

A Work Project, presented as part of the requirements for the Award of an International Master's Degree in Management from the NOVA - School of Business and Economics

**Portugal's Position on the Opportunities of Blockchain and 3D Technology
in the Footwear Value Chain**

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Abstract

The Footwear industry is threatened by a shift in customer preferences, where digital advances seem to be changing the way companies operate and restructure their value-chain. Blockchain and 3D Technology are disruptive innovations that can support footwear companies in many ways and help the industry grow. This paper identifies and evaluates a set of concrete applications of these two technologies in each step of the value-chain of this sector. Additionally, Portugal has a very solid presence in the footwear industry globally. Thereby, a study was conducted: several qualitative in-depth interviews to footwear experts from Portuguese companies to understand the current position of these technologies. Correspondingly, the answers showed that Blockchain and 3D Technology had the potential for further investigation, application and research in Portugal.

Keywords: Footwear; Blockchain; 3D Technology; Portugal.

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1. Introduction

It is undeniable how much technology has advanced in recent years. Some of the key players in the world of internet and information have emerged and consolidated over the past years in different industries, revolutionizing once again how companies and businesses around the world work and evolve.

The Footwear Industry has transformed tremendously through time and across cultures. For decades, shoes have been made with a robust emphasis on style, comfort, durability and basic functionality, plus using the same methods and tactics for its production (Petro, 2015). Though, with new trends, preferences and innovations, consumers want more and expect more from brands, that consequently have the need to investigate more on how to bring their products into the future and how to gain competitive advantage to retain their customers by revolutionizing their value-chain. Some solutions could lie in Blockchain and 3D Technology. These two technologies have been disrupting industries for years and a variety of applications are already being used in the commodity-chain of some companies in this sector.

Nevertheless, the diffusion of innovation proceeds at varying rates in different countries, creating differences in the productivity, and consequently affecting the competitive position of nations (Mody, 1991). Portugal has a very strong presence in this industry as it is one of the top largest exporting countries of footwear in the world (Portuguese Shoes, 2017), and it is considered one of the industries with the most technological advances worldwide (INESC TEC, 2019). Thus, it is relevant to understand what the current situation regarding these 2 technologies is in this country, based on the applications and advantages they can bring. Thereby, this Work Project is conducted with the aim of: (1) providing an extensive overview of promising developments and applications of Blockchain and 3D Technology in each step of the footwear value-chain, (2) understanding the current position of Portugal regarding these

technological opportunities and (3) offering a discussion on the results and direction for future research for the Portuguese Footwear companies.

2. Literature Review & Theoretical Framework

Disruptive technologies are playing an important role in various industries, and in order to be successful and stand out from the competitors, companies are expected to track these innovations. As a distributed ledger technology that already exists for more than a decade, Blockchain has several applications that can play an important role in the footwear industry. 3D Technology is also a well-known study area for this sector that has already been integrated in some leading firms, such as New Balance, Adidas, etc (Sher, 2019).

Additionally, after a thorough analysis was conducted on Portugal's footwear market and its current technological position, it was found that, according to INESC TEC, it is considered a very advanced industry. In fact, the Centro Tecnológico do Calçado de Portugal (CTCP) every year organizes the STEP2FOOTURE project, where the main objective is to transfer and disseminate digital knowledge and technologies for footwear companies. One of the main areas of application developed is advanced manufacture, that includes 3D Printing. However, a necessity to understand whether any of these two technologies were actually applied in a practical and indeed useful context for footwear companies in Portugal was found. Therefore, the main research question of this paper is the following: *Is Portugal taking advantage of the opportunities that Blockchain and 3D Technology can bring to their footwear value chain?* The overall objective is to introduce concrete applications of these technologies that can be exploited in the respective steps of the footwear value chain and later understand if they are indeed already used by Portuguese footwear companies.

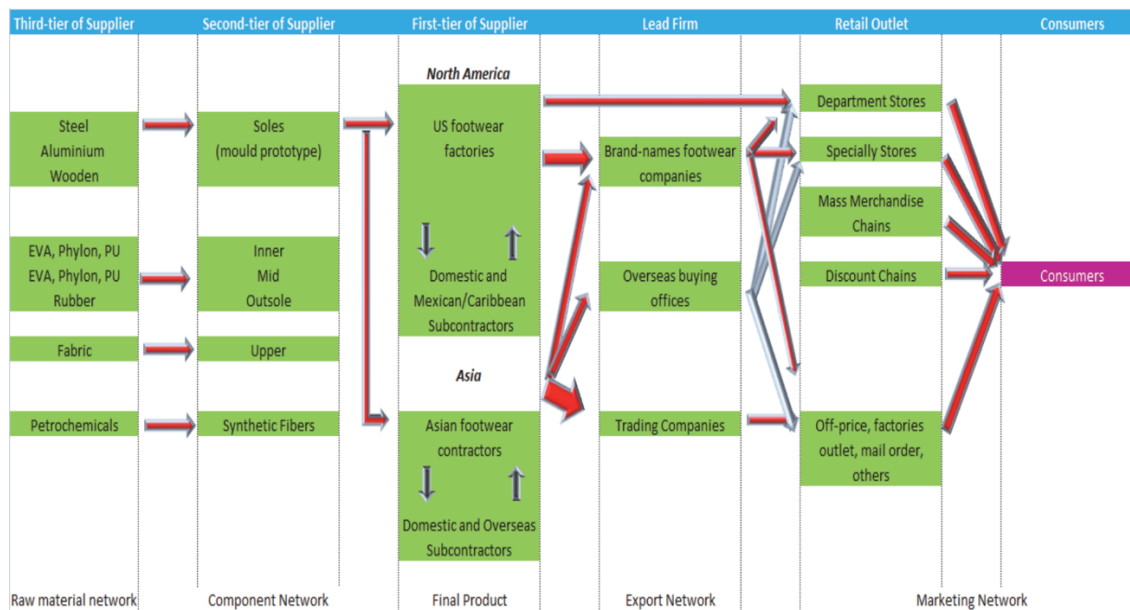
In a first step, a generic model framework of the footwear industry value chain is introduced. Afterwards, definitions of both Blockchain and 3D Technology are described, followed by the applications of these two in the footwear sector. Furthermore, a study on the current condition of the Portuguese footwear industry regarding these technologies is made, which includes a discussion and possible recommendations for future research.

3. The Footwear Value Chain

For this Work Project, it is necessary to clearly describe and identify all significant steps of the footwear industry value-chain in order to analyze it, as well as integrate new technological opportunities suitable for each process. So, for this matter, it is essential to follow a reliable framework to develop a structured and coherent approach.

The Global Value Chain theoretical framework has become a tool for companies to understand its competitive advantage and position in the global economy, by showing the relationships along the process and the great value added by the finished product. It was first introduced by Gary Gereffi in 1994 and it is characterized by the possibility of outsourced production developments in other countries due to the globalization in the latest decades. As the Footwear Industry has had a strong growth in the last decade (Portuguese Shoes, 2017), the industrial adjustment towards these changes in the world have been shaping its supply chain management into a more interconnected and liberal process. Figure 1 shows the footwear value-chain according to Joklan Goni, Yohanes Kadarusman (2015), adapted from Gereffi and Memedovic (2003) which gives a complete overall look over the chain and its interactions, from materials supplier relationships, production and sales cycles to the final export and marketing phase. It is organized in six main segments:

Figure 1. Footwear Global Value Chain



Source: Joklan Goni, Yohanes Kadarusman 2015, adopted from Gereffi and Memedovic 2003

Raw Material & Component Networks: The process starts with sourcing the raw materials needed to build each component of the shoe, meaning the sole, upper, mid, inner parts and also the synthetic fibers for the fabric. Other supplier companies such as textile or leather companies (Aleksandar Draganić, 2014) are usually responsible for these stages and, for the purpose of the Work Project, it is important to distinguish them from the footwear industry, that makes it into a finished shoe (Gereffi and Memedovic, 2003).

Production networks: In this industry, it is relevant to define what type of value-chain we are in. Footwear factories start the production once they have the necessary materials, where they can have their local factories, or operate with domestic and overseas subcontractors, which is what happens most of the times. For instance, for the leading firms in this industry, such as Nike, Adidas, New Balance, etc, they usually do not own any factories, but instead, have a decentralized production network in developing countries around the world (Merk, 2004). This is the so-called buyer-driven value-chain, where they design, market and sell the product, but

do not make it (Gereffi and Memedovic, 2003). According to the World Footwear Yearbook 2017, footwear production is strongly concentrated in Asia, which accounts for 87% of the world's share, whereas South America, Europe, Africa and North America alone do not account for more than 5% of world footwear production. The main reason for this is that this industry faces great challenges with the labor cost, due to the “short production life-cycle, high volatility, low predictability, high level of impulse purchase and the quick market response” (Nayak and Padhye, 2014). So, they have gradually reduced production and are now more focused on performing only commercial functions such as buying the raw material, designing shoes and distributing and marketing the finished product (Nayak and Padhye, 2014). It has become better and safer for their manufacturing operations to be located in areas where “low-wage labor offers quick turn-around at the lowest cost” (Appelbaum and Gereffi, 1994), that in turn converts into higher profits. Footwear brands, international buyers or retailers design for each piece and then communicate to the overseas subcontractors for the mass production to meet the growing demand, which makes these leading firms that dominate the industry extremely dependent on the outsourced footwear manufactures.

Export networks: After the production, either the brand-named footwear companies, the overseas buying offices or trading companies proceed to the distribution process, taking the finished pieces to the footwear brands or retailers who initially designed them and outsourced the manufacturing.

Marketing & Sales networks: This stage brings and introduces the creations of shoe designers around the world to the final customers, helps the buyers connect to the brand itself and increases brand loyalty. In the Footwear industry, the consumer cares a lot about the message of the designer and company behind each piece, so, it is extremely important to develop a good relationship with the public. New methods to gain the end consumer’s attention has become

more and more essential. Traditional marketing includes well-known activities like price deflation (promotions & sales seasons), getting the design and quality to match the consumers' needs and managing innovation (Hines and Bruce, 2007). Nowadays, with the merge of the Internet in our routines, e-commerce has been a widely used option by consumers and the global e-retail sales amounted to 2.8 trillion U.S. dollars in 2018 (Clement, 2019), and, as a consequence, digital marketing has been a popular strategy among many footwear retailers.

Lastly, although *Customer Service* is not in the framework followed, it is also a very important stage of the value chain in the footwear industry as it aims to ensure customer satisfaction. This includes showing the available inventory, help & make suggestions, handling inquiries and complaints and managing returns due to poor quality or wrong size/color.

4. Technologies in the Footwear Industry

In the following chapter, 2 technologies are introduced to the readers: Blockchain and 3D Technology. Definitions, basic concepts, theories and methods are discussed briefly to develop an initial understanding of the topics.

4.1 Blockchain

Blockchain, as the name implies, is a chain of blocks that contains information. It was adapted by Satoshi Nakamoto in 2009 to create the digital cryptocurrency Bitcoin and it can be compared to a block of data. However, instead of being a traditional data center, centralized by a company where only they can add information and make changes, Blockchain is decentralized. This means that thousands of people can not only share and add information but also check all data and transactions that have been made so far, as they receive a copy of the database automatically. Whenever there is a new transaction, a new block is created, usually

every 10 minutes (Melanie Swan, 2015), which, after going through the validation process by all the participants of the relevant Blockchain ecosystem, is added to the chain. These blocks are added in chronological order and are an ideal method for keeping track of all transactions on a network. This is why the so-called cryptocurrencies like Bitcoin can make use of this technology, as it is very good at keeping the historical balance of who spent what and for what. Since everyone has access to this data, everyone can get the entire transaction history of the network. A Blockchain entry is immutable, meaning that once created it cannot be deleted or changed.

Additionally, this technology is increasingly relevant and innovative because “it stands as a “trustless” proof mechanism of all the transactions on the network” (Melanie Swan, 2015). Users can trust on the public ledgers of this system that are stored all around the world on many decentralized “nodes”, instead of maintaining a relationship with a third-party intermediary, for instance a bank.

4.2 3D Technology

3D technology has gained a lot of importance in recent years and thanks to its innovations, it is possible to think bigger in various fields of application. For this Work Project, the focus is on both 3D printing & scanning.

A 3D printer is a totally different machine from the ones that print on paper. 3D printing, also known as additive manufacturing (AM), is an innovative technology that allows to quickly and accurately create a physical object from a digital model on a computer, where the three-dimensional object is created by laying down successive layers of materials with defined dimensions and texture details (Piperi, 2013). In general, 3D printers work as a hot matter injector (a plastic filament) or light emission on a moldable material. The most common ways for it to build up the layers are polymers laser fusion, binding small granular particles with a

laser or a liquid binding material, or extruding melted materials (Hausman and Horne, 2017). Moreover, as it can be used to create everything from simple prototypes and parts to highly technical end products, this technology can encourage and drive “innovation with unprecedented design freedom” (THINK3D TEAM 2015), where any idea can go directly from a design file to a product, skipping many traditional manufacturing steps. As for 3D scanning, it is a technology that analyzes a real-world physical object, environment or even a human body and digitally captures the shape of it. Besides digitizing all the measurements and structural details, it is able to convert the results into a file compatible with 3D modeling software. This technology is going through a boom just like 3D printing, where there exists a variety of 3D scanners, each suiting a different goal, and currently, even smartphones are built with sophisticated sensors that are capable of scanning in 3D directly (McCue, 2015).

5. Applications of Blockchain and 3D Technology in the Footwear Industry

Previously, it was introduced an ideal-model value chain of the footwear industry and basic models and concepts of Blockchain and 3D Technology. In this section, opportunities for integration and potential applications for both technologies in the footwear value chain will be discussed. The identified applications will be described and evaluated based on the importance for the footwear industry in each step.

(a) Raw material, components & production networks:

End-to-end visibility: As shown and described above, the footwear value-chain is mostly a buyer-driven value-chain, where the footwear leading firms are extremely dependent on the outsourced footwear manufactures & supplier companies, which consequently makes the managing of it and all its links involved in the creation of shoes a very complex process. They have to carefully choose the factories from the manufacturers according to their specific

production requirements, which makes them more exposed to different kinds of risks from these intermediaries, such as fraud, code of conduct violations and more. Hence, the major challenges faced by this industry within this process relate to information sharing and trust. Blockchain can overcome this problem by allowing the creation of aggregate records between manufacturers, supplier companies and footwear retailers. Each virtual or physical good can be matched with a complete list of transactions leading all the way up to the origin of an item, and each step in this process is recorded, from raw materials to finished products, resulting in resource savings and process bureaucracy (Patel, 2018). With this technology, shoe brands have more control over their shoe production, for instance, they are able to recognize weak links in their operations, such as a supplier providing defective/damaged materials or a production section not following quality standards.

Smart Contracts between suppliers: In the Blockchain context, a smart contract refers to a contract that can be executed or enforced on its own through a transaction, formalizing negotiations between two or more parties, without centralized intermediaries.

These types of contracts can obtain information, process it and take appropriate action according to the rules of the contract, which makes it a very autonomous, self-sufficient and decentralized compromise (Melanie Swan, 2015). This could be a way for the footwear firms to have more control over the whole negotiation between their suppliers and subcontractors. Moreover, it could reduce the transaction costs, as these intermediaries can charge significant fees and make huge profits out of it.

Eliminate high-volume production: One of the biggest problems of this industry is the waste and pollution of mass production to try to meet the consumers' demand and make the cost of production worthwhile. In 2017 there were produced 23.5 billion pairs and the footwear

industry is responsible for 1.4% of global GHG emissions, in which 60% of these emissions come from this stage (Quantis, 2018). 3D Printing could help reduce and simplify the production processes by printing customer-specific shoe orders, have smaller batches of collections and be more precise on the number of total shoes produced. By using this technology, this industry could even be more sustainable and less polluting since it wouldn't produce as much as in the traditional production methods. Furthermore, from this point of view, it might not even be efficient to outsource production anymore when a pair of shoes can be printed from almost anywhere at the same cost or lower. In fact, five footwear industry leaders are already using 3D Printing for the production phase, them being, Adidas, Nike, New Balance, Reebok and Under Armor (see Appendix I).

(b) Export networks:

Custom declaration optimization: Every time the finished shoes are shipped from the subcontractors, it needs a set of documents for every asset transferred that includes the value of the shoes, description of the content, export & import licenses, product commodity classification and other logistics information (Godbole, 2017). This huge number of documents need to be sorted out by the collecting logistics provider to pass on the information to other entities for process management and control, which is a data-intensive process. In this typical logistics network, the traditional tasks are labor-intensive and tedious which increases the processing time and the risks of errors, losses and fraud (Ganne, 2018). Blockchain can optimize this phase by sharing all this data within the logistics network, where all the information would be available for everyone anywhere and that could make approvals for goods at customs checkpoints more efficient and processing times shorter.

(c) Marketing & sales network:

Intellectual property protection: Shoe designers are really affected by counterfeiting, in fact, according to the OECD (Richter, 2019), today, shoes are the most counterfeited item in the world. As this industry has had a huge growth over the years and with the emerging of the fast fashion concept where consumers can rapidly keep up with fashion trends at a low cost (Bhardwaj and Fairhurst 2009), it has become evident for counterfeiters to respond to this success with a variety of imitation products from top designers, and try to deceive people. Blockchain can help manufacturers, designers and customers to protect their brands by implementing in each shoe an authentic chain of records that includes its origin, location and ownership of goods across the chain (Bhatia, 2019), whereas counterfeited shoes won't. Each shoe can have its own "digital identity", and some leading firms have already begun to use this technology. For instance, New Balance Athletics Inc. announced in October 2019 the launch of a pilot program to track the authenticity of a basketball shoe using a blockchain to provide trust and provenance for every customer by partnering with start-up Input Output Hong Kong's Cardano blockchain.

Shipment tracking and real-time delivery of products: As mentioned before, nowadays, consumers are increasingly buying online, and as a consequence, they must order the product and wait for it to arrive to get their hands on it. With Blockchains traceability and transparency characteristics, consumers can keep track of their current orders and even trace each pair of shoe back to the source (Patel, 2018). As it comes new data or information about the order such as delays or hitches, the shipping status is updated immediately, so, it gives the users a full picture of the lifecycle of each shoe order in each shipment. Additionally, it could allow them to schedule the deliveries at home whenever it is convenient. Alibaba is already implementing this for their e-commerce customers (Northam, 2019).

Improved Inventory Management: Inventory management is an important activity for any commercial or industrial company because its accuracy affects directly the purchasing of products by clients (Ali, 2012). In the footwear & apparel industry, customers appreciate that stores have the size they need available when they need it without waiting too long. To meet their demand, inventory systems need to have updated and accurate data, otherwise they can have the risk of short inventories or even give false statements to clients that wish to purchase. Blockchain could solve this problem as it maintains a system of records up to date of all the transactions and events, which in turn would give the precise number of shoes in stock as well as which sizes are still available (Xylus, 2018). Having this information, stores will always be ready to meet the needs and requirements of their customers who will be satisfied with the service they provide them.

Simplifying shoe shopping: Finding a pair of shoes that fits it's not always as easy as knowing the general shoe size, as it often depends on the brand or type of shoes that consumers desire. One solution for this can be by using a 3D scanner, which would scan the exact measures of the feet, meaning the length, the width and also the volumetric information about the foot so that each consumer is able to get the right size for them. Also, some companies are already taking advantage of this concept to make some recommendations and suggestions for costumers on styles of shoes that would better feet their foot according to this new data. This 3D scanner can be a pressure plate (Fitstation, powered by HP), a foot digitizer (used by the Japanese startup Flicfit) or even smartphones which Nike has already started to invest in it this year for its customers, where they only need to log on to the app and scan their feet using their smartphone camera (Hanbury, 2019).

Customized shoes: As production of shoes can get smaller and smaller with 3D printing, footwear brands can get even closer to the consumers' tastes and needs by giving them the chance to design their own shoes according to their preferences and with their specific measures using 3D scanning. It would not only improve the unique consumer experience but also save time and money for the designing and manufacturing processes. Each individual could order or even walk out of the footwear store with a shoe that has been perfectly customized for their foot in a matter of minutes.

(d) Customer Service

Increase customer loyalty & satisfaction: Transparency and trust are key to bring satisfaction to the client, and Blockchain is able to deliver these values since all the shoe information they store always remains updated. This technology brings to the consumers flexible, reliable and safe data, meaning certificates, descriptions and other data-certifying qualities which makes it really easy for everyone to be informed about the shoe itself.

Lower return rates: The lack of a universal sizing guide for footwear can cause frequent returns when a consumer orders online and it doesn't get the right fit. Consequently, reverse logistics can represent added costs for any company. As consumers get closer to 3D scanning and the improvements it can bring to their shoe shopping experience, a customized shoe with the shoe size corresponding exactly to the customers' measures can decrease these rates and let consumers more satisfied with the service.

6. Footwear Industry in Portugal

Portugal has a huge, high quality and fashion footwear industry that belongs to one of the most competitive and dynamic sectors of the Portuguese economy. In fact, in 1994, Michael Porter applied its competitive advantage model to Portugal, where he considered the footwear industry one of the “clusters” that should focus its energy, innovation and marketing to differentiate itself in international contexts. Since then, this industry has had several changes in its strategy and market position.

As mentioned before, due to the relocation of companies to developing countries, mainly in Asia, due to the high labor used in production and lower wages, Portugal, like many other countries in Europe with a strong presence in this industry, had the need to rearrange its strategy in order not to lose market value. These strategies were based on modernization, speed, flexibility, product quality and the adaptation to the demand of each market (DGEA, 2017). At the same time, domestic companies had to take on new marketing responsibilities, looking for new customers in foreign markets by participating in international fairs and marketing their shoes abroad. Today, the Portuguese footwear industry has a very consistent and sophisticated supply, including collections and private labels that have allowed the Portuguese footwear image to be associated, internationally, with fashion, creativity and design, without forgetting the know-how in terms of manufacturing (DGEA, 2017). This enabled the industry to move up the value chain from the relatively low quality “First Tier of Suppliers” position to directly reach the end consumer with high-quality products, or even continuing in this position, but for very prestigious brands of very high quality.

In fact, Portugal exports 95% of its production to 152 countries on five continents and it is the 13th largest exporting country of footwear in the world (Portuguese Shoes, 2017), which makes several international quality brands use Portuguese shoes factories to produce their footwear. Nevertheless, recently, there has been a huge growth in the number of national brands and own

design, with the creation of design centers and technological centers, taking the manufacture and quality of Portuguese shoes to higher levels (DGEA, 2017). According to INESC TEC, nowadays, the Portuguese footwear industry is one of the most advanced in the world, where it has invested heavily in the development of new equipment, the use of information and communication technologies and more demanding management methods.

Additionally, the industry is essentially characterized by micro, small and médium-sized companies (Banco de Portugal, 2018), concentrated geographically in Felgueiras, Santa Maria da Feira, Oliveira de Azeméis and S. João da Madeira, where the major sector associations are APICCAPS (Associação Portuguesa dos Industriais de Calçado, Componentes, Artigos de Pele e seus Sucedâneos), Centro Tecnológico do Calçado Português and Centro de Formação Profissional da Indústria de Calçado.

7. Addressing the Work Project Study

To address the Work Project topic, primary data was collected from interviews to specific associations and Portuguese brands to better understand the current situation in the Portuguese footwear industry from a technological point of view.

7.1 Methods and Data Collection

The purpose of this study is to formulate an understanding on whether Portugal is following and taking advantage of the newest technological advances and applications presented earlier in the value chain of the footwear industry, specifically regarding Blockchain and 3D Technology. This goal has been pursued by collecting data from 4 different players in this industry. Interviews were conducted to industry experts from 1 sector association and 3 Portuguese brands using a standardized written questionnaire that were made by phone call and lasted between 10 to 20 minutes. The questionnaire began with a segmentation question

organizing the players in two groups – 1. if any applications of these two technologies were currently implemented or about to be implemented in the value chain of the association/brand; 2. if there weren't any applications implemented or planning to be at all. The questions made to the first segment were focused to understand what type of applications are being used and in what stage of the value chain they are present. At this phase, the aim was also to gather information on how these technologies were improving the efficiency and productivity of the business by trying to improve and facilitate the management of the value chain. The questions placed to the players that did not have any applications implement (or planned to) had the objective of understanding the reason behind that decision and thoughts about the possibility of adopting these technologies in the future. The industry experts of each player were interviewed and chosen based on their professional background and position in the association/brand in question.

Table I - Detailed List of Interviewed Experts from Associations/Brands of the Footwear Industry

Name	Occupation	Company
Carlos Silva	Studies Office Adviser	APICCAPS
Joana Lemos	Founder & CEO	Freakloset
Eduardo Avelar	Operations General Manager	Ferreira Avelar & Irmão Lda
Simão Pereira	CEO	Magiperles - Calçado, Lda

Source: Own Presentation

**All the experts gave permission to use their interviews in this Work Project. Interviews are available by request.*

7.2 Presentation of the results

Valuable insights were extracted from the expert interviews, where the answers were mostly consistent with each other. Based on the brand/association profile, needs and current market position, the interviewees stated that neither of these technologies are currently implemented in

their value chain, meaning that all the players that answered the questionnaire were a part of the second segment.

Regarding Blockchain, Carlos Silva, Studies Office Adviser of APICCAPS, which is the leading sector association that represents the Footwear, Components, Leather Goods and its Substitute Industries in Portugal, stated that they know about the existence of this technology and its applications, however, *“from a practical point of view, we are unaware of its competitive and advantageous use in any company or sectoral organization linked to footwear, whether in Portugal or even worldwide”*, and, as a consequence, did not have Blockchain integrated in any stage of their value-chain neither on the brands they represent. Joana Lemos, Eduardo Avelar and Simão Pereira also declared that they never heard about this technology neither their possible applications or advantages to the footwear industry or to their brands.

3D Technology had some different opinions and experiences among the interviewees. Two years ago, Freakloset had a partnership with a Portuguese App created by André Garcês called “Feet It” that had the objective of scanning the foot using 3D scanning with a phone camera and identified what shoe size each person corresponded to, however, they were still testing and the functionalities weren’t working 100%, so they dropped the partnership and since then, the brand never tried anything related to that technology. 3D printing, on the other hand, was never used by any of the players for many reasons. Freakloset heard about this technology five years ago and started investigating a possible application in the production phase for the brand at the time, yet, as Joana Lemos, Founder and CEO, stated *“we could not implement it because at the time the 3d printer that we found available was used for shoes made of rubber, and was not prepared for leather and fabric, that are the materials used to create our shoes”* which made them give up on the idea. For APICCAPS, the manufacturing time of these technologies was an obstacle since it can be up to several hours, making it completely unworkable for their multi-

functional manufacturing processes. Moreover, a reason these brands and association all shared for not considering 3D printing & scanning is that they don't feel the need to, and when asked about the possibility of starting to use it, all of the interviewees believed that there is nothing in their value-chain that this technology could improve or be beneficial. Accordingly, Simão, CEO of Magiperles, affirmed that *“our current system works very well, everything is already elaborated, defined, and we feel no need to change that”*. In their current business configuration, no real problem felt by the experts can be solved by these technologies and *“it would be a huge investment that today we don't think it would be justified”* as Eduardo Avelar, Operations General Manager of Ferreira Avelar & Irmão, added.

7.3 Discussion

This Work Project was developed to present the current state of Portugal regarding the new opportunities that Blockchain and 3D Technology can bring to the footwear industry. Based on the interviews made to some of the players in the Portuguese industry, Portugal is not currently using/investigating any of these technologies or planning to. Knowing that Blockchain is a technology that has been around for more than a decade, it should be expected some adoption on the matter. According to Deloitte's 2018 global blockchain survey, 95% stated their company plans to invest in blockchain tech this year (2019), which demonstrates that, besides the footwear industry itself, a lot of other industries worldwide are already aware of the benefits and are challenging traditional business models with the use of blockchain. This shows and should encourage the Portuguese industry to go further on the research. Based on all the found applications of blockchain, it is clear that it has the potential to be invested in, and CTCP should help bridge this gap since it supports the technological innovations in this sector for the companies that represents. It is possible, however, to discuss several factors that may be influencing the few advances in this area by the Portuguese industry. First of all, the Portuguese industry is not characterized by large companies for whom this technology can certainly have

an important impact due to the control and efficiency they need to have throughout the value chain, integrated by players in various parts of the globe. In Portugal companies are concentrated in a small area of the country where practically everyone knows and contacts with great ease and can exercise the control needs of their value chain in a closer and personalized way. The business size also needs to be considered when it comes to technologies that require a significant investment, which are much easier for bigger companies, like Nike and Adidas, to do, than micro, small and medium enterprises. These large enterprises may have a greater incentive to invest in these technologies because, as mentioned before, today one of the challenges that they face is their reliance on the production companies for low-wage Asian end-products.

Nevertheless, Portuguese companies, as mentioned above, have been able to evolve technologically, so it seems that these difficulties could be overcome, as it has been in the past with the introduction of other technologies. The industry association APICAPPS may have an important role to play here, adding knowledge and critical mass to encourage the use of this technology. The influence of major market players in the introduction of this technology may also be an important point to discuss. Certainly, if part of the Portuguese industry that is in the “First Tier of Suppliers” position of the footwear industry value chain, producing for other brands, is stimulated by these brands to integrate this technology, a greater knowledge may come from this and be a boost for its use.

Among the interviewees, everyone heard about 3D Technology, knew some of its functions and even tested some in the past, but still they felt no need to explore more this technology in the present and turn it into a functional element of their value-chain. This innovation has great potential for the companies that are in a higher position in the value chain and are internationally recognized as private label brands, especially in product customization. Besides the factors outlined above in adopting Blockchain technology which also apply in the case of 3D

technology, another factor that might explain the non-adoption is because many companies without the adequate knowledge on how it works and how exactly to implement the technology in their business, usually might prefer not to risk it and simply steer clear of it. 3D Technology is a new territory for everyone where the leading firms are the main users in the industry, such as Adidas that already has it completely integrated in their processes, especially manufacturing (Cheng, 2018). Though, adopting digital innovations is an essential step for companies if they want to meet their customers as they move more of their lives online. All of the interviewees weren't interested in changing the way their processes currently work, because it was "*not worth creating a new problem with the use of these technologies without any practical use*" as shared by Carlos Silva, but research on these technologies can make companies more efficient and bring them closer to the consumers, which is essential to grow competitively. Sooner or later, other international players with very strong footwear industries will take advantage of these revolutionary technologies to gain market share, and whatever a company's vision for the future, it must include digital transformation in order to grow.

7.4 Limitations

This Work Project has taken important steps to investigate the current position on the opportunities of Blockchain and 3D Technology to the Footwear value-chain in Portugal. Despite its strengths, some limitations need to be taken into consideration. Only three Portuguese footwear brands and 1 Portuguese association were interviewed, however, APICAPPS represents a large part of the Portuguese industry brands, which even though it does not represent the total, turns out to be a representative sample of the footwear industry in Portugal. Additionally, as the study focuses on the opportunities of Blockchain and 3D Technology in the footwear value-chain, other specific technologies that might be used in this sector were not explored in detail for Portugal.

8. Direction for future research

Since in this Work Project the focus was to present several opportunities for Blockchain and 3D Technology applied to the footwear value-chain and understand if any were already used in Portugal, future research is suggested to study in detail the specific factors on why these technologies are not being adopted. It would also be interesting for future researchers to develop a strategic plan on how Portuguese footwear companies could educate themselves on the recent innovations and adapt their strategies to start including their applications and benefit from them, depending on each business structure. Finally, more research could be conducted to replicate this study in Portugal with other specific technologies such as Artificial Intelligence or Augmented & Virtual-Reality, to have a better overview of the technological position of this industry.

9. Conclusion

The research question of this work is if *Portugal is taking advantage of the opportunities that Blockchain and 3D Technology can bring to their footwear value chain*, which has been answered. Blockchain Technology is essentially a transparent and decentralized database where everything is recorded, and 3D Technology is divided into 3D printing & 3D scanning. Both of these highly dynamic technologies have a lot of potential and numerous opportunities have been identified nearly in every step of the value chain, from the production & exports networks to marketing, sales and finally customer service, where some are already applied and invested by footwear companies all around the world. As Portugal's footwear industry is known by its high-quality shoes and by being one of the most advanced in the world, it was expected to see some kind of technological breakthrough in this industry, however, the current position on these technologies is not as promising as it could be. From experts' perspectives, Blockchain

technology it's not used, and regarding 3D Technology, some have already had trial experiences in the past, but none are planning to invest on further research on the topic any time soon.

The practical adoption of these technologies is being much slower than what was expected, yet, this might be explained by the current structure of the Portuguese industry that is composed by micro, small and medium companies. In some cases, it might not justify the huge investment these technologies need and depending on the position on the value-chain of the footwear Portuguese companies, there might not be an urgent need for the adoption. In fact, some of the explanations by the experts to this is that their current business format works and has worked well for years. However, even with a good track record of technology adoption, these 2 technologies have a lot of unique opportunities that could make some processes much more efficient and increase their customers satisfaction. Thus, Portugal could and should invest more in research in order to know which ones would fit better in the business and be ready to react to this ever-growing digital world and to its consumers.

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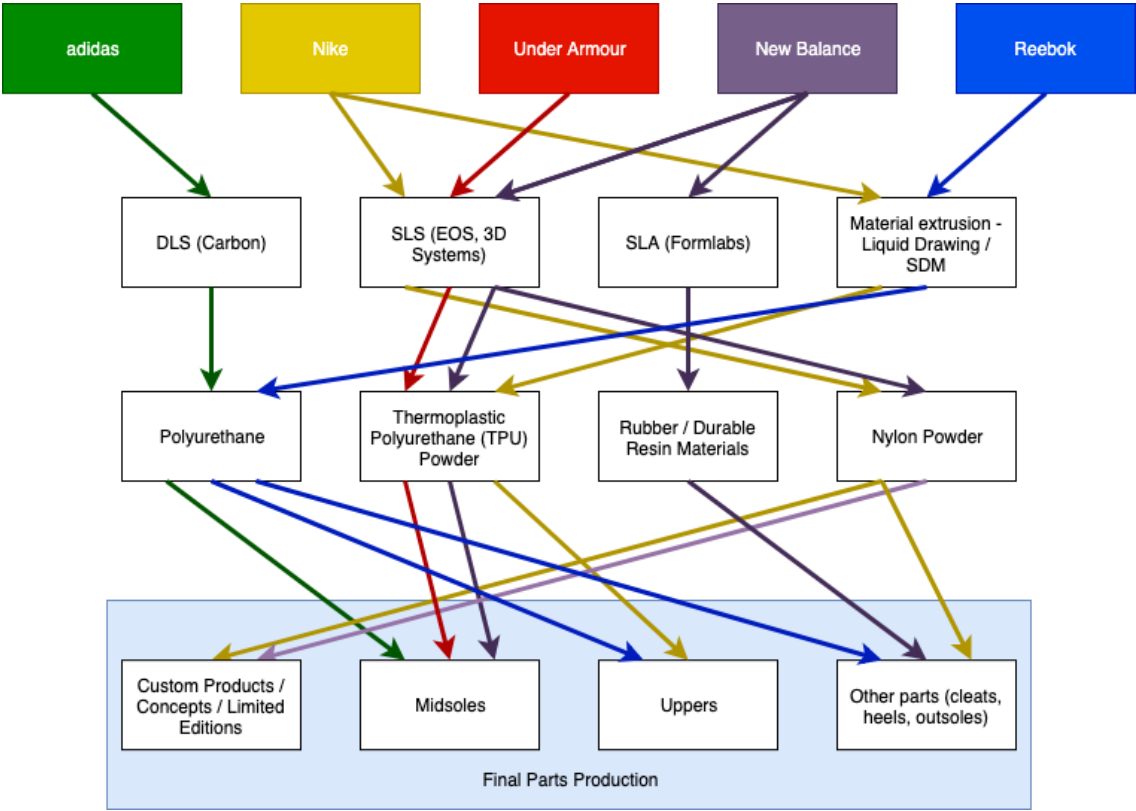
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Appendix

Appendix I - Footwear Industry leaders using 3D Printing for different production parts



Source: 3D Printing Media Network - Davide Sher, 2019: Five footwear industry leaders using 3D printing for production today