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CRYPTO COPYCAT: A Fashion Centric Blockchain Framework for Eliminating Fashion Infringement

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***Abstract*—**The fashion industry represents a significant portion of the global gross domestic product, however, it is plagued by cheap imitators that infringe on the trademarks which destroys the fashion industry's hard work and investment. While eventually the copycats would be found and stopped, the damage has already been done, sales are missed and direct and indirect jobs are lost. The infringer thrives on two main facts: the time it takes to discover them and the lack of tracking technologies that can help the consumer distinguish them. Blockchain technology is a new emerging technology that provides a distributed encrypted immutable and fault resistant ledger. Blockchain presents a ripe technology to resolve the infringement epidemic facing the fashion industry. The significance of the study is that a new approach leveraging the state of the art blockchain technology coupled with artificial intelligence is used to create a framework addressing the fashion infringement problem. It transforms the current focus on legal enforcement, which is difficult at best, to consumer awareness that is far more effective. The framework, *Crypto CopyCat*, creates an immutable digital asset representing the actual product to empower the customer with a near real time query system. This combination emphasizes the consumer's awareness and appreciation of the product's authenticity, while provides real time feedback to the producer regarding the fake replicas. The main findings of this study are that implementing this approach can delay the fake product penetration of the original product market, thus allowing the original product the time to take advantage of the market. The shift in the fake adoption results in reduced returns, which impedes the copycat market and moves the emphasis to the original product innovation.

***Keywords*—**Fashion, infringement, Blockchain, artificial intelligence, textiles supply.

I. Introduction

FASHION is one of the world's most important creative industries [15]. Fashions change. Styles emerge, become fashionable, and are eventually replaced by new fashionable styles. This is not simply attributed to physical needs or the quest for new materials to satisfy certain requirements, rather, new fashions can be a goal by itself [26]. Fashion infringement is a significant problem, costing the European economy alone €26.3 billion of revenue and more than half a million direct and indirect jobs lost annually by the sector [1]. To have an appreciation of the problem we are addressing, we need to first visit the current status in the textile industry and then provide an understanding of what blockchain technology is.

A. Mechanism of Fashion Dynamics

Fashion is a fundamental expression of human culture and individuality. Throughout history, philosophers, thinkers and fashionistas pondered the meaning of fashion and further more, what accounts for a successful movement of fashion. Ultimately, the impact of fashion itself across geographic boundaries is an attestation to the universality of it's impact. what you think? [15]. This is not limited to common brands but also true in luxury brands [8]. To give a quantitative description of these mechanisms, we consider the dynamic interplay between two parts of the population: the article who bears the brand name and the number of articles which give the name to their new production. The growth rate of the first group is given by the difference between their new article rate, which is proportional to the size of the second group, and the out of fashion rate. The second group, in turn, must overcome a certain threshold size for imitation to act, above which it grows at a rate proportional to its own size. This rate, however, decreases as the first group grows. For larger sizes, moreover, the second group inhibits its own growth. The fashion trend rises as a form of emulation, and then declines when elites or early adopters feel the need to distinguish themselves from the copying masses and adopt a new style as a means to do so. If one thus equates trend-joining with copying, then one might reasonably conclude that fashion is driven by copying [22].

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B. Original Versus Fake Product

Assuming that the probability of choosing a certain article at a certain time follows a distribution, then -

- Original may be better than normal distribution
- Fake article also has another similar distribution

As shown in Fig. 5, the two distributions are intersected at the point C_1. The point of intersection represents that both curves have the same probability to be chosen by the customer.

The probability of choosing the original product and quantity of product sale, at the early time of its production, will predominate till the point of intersection of the two curves as the fake product starts earlier (thus less probability for the real product to be sold). Also, at the time of the appearance of fake product, large-scale, low-cost rapid copying influences the popularity of sale of the real one. The rapid change of fast fashion will help to reduce the quantity of real product unsold due to competition with the fake one. But it will increase the cost of the reduction of the quantities of the new fashion product and rapid change of the fashion. An interesting example of this phenomena is the emergent of fast fashion like-brands. Consider Forever 21's success story, this fashion mega-retailer has no design team of its own. Rather, it functions through ”savvy designer merchants” who attend runway shows and take inspiration of the latest ”runway hits”. Those inspirations are then duplicated, manufactured

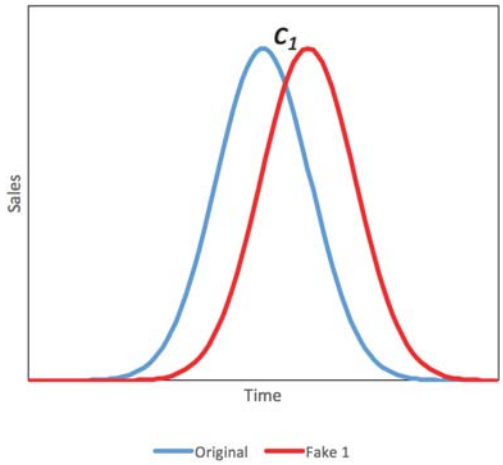

Fig. 1 The Original Versus Fake Product Sale Cycle

and arrive on Forever 21's shelves in a matter of weeks. Consider point C_1 above in cases even before the originals hit their own markets. They are almost always identical to the originals in color, pattern, fabric type and garment measurements [9], [17]. The copyrights laws are quite different globally. While European standards are seen as too weak, the Japanese standards are too high. It is only natural that only few European and Japanese designers have registered their designs. Innovation in both fashion markets has not stalled, rather the designers adapted to ineffective law enforcement [10].

Fashion change is an elusive phenomenon, in need of cultural explanation. It has been debated by many researchers in various fields to define what constitutes fashion. Why some fashions are quickly replicated with firm success [32]. Fast-fashion copying, by contrast, threatens the amount and pulls the direction of innovation toward fashion status conferral aspects and away from its expressive aspects [26]. Often, these copies could be accomplished quickly and reach the markets as soon as they can [18]. The fake product has reflection on: The threat to innovation and reduced profits. The textiles supply chain is both complicated and long. It is very hard to change the production process while assuring quality and meeting deadlines. Fig. 2 illustrates a conceptual view of the textiles supply chain. Our analysis is a narrow new blockchain that protects designers and products against forms of similarity that may arise as designers commonly participate in fashion trends. In recommending tailored protection for the fashion industry, we join other scholars who have urged industry-specific solutions to the regulation of innovation [15], [22], [5], [21]. By analyzing fashion business models and their corresponding dynamics [3], future consideration on business models in the fashion industry should therefore be based on application of blockchain framework, which not only includes economic profit as a value dimension, but also the transparency and quality aspects in the manufacturing chain.

C. Blockchain

Blockchain technology is a form of an encrypted distributed ledger, essentially a distributed database of records, or public ledger of all transactions that are shared among participating parties [7], [33].

Consensus of a majority of the participants in the system is the main mechanism by which each transaction in the public ledger is verified. Once the transaction is deemed verified, it is then admitted to all the records and can never be erased. The verified transactions are put in a queue to be committed to the next block. The data is secured using a hash function, which is any function that can be used to map data of arbitrary size to data of fixed size, more formally defined by (1), where H is the hash and n is number of bits returned by the hashing function [23].

$$H : K \times M \rightarrow \{0,1\}^n \tag{1}$$

A block consists of the following main parts:

Payload
: Which contains the actual data to be committed to the blockchain.

Previous Block Hash
: The digital fingerprint of the previous block.

Current Block Hash
: The current digital fingerprint of the current block payload and the previous block hash.

The main concept of the blockchain can be illustrated in Fig. 3.

The transactions can be traced back to the original first block, commonly called the genesis block. The genesis block is the only block that does not reference an actual previous block hash. Blockchain contains a certain and verifiable record of every single transaction ever made. The first example of a widely used blockchain application is Bitcoin, the decentralized peer-to-peer digital currency. The central hypothesis is that the blockchain provides a system of a distributed consensus in the digital universe, removing the need for trust and transferring it to a binding contract. This assures the users that a digital event occurred by creating an irrefutable record in a public ledger [31].

The blockchain can be viewed as a global computing machine with near 100% uptime due to the fact that the contents of the database and ledger are copied across thousands of computers. Thus in case of 99% of the computers running it were taken offline, the records would remain accessible and the network could rebuild itself. The distributed nature of the blockchain also means that a local copy can exist at or near the user. This is a very important practical consideration as many of the textile facilities are located in developing countries with very limited bandwidth. Having a local copy that auto updates, reduces potential failure due to Internet bandwidth.

The central feature of the blockchain technology is an immutable ledger [27]. Immutable means that the contents of the payload of each block cannot be changed after it is committed to the chain. This is due to the fact that each block hash is computed based on the payload of the block and the hash of the previous block, as shown in Fig. 3. If we want to tamper with block i, we will need to recompute the hash of block i. That will require us to recompute the hash of every and all subsequent blocks as changing one

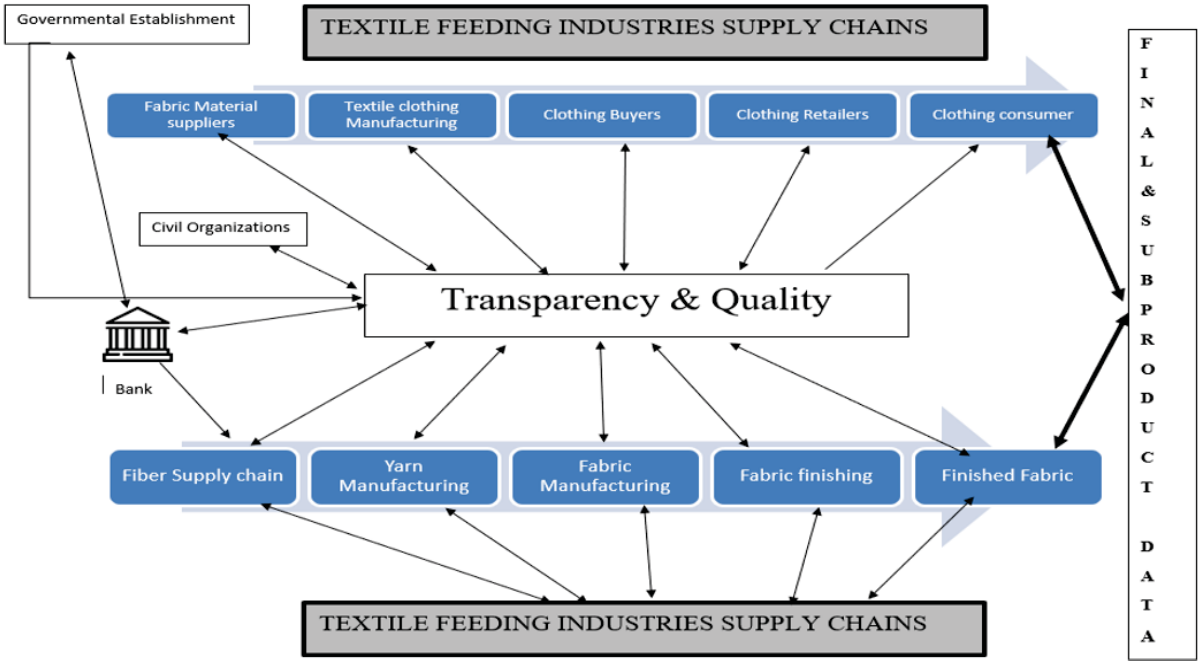

Fig. 2 A Conceptual Illustration Of Textiles Supply Chain

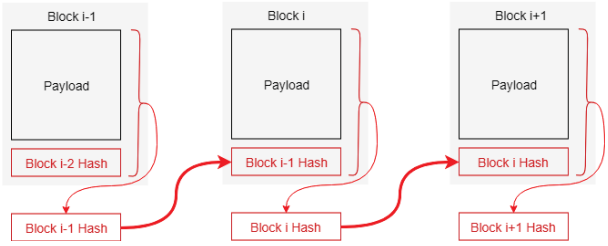

Fig. 3 Conceptual Illustration Of The Blockchain

hash will invalidate all subsequent hashes. Now, because the ledger is distributed, we will need to gain control and change the hashes of at least 51% of the entire network. The sheer amount of required effort renders it practically impossible. Blockchain can be compared to the new IP application layer as it can enable all types of lengths of economic transactions and complex financial contracts. Blockchain can also be a layer for economic transactions of various types of currency, assets and/or financial contracts. Blockchain can manage an inventory system and registry for recording, monitoring, and transacting any type of assets [24].

II. Problem Statement

The fashion industry is requiring quick response technology to increase or decrease the production of a certain item according to the demand of the market. This increases the cost of the product due to the changes of the production lines. It needs to optimize the size of production to insure less inventory in the supply chain and less need to finance the inventory with working capital. The fashion industry only does 50 to 90 percent of their manufacturing in advance [13].

The presence of fake production will affect the percentage of inventory in the supply chain through the data collected from the blockchain for each product. Decision making requires demand estimation. Future sales need to be projected to maximize profit and strengthen the market position. [20].

The connection between retail and consumer is the only method to fight the fake product [4]. Research on counterfeiting has focused on the supply side, with scant attention to consumer demand for counterfeit goods. Understanding and identifying the segment(s) of consumer counterfeiting accomplices, consumers who knowingly purchase counterfeit products, would help in the efforts to stem it [28]. While one could argue that signaling status with luxury goods by using fake replicas is understandable in low income consumers, the role of brand prominence can transcend income barriers. The research in [14] introduces ”brand prominence”, a construct reflecting the conspicuousness of a brand's mark or logo on a product. There should be a taxonomy that assigns consumers to one of four groups according to their need for status and wealth. Each group's preference for branded luxury goods corresponds with their desire to affiliate or not with members of various groups. The interpersonal influences and branding cues shape consumer luxury purchase intentions as shown in [25]. Just like in business selection, understanding consumer expectations can play a huge role in why the consumer would gravitate to one product rather than the other [11].

As shown in Table I, the majority of respondents would prefer the original over the fake if price was not a factor. However, due to the copycat effect, the original product is deprived from the chance to have a larger market and thus forced to keep the price high.

Collaborating this finding are the results of a similar study conducted by [2] - Fashion Brand Motivation Parameters (under publication) on factors that motivate consumers to

TABLE I
ORIGINAL VERSUS FAKE PREFERENCE QUESTIONNAIRE RESULTS

Question	Percentage [1]
The original brand product is more attractive	25%
The fake brand is cheaper	78%
Original brand available earlier	15%
Status symbol associated with original	5%
Peer influence	20%
If price is not a factor, would you choose the original brand	95%

Fig. 4 The Factors Motivating Fake Over Original Purchase

engage in purchasing fake over original products shown in Fig. 4.

A. Fashion and Blockchain

Fighting fake is not the only benefit that blockchain technology can offer the fashion world, it also gives consumers and brands the opportunity to track and display supply chain information [16]. It answers the question, where does my product come from? As one of the new emerging technologies, blockchain technology is empowering brands to take steps towards greater transparency. The total quality of a product is a dynamical function and depends on the transfer function of the sequential process involved in its production [12], [29]. Proper communication will result in good impressions on buyers while good coordination can result in increased order flow. Coordination makes the merchandiser a crucial unit for the entire fashion supply chain [19]. VeChain [30] was key when it came to how people connected with the BABYGHOST [30] brand. On this, BABYGHOST shared: "Imagine that each garment now goes from common to unique. This speaks to our fans as the way we communicate with them via social media" VeChain brought digital and individualized experiences to BABYGHOST's customers.

III. PROPOSED FRAMEWORK

The proposed framework works by adding each fashion product's information to the blockchain at each point along

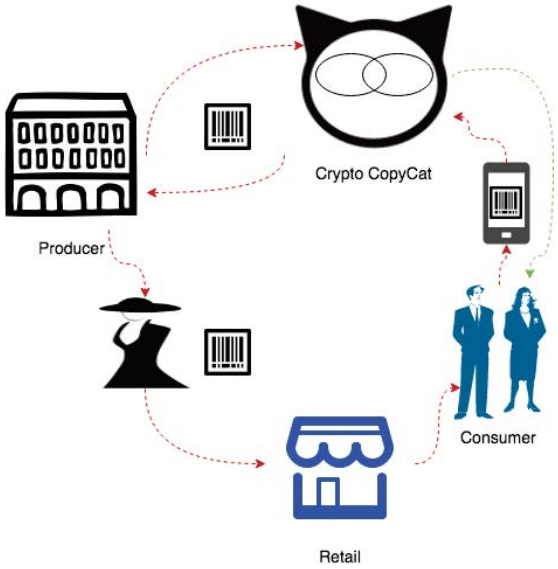

Fig. 5 The Proposed Framework Workflow

the supply chain journey. Each atomic unit of product will be uniquely identified. As raw materials are used in each manufacturing process, the resultant product will be recorded as a transaction on the blockchain. The transactions can identify the processes and manufacturers used and be traced to the previous manufacturing stage. The final product is then shipped to the retail store and recorded as a transaction on the blockchain. When a consumer purchases the final product, the transaction is recorded on the blockchain. The consumer can use a smart phone to scan the product label providing full product history and validating the product to the consumer. The proposed framework workflow is illustrated in Fig. 5.

A. Product Creation

Each manufacturer will obtain access to the blockchain with a unique identifier. The manufacturer can add new product classes on the blockchain which will be linked back to this manufacturer. Each produced unit can then be registered on the blockchain and a unique address for this product is generated. The produced code can serve as inventory control of the products as well. When the product is shipped to the retailer, a send transaction is generated on the blockchain. Fig. 6 illustrates the producer workflow, where:

- Product Design
  - When the producer designs a new product
  - A new product asset is requested on the blockchain
  - A unique address is returned for this new product
- Item Production
  - When a new item is produced for a product
  - A new item request is sent to the blockchain
  - The producer ownership of the product is verified
  - Once confirmed, a new item is created with a unique code
  - The unique code is sent to the producer to be associated with the product item

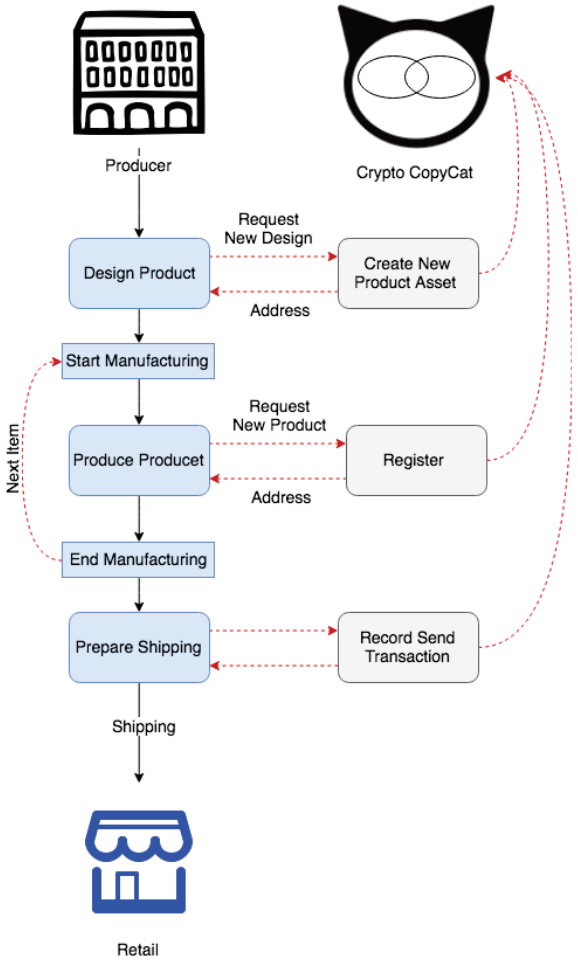

Fig. 6 The Producer Workflow

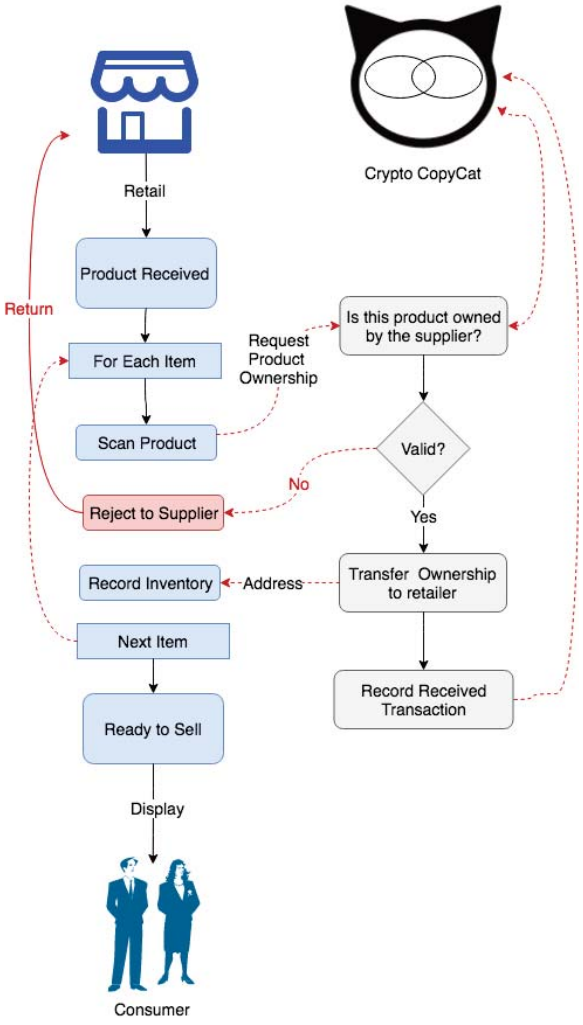

Fig. 7 The Retail Workflow

- Retail Distribution
  - A transfer of ownership is requested
  - The blockchain confirms that the producer is the current owner of this unique item
  - Once confirmed, the request is recorded
  - Ownership is pending the acceptance on the retailer side

B. Retail Point of Sale

As each retail point of sale receives the product, it is scanned and a receipt transaction is generated on the blockchain. The transaction is now confirmed on the blockchain. When the product is sold, the consumer would display the unique consumer account on the consumer smart phone. The product address is then associated with the consumer address to signify the ownership transfer from the retailer to the consumer. The transaction is validated against the confirmed received transactions for this retailer. A retailer would not be able to sell a non received product. Once a product is sold, the same unique product can not be resold by the same retailer as it is owned by the consumer. This protocol eliminates infringement at point of sale. As illustrated in Fig. 7:

- The retailer receives the product
- For each received item
  - The retailer scans the unique item code
  - The retailer requests transfer of ownership from producer
  - The blockchain will confirm that:
    - The producer has ownership of the item
    - The producer has issued a transfer to the retailer
  - If confirmed, the item ownership is transfered to the retailer
  - Otherwise, the item is rejected to be returned to the producer

C. Consumer Validation

Once the consumer unique code ”known as wallet address in blockchain” is associated with the product at the point of sale, the consumer has ownership of the product. The user can use a smart phone application to access the full history of the product. This way, the consumer can validate the authenticity of the product as the network will reflect that no other consumer is recognized as the owner of this product. The consumer can also scan the code of a product

to query the system without purchasing the product. The result would either confirm that this product should be in the position of the retailer or not. If a product is scanned and should not be in the position of the retailer, the consumer would have the opportunity to flag this retailer as an infringer. A consensuses mechanism is used to guarantee a minimum number of consumers agreement before the retailer is flagged in the system. Once a retailer is flagged in the system, the retailer access will be disabled and the last manufacturer will be notified. The steps as illustrated in Fig. 8 are:

- Consumer Validation
  - The consumer scans the unique retailer address
  - The consumer scans the desired item unique code, known as the address
  - The request is sent to the blockchain to confirm that this item ownership belongs to the retailer
  - If the item is confirmed, the item history is displayed
  - If the item is not confirmed, the transaction will be recorded for consensuses
- Sale Process
  - If the item is confirmed by the consumer or the retailer initiates the sale -
  - The retailer sends a request to transfer the item ownership
  - The request is sent to the blockchain to confirm that this item ownership belongs to the retailer
  - If confirmed, the transaction is accepted and ownership is passed to the consumer
  - If the item is not confirmed, the transaction will be recorded for consensuses

IV. Evaluation

It is clear that from a traceability and transparency point of view, our proposed workframe provides capabilities that do not exist in the current status quo. To evaluate our proposed workframe from the impact on fake point of view, we need to take into consideration the potential cost waste due to the time consumed in identifying the fake product [6]. While the complete prevention of fake replicas is very difficult, the proposed workframe allows early detection, especially in the initial phase. The desired effect would allow original products taking full advantage of the market pushing the fake introduction further away into the tail of the normal distribution curve. Our simulation, shown in Fig. 9, indicates that the effects of early detection would push the expected impact market to point c_2, by which the original product has taken full advantage of the market.

Now, let's define both original and fake curves in terms of their probabilities. The probability density function is defined by (2) while the cumulative density function is defined by (3). The original and fake product sale curves can be represented by (4) and (5), respectively.

$$pdf(x) = f(x) \tag{2}$$

$$cdf(x) = F(x) \tag{3}$$

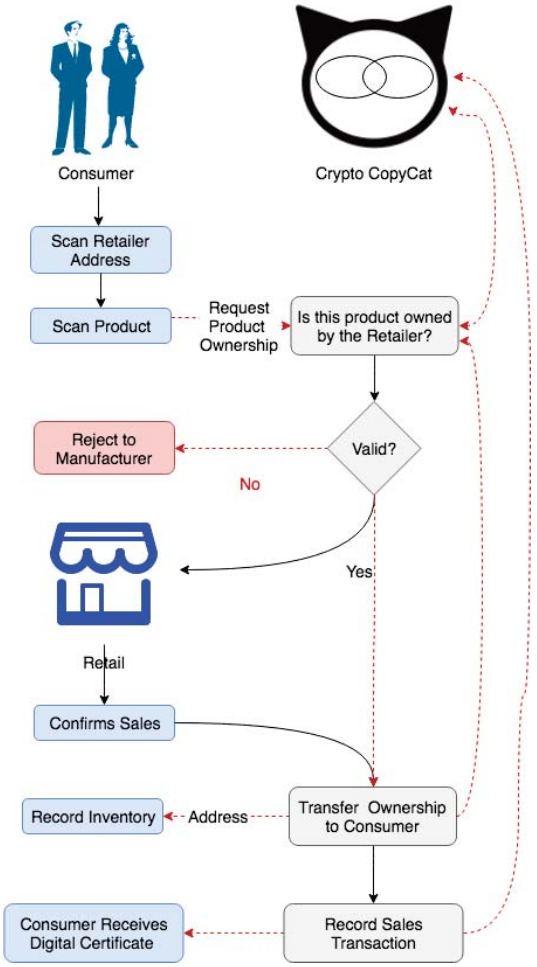

Fig. 8 The Consumer Workflow

$$X_1 \sim N(\mu_1, \sigma_1^2) \tag{4}$$

$$X_2 \sim N(\mu_2, \sigma_2^2) \tag{5}$$

To compute the lost opportunity, we need to compute the area under the intersection point of C_2 as shown in (6)-(8) where $erf()$ is the error function.

$$Area = P(X_1 > C_2) + P(X_1 < C_2) \tag{6}$$

$$Area = 1 - F_1(C_2) + F_2(C_2) \tag{7}$$

$$Area = 1 - \frac{1}{2} erf(\frac{C_2 - \mu_1}{\sqrt{2\sigma_1}}) + \frac{1}{2} erf(\frac{C_2 - \mu_2}{\sqrt{2\sigma_2}}) \tag{8}$$

The intersection point C_2 itself can be computed using (9).

$$C_2 = \frac{\mu_2\sigma_1^2 - \sigma_1\sqrt{(\mu_1 - \mu_2)^2 + (\sigma_1^2 - \sigma_1^2)\log\frac{\sigma_1}{\sigma_2}))}}{\sigma_1^2 - \sigma_2^2} \tag{9}$$

It is clear from the above evaluations that we would want to get μ_2 as large as possible to minimize the impact on the original sales curve.

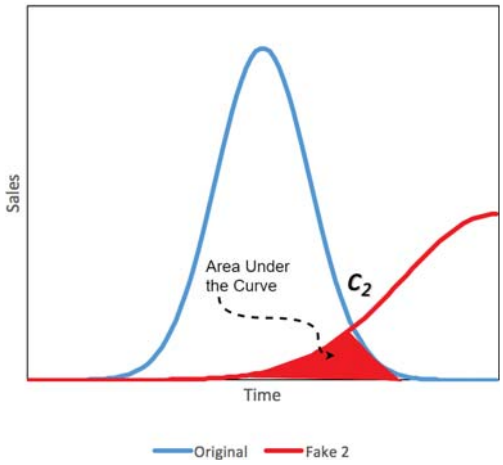

Fig. 9 The Simulated Area Under The Curve

V. Conclusion

Most agroindustry corporations believe new technologies of blockchain will be transformational for the cotton industry by making it easier and more secure to trade the commodity. This is especially critical in the fashion industry due to all the potential savings and job preservation it can achieve. In this work, a novel approach to solve a huge problem in the fashion supply chain is presented. The approach shows how it will interact with the current status quo and how it will lead to massive improvement in the traceability, transparency and preservation of value in the fashion production and end product. Our work combines one of the oldest technologies known to man with the latest cutting edge one. In our further research, we will explore exact parameters for this approach to be adopted, as well as the impact on the end user, consumer, and how it can change the social sensibilities of the consumer.

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