

An Introduction to Global Counterfeiting

Roziena A Badree

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1 Introduction

To counterfeit means to make an exact imitation of a product with the intent to deceive or defraud. These imitations are produced and distributed illegally, and are often of inferior quality compared to the original items. Today, counterfeiting is a significant threat — counterfeit goods circulate the globe and jeopardize consumers, industries, and pose serious safety risks. Fake toys containing hazardous and prohibited chemicals, counterfeit microchips for civilian aircrafts, pharmaceutical drugs containing inappropriate quantities of active ingredients have led to injuries and deaths. These products also have detrimental effects on economies due to decreased innovation and loss of revenue and taxation, and harm the original manufacturers by undercutting prices and damaging brand reputation. Lastly, counterfeiters thrive in economies with weak governance standards and counterfeiting has been linked to funding terrorist activities [2].

Over the years, various organizations have estimated the size of the international counterfeit market. Their figures range from a low \$200 billion in 2008 to \$509 billion in 2019. Exact scope and impact figures are scant because of the illegal nature of counterfeiting and because the market encompasses goods from and impacts all industries and economies. Some industries are also more heavily represented than others in the research — for example: clothing, electronics, luxury goods, and pharmaceuticals are studied with greater frequency than food or tobacco products [1].

This report attempts to highlight the data points that do exist in the relevant literature, providing a broad look at counterfeiting to make clear its economic impact in the global market. There are three sections: the first section provides a brief overview of the state of trade-related counterfeiting today; the second section presents the idea of using computer science to provide assistance with this problem; the final section offers concluding thoughts and an overview of this report's key findings.

2 Counterfeiting: A Global Threat

The U.S. Customs and Border Protection (CPB) appears to be the main domestic source on counterfeiting. Data provided by the Organisation for Economic Co-operation and Development (OECD) make up the foundation of further research [1].

2.1 Counterfeiting 101

Hong Kong and China are estimated as the source for 86% of global physical trade-related counterfeiting, translating into \$396.5 billion annually. Counterfeiting accounts for the equivalent of 12.5% of China's goods exports and approximately 1.5% of its GDP [2]. A good amount of counterfeiting activity can be attributed to other countries as well (please see Figure 1).

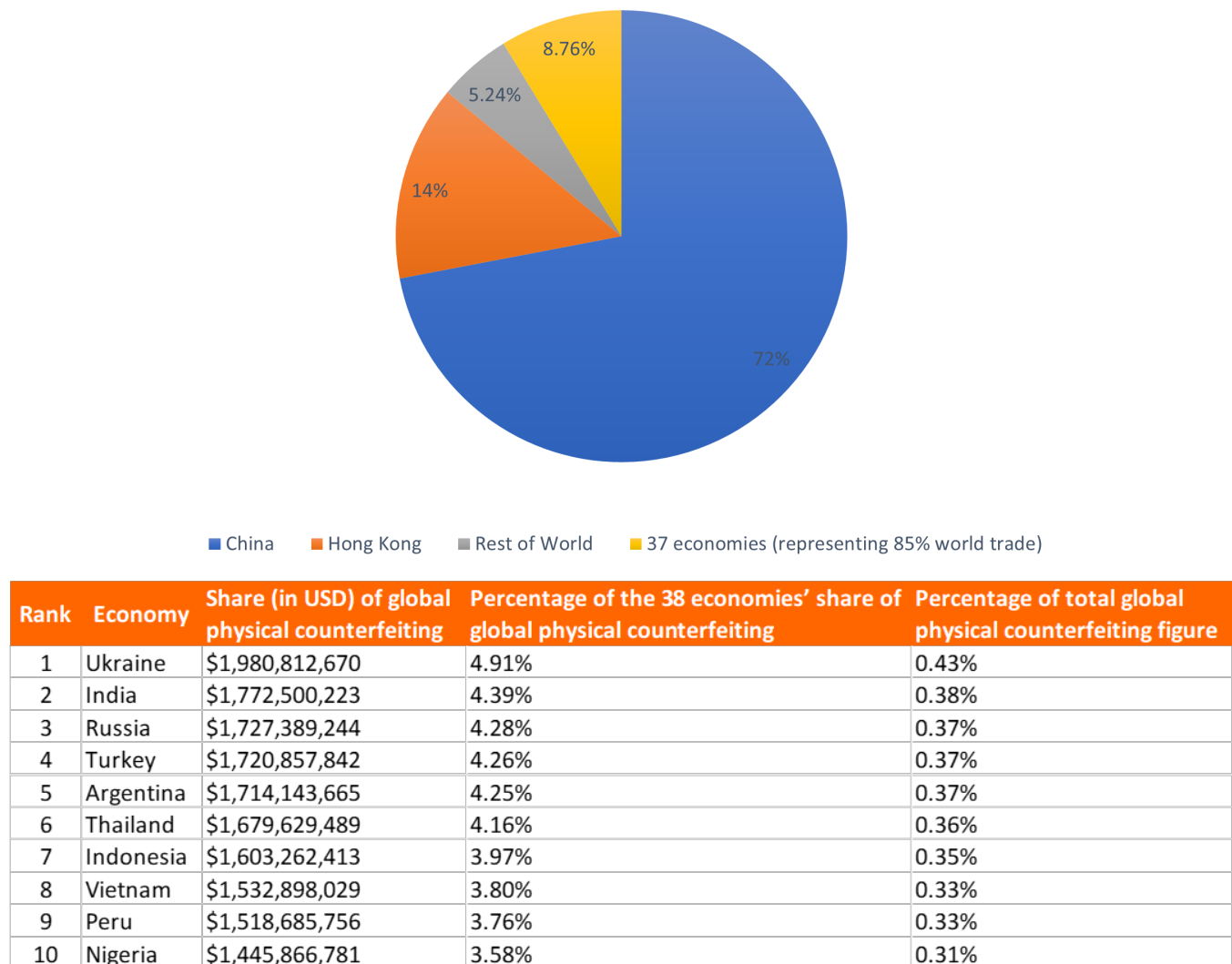


Figure 1: Top 10 Economies' Relative Share in Global Physical Counterfeiting [2].

Fake goods cause a great deal of economic damage to consumers, trademark owners, wholesalers and retailers associated with the brand, and the economy at large. As consumers purchase lower-quality and less-effective products, the brand's integrity is compromised, resulting in revenue losses. The blow is worse for intellectual property owners who sustain direct losses due to decreased market shares and irreparable damage and dilution to their brand's reputation. They also incur costs related to defending their intellectual property rights, which are patents, trademarks, and copyrights, that provide their owners with a limited term of protection and exclusive rights to use and benefit economically from their invention or creation. The direct losses of revenue due to counterfeit products are estimated at billions of dollars for each market industry — some companies spend as much as \$20 million dollars each year in attempts to fight the counterfeiters [1, 2].

In a recent testimony before the Subcommittee on Oversight and Investigations, the U.S. Government Accountability Office reported that counterfeiting slowed the growth of the U.S. economy and produced decreased innovation, contributed to loss of revenue and taxation and higher unemployment rates. The Business Action to Stop Counterfeiting and Piracy initiative estimates that 2.5 million jobs and over \$125 billion annually is lost among the G20 economies. It also estimates an additional \$6.5 billion loss due to weak IP protection including trademark enforcement, and in extreme cases, the G20 economies discourage direct foreign investment [2].

2.2 Free Trade Zones (FTZs)

FTZs are designated areas within countries where goods can be imported, handled, manufactured, and re-exported without the intervention of the customs authorities. They are a type of special economic zone exempt from certain national laws and regulations, particularly concerning customs duties and taxes, to encourage trade and investment. FTZs typically offer benefits such as duty deferral, reduction, or elimination on imports and exports, streamlined customs procedures, a less restrictive regulatory environment, and incentives for businesses to set up operations within the zone. The number of FTZs has grown significantly, with over 3,000 zones in 135 countries, creating an economic impact with millions of direct jobs and over \$500 billion of direct trade-related value added [5].

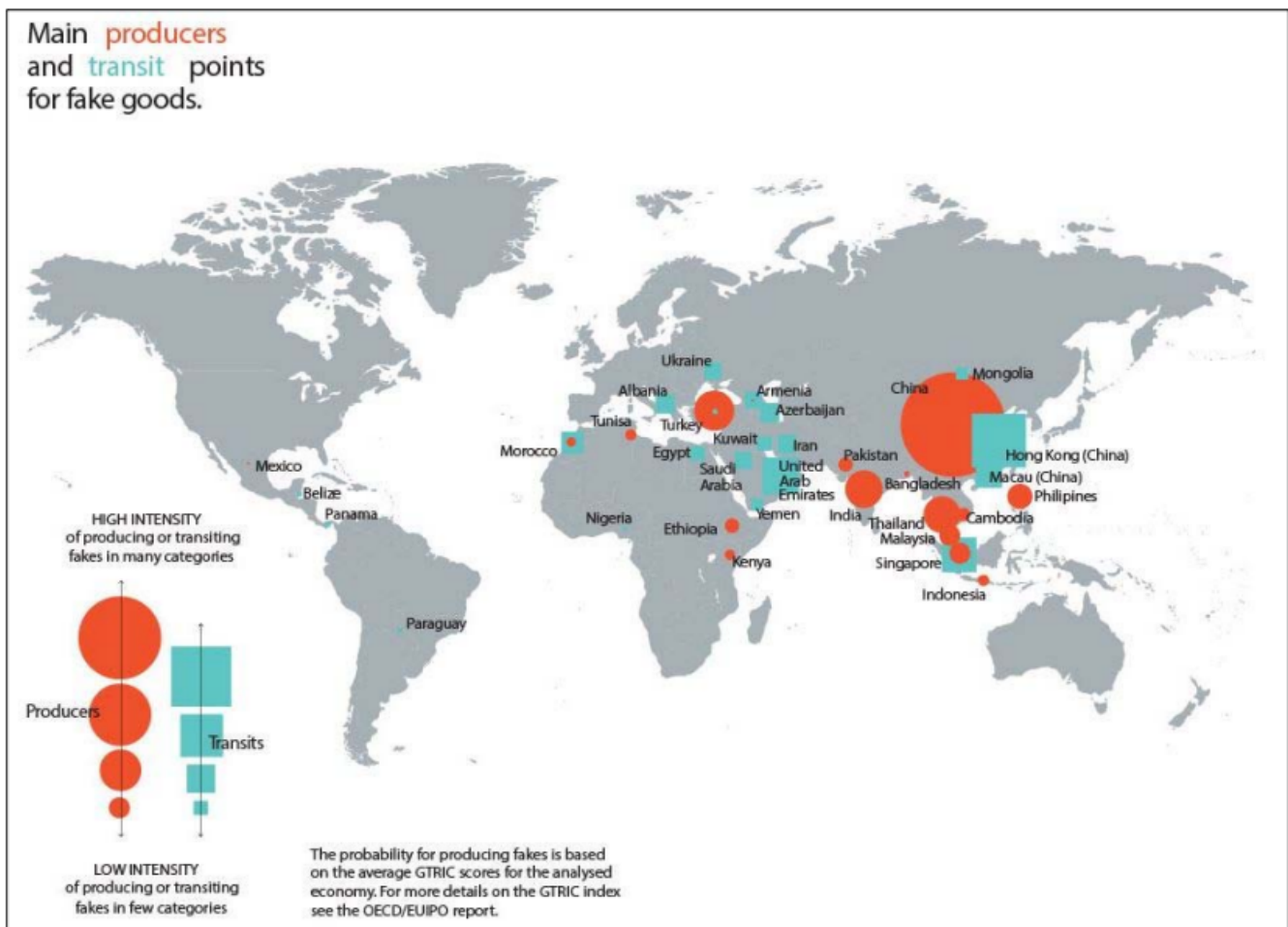


Figure 2: Main Producers and Transit Points for Counterfeit Goods, 2013 [5].

Some FTZs are important hubs in general international trade, while others are associated with weak governance or criminal activities. They are commonly used by counterfeiters to conceal the origin of goods, repackage or re-label items, and establish distribution centers. Since goods in transit are often not within the scope of local enforcement authorities, they are less likely to be intercepted, making FTZs strategic points for facilitating the flow of counterfeit goods [5]. Figure 2 shows the main producers and transit points for fake goods in 2013.

2.3 FY 2021 Intellectual Property Rights (IPR) Seizure Statistics

CPB's FY 2021 IPR seizure statistics revealed a concerted effort to protect American intellectual property, curb smuggling, and combat trade in illegitimate goods. CBP made over 27,000 seizures, with an estimated manufacturer's suggested retail price (MSRP) of over \$3.3 billion, marking a 152% increase from the previous fiscal year. These seizures not only affect revenue but also have significant implications for the U.S. economy and public health and safety[3].

The report highlights the prevalence of counterfeit cell phones and accessories, noting the industry’s reliance on IPR-protected technologies and the impact of the global semiconductor chip shortage, which counterfeiters have exploited. In FY 2021, over 1895 shipments valued at approximately \$64 million were seized, with the majority originating from Hong Kong and mainland China. CBP also targeted illegal imports of counterfeit and substandard COVID-19 related products. These included over 38,000 prohibited test kits, 35 million counterfeit face masks, and nearly 8,700 prohibited hydroxychloroquine tablets [3]. Figure 3 shows the top health and safety products sized for the FY 2022 according to CPB’s data. The full report is not yet available.



Figure 3: Top Health and Safety Products Seized - FY2022 (report not yet available).

2.4 The Pharmaceutical Industry

Counterfeit drugs are produced and sold with the intent to deceptively represent their origin, authenticity, or effectiveness. They contain inappropriate quantities of active ingredients or no active ingredients or ingredients that are not on the label, are sometimes supplied with inaccurate packaging and labeling and may cause bodily harm. According World Health Organization’s (WHO’s) 2017 report, the global counterfeit drug market’s profits range from \$75 to \$200 billion in annual sales and can make up half of all drugs sold in low-income countries. In these countries, one in ten medical products is substandard or falsified and likely responsible for the deaths of tens of thousands of children each year from diseases like malaria and pneumonia [6].

Production and Transit: India and China are identified as the largest producers of counterfeit pharmaceuticals, which are shipped worldwide, particularly to African economies, Europe, and the United States. Transit economies such as Singapore, Hong Kong, the United Arab Emirates, Yemen, and Iran are crucial transit points and play a significant role in the distribution chain, and there has been a shift in production to other Southeast Asian economies due to increased law enforcement and regulatory pressure within China [9].

Prevalence and Online Trade: The Pharmaceutical Security Institute reports between 15,000 to 17,000 cases of counterfeit drugs globally. Over half of medicines purchased from illegal online sites are coun-

terfeit. A significant percentage of online pharmacies were found to be operating illegally, and a majority of medicines purchased online were fake or substandard [9].

Health Risks: Counterfeit medicines can cause significant harm to patients. For instance, in the UK, about one-third of consumers who bought counterfeit medicines experienced health issues. There have been cases where patients have died or suffered harm due to counterfeit drugs, such as a counterfeit diet pill which turned out to be a lethal pesticide [9].

Counterfeiting Incidents: The PSI reported an 18% increase in the number of products targeted by counterfeiters from 2017 to 2018. Counterfeit drugs often lack the correct active ingredients and may contain undeclared substances that can have serious health consequences. US brands and European economies are most affected by counterfeit pharmaceutical goods [9].

Challenges: Counterfeiters penetrate supply chains that are mostly secure at the wholesale level but may exploit vulnerabilities among second-tier distributors. The detection of counterfeits requires expert examination, which can be costly and resource-intensive. The ability of counterfeiters to make fake products look like genuine ones is a significant challenge [9].

Terrorism: Counterfeiting is increasingly linked to terrorist groups. Interpol and Federal Bureau of Investigation (FBI) seizure records suggest that millions of U.S. dollars in proceeds from counterfeit goods (e.g., brake pads and cigarettes) have been destined for terrorist organizations, such as Hezbollah and Al-Qaeda [9].

Type of product	Number of Member States reporting	Total number of product reports	Percentage of all products reported to database
Anaesthetics and painkillers	29	126	8.5
Antibiotics	46	244	16.9
Cancer medicines	19	100	6.8
Contraception and fertility treatments	19	29	2
Diabetes medicines	7	11	0.8
Heart medicines	22	75	5.1
HIV/hepatitis medicines	9	43	2.9
Lifestyle products	37	124	8.5
Malaria medicines	26	286	19.6
Mental health medicines	19	45	3.1
Vaccines	11	29	2

Figure 4: Examples of substandard and falsified products reported to the GSMS between 2013 – 2017 [6].

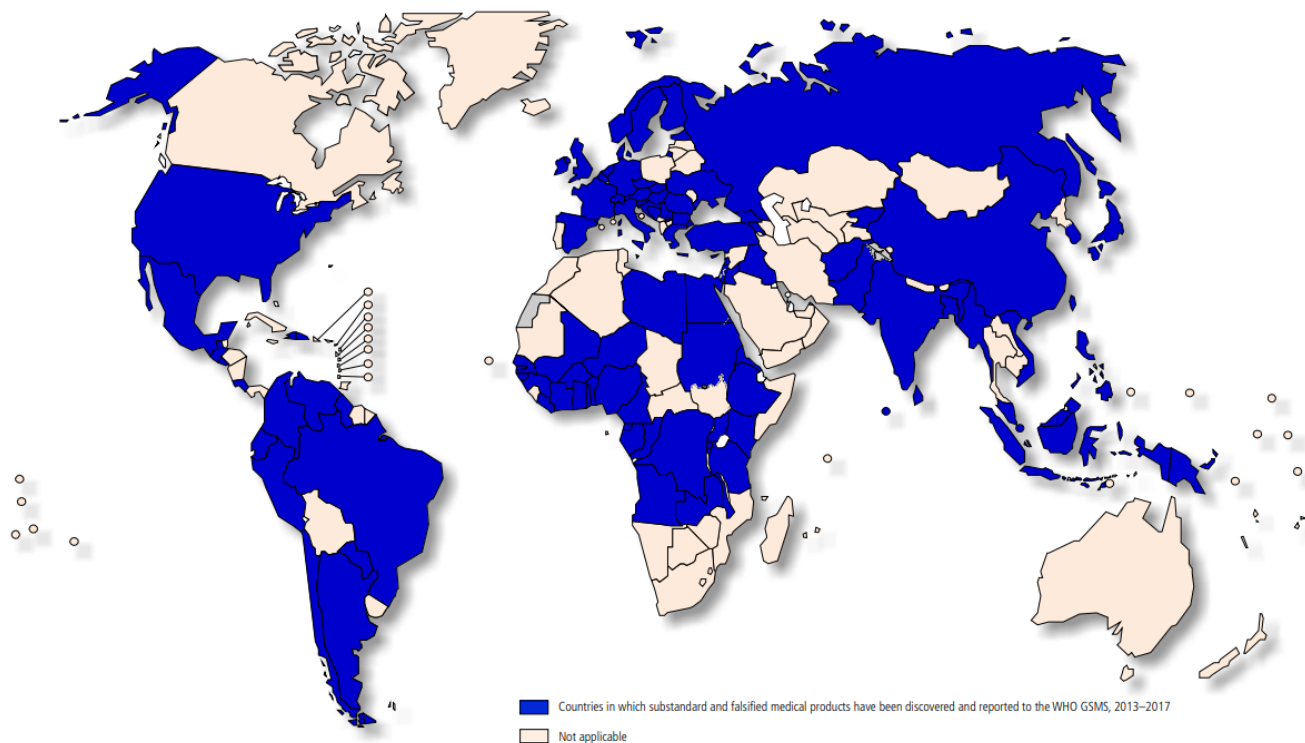


Figure 5: Countries in which substandard and falsified medical products have been discovered and reported to the WHO GSMS, 2013–2017 [6].

Most Counterfeited Pharmaceuticals: Antibiotics, lifestyle drugs, and painkillers are the most targeted by counterfeiters. Other frequently seized counterfeit pharmaceuticals target treatments for malaria, diabetes, epilepsy, heart diseases, allergies, blood pressure, cancer, and more [6]. WHO’s 2017 report contains the following cases of counterfeit or falsified drugs:

- *Ghana:* Inspectors found antimalarial tablets with less than 2% of the expected active ingredients at a rural dispensary. The dispensary bought the medicines from a licensed wholesaler, who, in turn, had purchased falsified medicines from a traveling salesman without proper paperwork [6].
- *Avastin Case:* Changes in insurance policies created opportunities for falsified medicines to be sold below list price. This situation arose when a disease outbreak increased demand for the meningitis C vaccine in Niger, and conflicts disrupted supply chains in the Middle East [6].
- *Yellow Fever Vaccine in Bangladesh:* New entrants to medical procurement, unfamiliar with certain medications, can become easy targets for falsified products. An example includes the procurement of yellow fever vaccines in Bangladesh, where a supplier provided falsified vaccines [6].
- *West Africa:* A pharmacist discovered a bag of partially packaged malaria medicines in a public health center. The medicines were found to be subpotent and were not manufactured according to required standards, leading to fines and suspended prison sentences for those involved [6].

- *Pakistan*: Hundreds of patients suffered from severe reactions due to contaminated cardiac medication. Over 200 patients died and 1000 were hospitalized. A judicial inquiry found that the contamination was due to poor manufacturing standards where an active pharmaceutical ingredient was confused with an inert excipient [6].

2.5 Current Remedies

To combat counterfeiting, various laws and actions have been implemented both in the United States and internationally. Here's a breakdown of some of the major initiatives:

2.5.1 United States

Federal Statutes: The primary legal framework for anti-counterfeiting in the U.S. is based on two federal statutes: the Lanham Act and the Trademark Counterfeiting Act of 1984. The Lanham Act provides civil remedies for trademark infringement and counterfeiting. Meanwhile, the Trademark Counterfeiting Act criminalizes violations of the Lanham Act's anti-counterfeiting provisions, making them federal crimes [8].

CBP: CBP is the federal agency tasked with combating counterfeit goods at U.S. borders. They have the authority to inspect, detain, and seize counterfeit goods. Trademark owners are encouraged to record their trademarks with the CBP to help identify counterfeit goods. The agency has also seen significant increases in the number of seizures, indicating a strong enforcement effort [8].

2.5.2 International Efforts

The Paris Convention: This is a foundational international treaty dating back to 1883 that established minimum standards of protection for various intellectual property rights, including trademarks and against unfair competition [4].

Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs): This World Trade Organization (WTO) agreement enhanced the uniform protection of IP rights, setting minimum standards for member states. It has been crucial in the international legal framework against counterfeiting [4].

Anti-counterfeiting Trade Agreement (ACTA): ACTA aims to establish international standards for enforcing IP rights to combat counterfeiting and piracy. It provides for cooperation among international enforcement authorities, implementation of best practices, and coordination of technical assistance. However, it has been controversial due to concerns about privacy and individual freedoms [4].

3 Computer Science as a Solution

For years, businesses have waged a relentless fight against counterfeiters, dedicating substantial effort and resources to shield their production systems from the infiltration of flawed and imitation parts. They strive to thwart the impact of skillfully crafted duplicates and reverse-engineered products that threaten their sales and have often had to maneuver with limited visibility due to disjointed data, networks, and supply chain structures, which complicates the tracking and verification process. Computer science offers promising, cost-effective tools to equalize this battle against counterfeiting.

3.1 The Database

I developed a comprehensive database of drugs, featuring simulated barcodes from various fictitious pharmaceutical companies. This database served as a centralized repository where each mock company input the details and barcodes of their imaginary drugs. Consumers were able to access this database through a dedicated website or a mobile application for demonstration purposes, enabling them to verify the authenticity of these simulated medications. This system was designed to showcase how consumers could easily confirm if a drug was genuine in a hypothetical scenario.

The drugs database was hosted by Caspio, which is an online platform for building database applications quickly and embedding them on websites. Caspio supports automation, notifications, and integrates with other web services and cloud apps. It also provides security and compliance features. The platform runs on AWS and includes a fully integrated SQL Server, supporting unlimited users, records, and transactions.

3.2 Barcode Generation

Barcoding plays a crucial role in the pharmaceutical industry by enhancing safety, accuracy, and efficiency throughout the drug supply chain. Pharmaceutical companies use barcodes on drug packaging to uniquely identify each product, allowing for precise tracking and authentication. Overall, barcoding in pharmaceuticals ensures the integrity of products, improves patient safety, and streamlines the distribution and administration of medications. Here's a summary of what I used to create downloadable barcodes on my website:

- **Barcode4J Barcode Library:** I integrated the Barcode4J library into my Java application. Barcode4J is an open-source library that allowed me to generate various types of barcodes.
- **HTML, CSS, and JavaScript:** I built a web-based user interface using HTML for the structure, CSS for styling, and JavaScript for interactivity.
- **CSV File Upload:** I created a form that allows users to upload CSV files containing data for barcode generation.

- **Barcode Generation:** I wrote JavaScript code to read the uploaded CSV file, extract data line by line, and generate individual barcodes using the Barcode4J library.
- **Display Barcodes:** I displayed the generated barcodes on my web page, allowing users to view them.
- **Download as PNG:** I implemented a feature to allow users to download the displayed barcodes as a PNG file.

3.3 Current Website & Mobile Application

You can access the website, equipped with barcode functionalities and a comprehensive database, and the mobile scanning application by visiting <https://rozienabadree.github.io/drug-scanner/>.

3.3.1 Levit Nudi & Tambua

Levit Nudi, a self-taught Kenyan software developer, created the mobile application known as Tambua. This app, whose name is derived from the Swahili word for "identity," employs blockchain technology along with barcode, QR code, and location tracking features to oversee the movement of prescription drugs in the supply chain. This robust combination of technologies makes it challenging for counterfeiters to replicate or interfere with these medications. Since Tambua was introduced, it has played a significant role in curbing the circulation of fake and subpar prescription drugs across Africa. Nudi points out that from February to September 2018, the app verified 5,000 legitimate medications [7].

3.4 Future Work

In future iterations of the app and website, I envision integrating blockchain technology. Blockchain represents a distinct type of database characterized by its structure, where individual records, referred to as blocks, are interconnected in a continuous sequence, forming a chain. As new data is introduced, it is recorded within a new block. Once a block is saturated with data, it becomes linked to the preceding one, creating a chronological chain of data. To delve deeper into its nature, blockchain is a decentralized and immutable data structure. Decentralization implies that it's maintained by multiple network nodes, whether public or private, without the need for mutual trust or extensive knowledge among them regarding the underlying data structure. To combat counterfeiting, manufacturers and suppliers can unite on a unified blockchain platform and utilize "smart tags" – unique cryptographic identifiers – to meticulously trace and verify the origin and journey of each product. Counterfeit tags won't find a place on the blockchain, and in the event of smart tag duplication, a swift blockchain scan will unveil the genuine item's manufacturing and sales history, promptly exposing any duplicates as counterfeits.

4 Conclusion

Counterfeiting is a tremendous and ever-increasing global threat. It is a form of consumer fraud: a product is sold, purporting to be something that it is not. Yet these products circle the globe and cause real damage to consumers, industries, and economies. In this light, this report highlighted the following data points:

1. China is estimated to be the source of over 70% of global physical trade-related counterfeiting, amounting to more than \$285 billion annually. Together, China and Hong Kong are believed to account for 86% of global physical counterfeiting, translating into \$396.5 billion worth of counterfeit goods each year. This represents 12.5% of China's exports of goods and over 1.5% of its GDP [2].
2. A significant portion of counterfeiting activity can also be attributed to other economies, indicating a widespread global issue with substantial economic implications. The presence of counterfeit goods in the market damages economies by decreasing innovation, causing revenue loss and taxation issues, and harming the original manufacturers through undercut pricing and brand reputation damage [1].
3. Counterfeit products often bypass safety standards and quality controls, leading to dangerous products in the market. For example, counterfeit toys may pose choking hazards or contain toxic paint, counterfeit auto parts may not undergo safety testing, and counterfeit medicines might lack active ingredients or contain harmful substances. The proliferation of counterfeit products not only affects consumer safety but also has broader implications for global health, as substandard drugs can lead to the development of resistance in target microbes [6].

This report also presented the use of a database with barcoding and a mobile application as a promising solution to the pressing issue of counterfeiting, as highlighted in the report. Here's how this technology can help:

- **Authenticity Verification:** By integrating authenticated barcodes for each product into a centralized database, it becomes possible for consumers and retailers to verify the authenticity of products. Users can scan the barcode using a mobile application, which then cross-references the information with the database to confirm if the product is genuine or counterfeit.
- **Traceability:** A barcode system enhances the traceability of products throughout the supply chain. From manufacturing to distribution, each product can be tracked, making it harder for counterfeit goods to enter the market unnoticed. This traceability also aids in identifying the source of counterfeit products when they are detected.
- **Consumer Awareness and Empowerment:** With the mobile application, consumers are empowered to check the authenticity of products before purchase. This consumer empowerment is a significant deterrent to counterfeiters, as it reduces the likelihood of successful deception.

- **Rapid Response to Counterfeiting:** The database and mobile application can be updated in real-time to flag counterfeit products and alert consumers and authorities. This rapid response capability can significantly minimize the spread and impact of counterfeit goods.
- **Data Analysis and Reporting:** The data collected through this system can be analyzed to identify trends and patterns in counterfeiting, helping manufacturers and law enforcement agencies to understand and combat the problem more effectively.
- **Market Integrity and Brand Protection:** By ensuring the authenticity of products, this technology helps in maintaining the integrity of the market and protects the reputation of brands, which can be severely damaged by counterfeiting.

In summary, the integration of a barcode-based database system with a user-friendly mobile application offers a robust tool against counterfeiting. It not only assists in safeguarding the supply chain but also empowers consumers, supports law enforcement, and preserves the integrity of brands and markets against the detrimental effects of counterfeit products.

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