual sampling in apparel product development process.

The conclusion made was that the current sample development process could be optimized using a mix of virtual technology and physical sampling (blended approach). Buyers and manufacturers in the apparel industry need to work closer and more effectively in order to optimize the sample development process through joint efforts.

Further research

Despite the attention given to and the discussions that have resulted from defining and managing the sampling process over the past years, the development of a strong theoretical foundation in this area is still in a preliminary stage. The conceptual model developed in this study attempts to define and encourage a theory of blended sampling that can be further discussed, dissected, and advanced in a supply chain context.

The following are some of the areas that merit future attention. First, interesting findings might be obtained from studies that focus on investigating the opinion of apparel buyers (retailoring companies, brands, etc…) and their acceptance to get partially virtual samples instead of physical samples. Second, on the basis of the cross comparison of cases and the identification of the new blended sampling module, we hope that subsequent supply chain studies will investigate the "fit" between environment and new technology adoption in greater depth.

Finally, new approaches to managing different 3D virtual software integration are expected to be generated on the basis of a more critical investigation and review. This will further enrich theoretical and managerial development in this area.

Acknowledgement

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