

# Data Visualization in Dashboards through Virtual Try-on Technology in Fashion Industry

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**Abstract**—An online platform virtual try-on allows the user to wear different types of clothes, shoes or accessories, increasing online sales in fashion stores. The goal of this work is to evaluate how to synthesize the obtained data from a virtual try-on application in a compact way for fashion entrepreneurs. This will allow decision-making in entrepreneurs who lack financial and operational information that allows them to be aligned with their business objectives. In this context, the satisfaction and understanding of entrepreneurs through three dashboards were considered. The collected data was obtained from 118 women who interacted with our virtual try-on mobile application. Then, 20 fashion entrepreneurs were interviewed to evaluate which dashboard can synthesize the information accurately. In the three dashboards, the results showed levels of satisfaction and understanding above 7 points on a scale from 1 to 10 points, which is a high level of acceptance. However, each synthesis of data implies different considerations, advantages and limitations.

**Index Terms**—virtual try-on, data visualization, business intelligence.

## I. INTRODUCTION

So far this year, there has been an increase in e-commerce in Peru. Five million Peruvians approximately buy online, motivated by the following factors: saving time, convenience and obtaining a reasonable price [1]. As a result, some companies in the fashion industry have restructured their sales processes to include e-commerce, which would increase sales and reach a more significant target [2]. In the same way, clothing retail stores grew 6.3% in 2017 and this year in Lima, an increase in e-commerce is estimated [3]. However, the returned items bought by e-commerce become a problem for the fashion industry. Around 23% of worldwide online clothing purchases are returned for different reasons that consumers fail to consider when they are about to shop online [4]. The main reasons why consumers return the product are wrong size, product expectations, product defects, late delivery, and others [5]. As a solution to the aforementioned problems, "Virtual try-on" was created to improve the online purchase experience. The virtual try-on tool is a new way to shop online that allows buyers to look at themselves wearing

different items of clothing without actually wearing them [6]. The problem Latin American retail entrepreneurs have is the misuse of financial and operational data, generating them to make decisions by their own intuition, causing inadequate planning and management of their resource [7]. The goal of this research was to evaluate the satisfaction and understanding of fashion entrepreneurs based on a proposed model. This model captured user data through a virtual try-on application. Then, a business intelligence tool was used to process data in three dashboards. Finally, the entrepreneurs evaluated the dashboards. In Section II, the related work is described. In Section III, theoretical foundations about business intelligence applied to retail and understanding considerations for dashboards are detailed. In Section IV, our proposed method is described. In Section V, experimental settings are detailed. In Section VI, results related to the evaluation of the proposed method is detailed. In Section VII, a discussion of results is presented. In Section VIII, the conclusions of this research are described.

## II. RELATED WORK

This section describes studies of business intelligence applied to small companies and satisfaction and understanding of the dashboard.

### A. Business intelligence applied to small companies

The adoption of Business Intelligence (BI) in small businesses can be very expensive, compared to large companies which assume the cost [8]. Although, there is the alternative of adopting a BI software as a service that allows the adoption of business intelligence cloud for small businesses [9]. The adoption of BI cloud in small businesses is very beneficial. As reported by Agostino et al. [10], the main critical factors of the adoption of the BI cloud of small businesses were implementation cost, the level of BI cloud functionalities, the access to data and responses of customer requests. Likewise, Hiziroglu and Ibrahim [12] proposed a Cloud BI design for the analysis of customer data, which allows sustainability in SMEs process their information and generate reports in accordance with the management of the customers. Similarly, Lopez and Guerrero [13] proposed an efficient BI cloud model

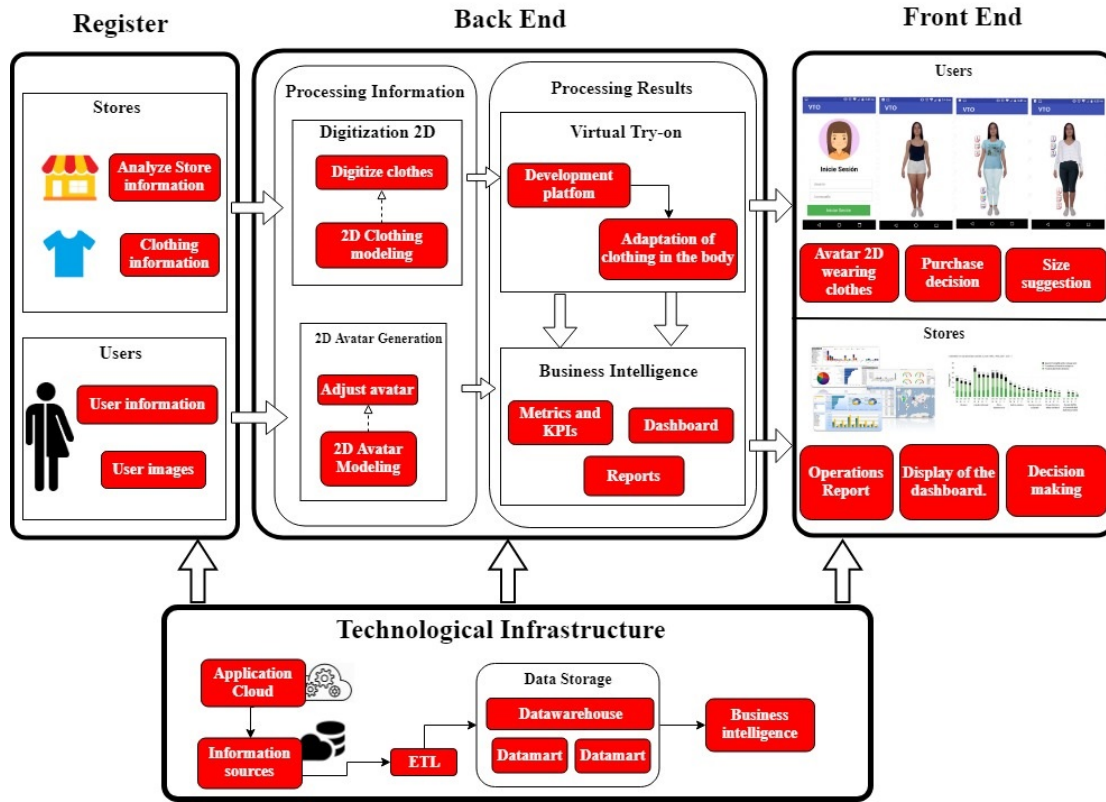


Fig. 1. Reference model based on the sections of Register, Back-End, Front-End and Technological Infrastructure.

that adjusts the needs of retail SMEs, improving information management and decision-making.

#### B. Dashboard: Satisfaction and understanding

The satisfaction of the user on the use of dashboard supported by a BI system generates a positive impact on the quality of decision-making and performance in the organization [14]. In addition, Cox [15], indicates that there is a positive relationship in the quality of the decision to greater use of dashboards, that is, the greater the confidence and effectiveness of the decision made, the greater the training. Similarly, the proper use of the dashboard is the ability that the user must have to understand, interpret and effectively use information metrics through data visualization. Likewise, the study carried out by Wakeling et al. [16] evaluated the understanding in the presentation of the data taking as variables the accuracy, speed and confidence of the users.

### III. THEORETICAL FOUNDATION

#### A. Business Intelligence

In 1989, Howard J. Dresner, of the Gardner group, defined the term Business Intelligence as a set of concepts and methods to improve business decision-making with fact-based support systems [17]. Subsequently, it takes as a reference a set of strategies that combine data, analytical tools and methodologies with relevant information, which allows organizations to make appropriate decisions [18]. BI satisfies the information

necessities of executives and business analysts to broaden understanding of their operations and define successful business strategies. In addition, BI provides users of the organization with crucial information to support their decision-making [19].

#### B. Dashboards

The Dashboard refers to a display of relevant information to achieve and achieve the objectives of the organization shown on a screen [20]. That is, a dashboard is a visual or graphic representation of information consolidated and organized in relation to the company's objectives [21]. The Dashboards are important for making decisions in organizations since they show the status of the objectives. An efficient dashboard is displayed on a page to favor the user's understanding in comparisons and analysis, identification of anomalies and patterns [20]. Dashboards help the executives to understand and analyze the processes of their business areas. For example, the dashboards help to understand sales patterns, manage human resources and improve production performance [22].

#### C. Virtual Try-on

Virtual Try-on refers to different types of virtual platforms that allow online consumers to wear one or more types of clothing, shoes, and accessories from an image, video, or graphical representation of consumers [23], thus shoppers can see themselves virtually wearing various fashion products [24]. In this way, the consumer's needs are met by having a

perspective and adjusting the product to make a safe decision [25]. The importance of virtual try-on focuses mainly on improving the online shopping experience for consumers, optimizing industrial purchasing processes and a new sales channel for fashion companies [26]. The standard flow of the virtual try-on process begins when users pose in front of a camera or mirror, depending on the type of technology. After the users, select one or more clothes, accessories and footwear of their choice. Finally, the product selected by the user adapts to his body [30].

#### IV. METHOD

The implementation of the reference model was associated with two tools: the first was a mobile virtual try-on application that captured user interaction data that was stored in the cloud database. The second was a business intelligence tool "Power BI" that extracted the data from the cloud database for the creation of the dashboards. Likewise, the reference model had four sections, as shown in Fig. 1, and its functionalities described in Table 1. The first section was "Register", which saved the information of stores and users. The second section was "Back-End", which generated the avatar of the user and digitized the clothes of the stores, the interaction between the user and the virtual try-on application, and the development of the dashboards. The third section was "Front-End", which presented the visualization of the virtual try-on application with users and the visualizations of metrics, reports and dashboards for fashion entrepreneurs. Finally, the "Infrastructure" that was the storage of information and the operation of virtual try-on operations and the business intelligence tool.

The dashboards show financial and operational information agree with the needs of fashion entrepreneurs. The variables were used to organize and show financial and commercial information being the most important and relevant according to the business. Among the variables used we have: Income, Net profit, gross profit, transaction per client, market demand, etc. [27]. Then, based on the "graph selection matrix" of Smith [28]. The variables were organized using graphics that allow to communicating the data in an effective way based on the information of Friel et al. [29] the authors established 3 levels for the understanding of charts. The first dashboard shows a distribution with graphics easy to understand these were taken from charts level 1 in the review. The second dashboard shows information that can help to detected opportunities using tables level 2 as the review showed. Finally, the third dashboard shows charts that permit a deep level of granularity for data. This granularity allows finding potential clients and products in demand by sector or age, using level 2 and 3 from review.

#### V. EXPERIMENTAL SETTINGS

##### A. Case Study

The objective of this research was to implement our model to evaluate the satisfaction and understanding of fashion entrepreneurs. This model was divided into two parts. First, 118 women interacted with our virtual try-on application to obtain their data. Second, 20 fashion entrepreneurs evaluated

TABLE I  
DESCRIPTION OF THE SECTIONS OF THE REFERENCE MODEL

Sections	Processes	Main Functionalities
Register	User register	The users enter their personal data: names, emails, addresses, age, sex, weight, height and front photo of your body.
	Store register	Retail entrepreneurs register their store catalog: JPG images of their clothes, brand, model, price, colors.
Back End	Processing information	Scan the images of the catalogs in 2D. Process and adjust the images of the users to generate the 2D avatars.
	Processing results	The virtual try-on application overlaps, adapts and deforms the image of the garment on the user's image. Business Intelligence processes virtual try-on data interaction with the users stored in the database. Then it generates graphics, tables, dashboard, indicators and metrics.
Front End	User	User perspective. Clothing combinations. Save combinations of clothes. Size suggestions. Purchase.
	Store	Control of sales by dates. Customer segmentation. Combination of various graphics.
Technological infrastructure		It is responsible for the operation of the virtual try-on tool to be available to users. The infrastructure stores the information of the users and store catalogs to process the information and use the business intelligence tool.

the dashboards with the information obtained from the virtual try-on.

##### B. Used Tools

It was used a virtual try-on app called "VTO", as shown in Fig. 2; the images of the clothes overlapped, adapted and fitted the user's image. Therefore, users could saw themselves wearing the clothes they chose. In addition, it was used the Power BI program to create dashboards using graphs, tables, indicators and metrics with data from various sources.

##### C. Measurement

The three dashboards were evaluated on a scale of one to ten, which one represented complete disagreement and 10 represented complete agreement. For the acceptance of this experiment, it established that the minimum value is 7.0. The values were presented in bar graphs and box graphs.

##### D. Procedure

In order to achieve the objective of this research, it was intended to measure the understanding and satisfaction of the three dashboards. First, a fashion store was used to create the virtual try-on (VTO) application. We proceeded to take pictures of the garments, then it was digitalized in 2D and stored in the database of the cloud, and finally it was included in the VTO catalog. Second, the VTO application was used



Fig. 2. Use of the virtual try-on application.

in 130 women between 19 and 35 years old with an online buyer profile. The women registered, generated their avatar and interacted with the VTO application. The information on women's interaction was stored in the cloud database. The average time of the interviews was 10 minutes. During the interviews, 12 women had to be discarded since their registration was erroneous. Therefore, we have considered 118 women for the creation of dashboards.

Third, the three dashboards were developed with the "Power BI" tool using the user interaction information, as shown in Fig. 3, Fig. 4 and Fig 5. The three dashboards present information related to the needs of fashion entrepreneurs. The graphs and metrics are based on other research taking into account the needs of fashion entrepreneurs.

Finally, twenty fashion entrepreneurs evaluated the dashboards. Ten rookies, who have no knowledge of dashboards. Five beginners, who barely have basic knowledge of metrics. Five intermediates, who have established knowledge of the dashboards and their use. A personal interview was conducted with each employer, where they interacted and evaluated the dashboard. The average time of each interview was 25 minutes. Some of them needed help in using the Power BI tool.

## VI. RESULTS

The results were based on the impact generated by these three dashboards, which are divided into basic, intermediate and advanced for dashboard 1, dashboard 2 and dashboard 3.

The satisfaction results of three types of entrepreneurs are shown according to their level of instruction: novice, beginner, and intermediate. a) The first dashboard shows lower scores 7.20, 8.07 and 8.27 points for novices, beginners and intermediate; b) The second dashboard shows scores 7.63, 8.13 and 8.40 points for novices, beginners and intermediate; c) The third dashboard shows high scores of 8.70, 9.20 and 9.20 points for novices, beginners and intermediate. It can see

TABLE II  
A SURVEY OF SATISFACTION AND UNDERSTANDING THAT WAS ANSWERED BY FASHION ENTREPRENEURS. EACH QUESTION IS EVALUATED IN A SCALE BETWEEN 1 AND 10.

Measure	Question	Objective
Understanding	Does Dashboard present the information clearly and concisely?	We want to know if the entrepreneur understands the dashboard clearly and concisely
	Does Dashboard help you understand the current sales situation of the business?	We want to know if the user understands the sales status of the business
	Does understanding Dashboard help you make decisions in your business?	We want to know if the entrepreneur can make business decisions when using the dashboard.
Satisfaction	How nice was the use of Dashboard?	We want to know how the user feels when using the dashboard
	Are you satisfied with the design and graphics of Dashboard?	We want to know if the entrepreneur is satisfied with the design and graphics of the dashboard
	Does Dashboard satisfy your expectations?	We want to know if the dashboard meets your expectations.

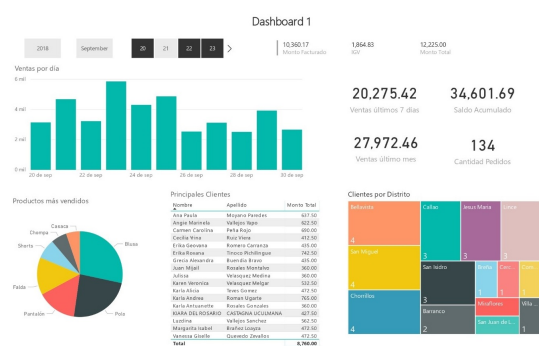


Fig. 3. The dashboard shows metrics of the invoice amount, the VAT, the total amount, the order quantities of 4 days, sales of the month, sales of the last 7 days, the accumulated balance of the month. In addition, a bar graph of sales per day, a pie chart of the most sold types of garments, a customer table with their respective purchase quantities, and a chart of the districts of customers from highest to lowest were included.

TABLE III  
RESULTS OF SATISFACTION FOR EACH DASHBOARD OF THE PROPOSAL. THREE DASHBOARD WERE EVALUATED BY FASHION ENTREPRENEURS WITH DIFFERENT INSTRUCTION LEVEL RELATED TO DATA VISUALIZATION.

Level	Dashboard 1	Dashboard 2	Dashboard 3
Novice	7.20	7.63	8.70
Beginner	8.07	8.13	9.20
Intermediate	8.27	8.40	9.20

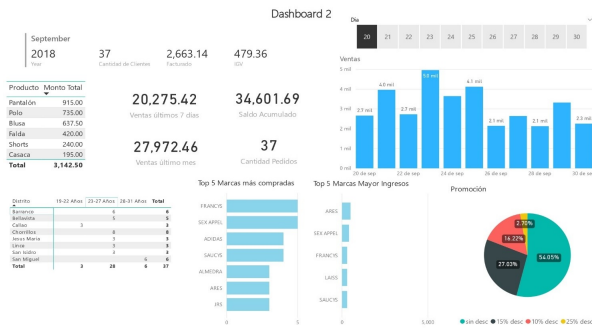


Fig. 4. Information displayed on the amount of the invoice, the VAT, the total amount, the sales of the last seven days and the last month, the amounts of the order of one day and the accumulated balance. Sales bar chart included for days. Added a pie chart of the promotions, a horizontal bar chart on the brands with the highest revenue and one of the most purchased brands. Finally, a table of the type of clothes with the total amount accumulated and a table of the districts by the age of the clients.

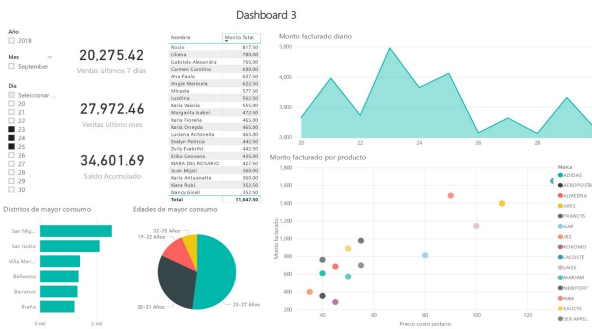


Fig. 5. The dashboard shows the metrics; accumulated balance, seven-day sales and the last month. A table of clients with their respective total amount and a graph of the amounts billed daily was included. A checklist was included that allows you to filter sales in a period of time that can be selected by day, month and year. In addition, a bar chart was included that shows the five main consumption districts and a pie chart of the customer ages. Finally, a graph of product comparisons by unit cost price and invoiced amount.

that the intermediaries have greater satisfaction in the three dashboards.

## VII. DISCUSSION OF RESULTS

The level of understanding and satisfaction achieved results above 7.1 points. The entrepreneurs were evaluated using the dashboards, as shown in the Fig.6.

The novices achieved the highest level of understanding in terms of 7.70 points for the first dashboard, and the lowest level of understanding in third dashboard, with an average of 7.25 points. They understood the dashboards, which makes them acceptable regardless of the level of instruction. Beginners and intermediates entrepreneurs did not show much difference in terms of understanding level in the case of the first dashboard, obtaining 8.80 points in both scenarios. However, it was in the second dashboard where those intermediates entrepreneurs stood out with a remarkable average of 9.00 points, as opposed to the 8.00 points obtained by the beginners. Therefore, intermediate entrepreneurs showed a high degree of understanding between 8.00 and 9.5 points, which

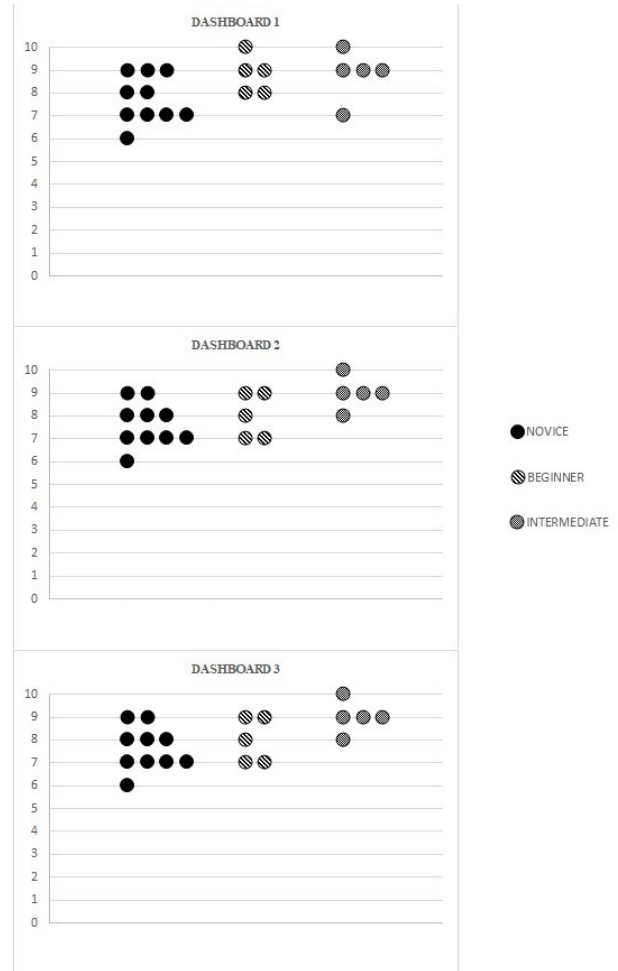


Fig. 6. The results related to understanding of three types of entrepreneurs are shown according to their level of instruction in dashboards: novice, beginner and intermediate. (a) The first dashboard for the intermediates and beginners had a high understanding concentration range with a value of 9, while the novices had a value of 7 and spread to level 9. (b) The second dashboard, it can be seen that the understanding of the intermediates is distributed around the 8 points; the novices are concentrated around the 7 and dispersion up to level 9; the intermediates are concentrated around 9. (c) The third dashboard, it can be seen that the majority of novices are concentrated between 7 and 7.5, beginners are distributed between 7 and 9 and the intermediates are concentrated around.

means that these entrepreneurs had an excellent knowledge of the information, which means that these entrepreneurs had more excellent knowledge of the information offered by this dashboard. On the other hand, the results of satisfaction, the first and second dashboards do not reach as much as the third dashboard, for the different levels of instruction, despite being the dashboard with the highest level of satisfaction. This is because all the retailers surveyed agreed that the third dashboard gave them more information about customers, products and sales, so they consider it relevant for making-decisions in their business.

## VIII. CONCLUSION

Our research was aimed at determining the suitability of data visualization in entrepreneurs in the fashion industry.

A reference model was proposed to extract data from 118 women, through a mobile try-on application with the purpose of showing on dashboards. Finally, we evaluate the satisfaction and understanding of the entrepreneurs with the respective dashboards. We have divided into three types of entrepreneurs: Novice, who do not know anything about dashboards. Beginner, who have basic knowledge about dashboards. Intermediate, who knows about the usefulness of the dashboards. The third dashboard was evaluated with a high degree of satisfaction, obtaining an outstanding average of 9.03 points. In contrast, the first dashboard showed greater ease of understanding, obtaining a range of 8 to 9 for the three types of entrepreneurs. Therefore, the first dashboard is understandable by all entrepreneurs, but it is not right for them. However, the third dashboard provides granular information, which is more useful for intermediate entrepreneurs, but it is not suitable for novices and beginners, but it is the one that most satisfies the three types of entrepreneurs. This research offers opportunities to improve the visualization of the data from the perspective of fashion entrepreneurs, as they would be interested in implementing the virtual try-on app in their businesses.

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