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The Challenges of Barcode Technology Deployment for Products' Marketing and Distribution in Nigeria

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ABSTRACT
Marketing and distribution of commodities is essential to human existence. Information technology has been observed to improve the activities that boder on human existence. This paper takes a detailed study of the challenges facing the deployment of barcode technology in products' marketing and distribution in Nigeria. The work through online-research, oral interviews, observation and other secondary sources of information retrival studied the existing barcode technology, its application, prospects and challenges in products' marketing and distribution. The outcome of the study showed that products can easily be tracked using barcode tracking software. Computation and management of inventory became more accurate and easy, centralized record keeping was achieved and the security of product on display or transit was ensured through this barcode technology.

Keywords: Barcode, Tagged products, Inventory, barcode tracking software, RFID, QR-Code, Barcode Reader

INTRODUCTION
According to TechTarget (2008-2016) barcode is the small image of lines, and spaces that is affixed to retail store items, identification cards, and postal mails. Barcode uses a sequence of vertical bars and spaces to represent numbers and other symbols and is used to identify a particular product, number, person, or location. A barcode is usually decoded with a barcode reader. This barcode reader uses a laser beam that is sensitive to the reflections from the lines and spaces' thickness and variation to translate the reflected light into digital data which is inturn transferred to a computer for immediate action or storage. Barcodes and barcode readers are most often seen in supermarkets, retail stores, and other channels of products' distribution outlets.

If you operate a busy sales outlet and you need to keep track of all the products you sell to enable you ensure that what your customers want to buy are always in stock, the commonest traditional way of doing that would be to walk around the shelves looking for empty spaces and simply replacing the products where you need to. Alternatively, you could document what your customers buy at the exit/checkout points(s), compile a list of all the purchases, and then simply use that to reorder your stock. These traditional methods could work fine for a small store. But, if you own and run a giant/superstore example a branch of Wal-Mart with thousands of items on sale, the traditional technique will fail you since it is time consuming and ineffective. If you mark all the items in your store (super market, wal-mart, etc) with their prices tags, and due to changes caused by the laws of demamnd and supply (wich is inevitable any way) you need to change the price tags before you sell the goods, you have to re-tag all the products. What about shoplifting? If you see a lot of chocolate packs missing from the shelves or tins of tomatoe cans disappeared for the shelves, can you really be certain you have sold them all? How do you know if some of these items have been stolen?

Using barcode technology can help you to solve all these problems. Barcode helps product marketers and distributors to keep a centralized record of the details of their products on a computer system. The system can as well track products, prices, and stock levels. One can change prices as often as one likes, without having to re-tag the products with new price whether there are in bottles, boxes or cartons. One can instantly see what the stock levels of all or some items are. More importantly, triggers or alerts can be set to remind the shop owner or manager when items are running low in the stock to enable them reorder. Because barcode technology is so accurate, one can be reasonably confident that any items that

are missing and do not appear to have been sold have probably been stolen or may have been moved them to a more secure part of the store. This ensures the security of the products in the shop.

2.0 Literature Review

History of barcode

The development of the modern barcode began in 1948 when the president of a local food chain (LFC) in philadephia challenged one of the deans to undertake research to develop a system that will automatically read product information during checkout. Silver a graduate student over heard the conversation and told his friend Norman Joseph Woodland about the food chain president's request. Woodland a twenty seven year old graduate student and teacher at Drexel was fascinated by the problem and he began a work on it. Woodland and Silver built a device which worked, but the system had problems with ink instability and it was expensive to print the patterns. Later in 1949, the pair invented and filed a patent application titled "Classifying Apparatus and Method." The inventors described their invention as relating "to the art of article classification through the medium of identifying patterns" (Woodland and Silver, 1949). Perhaps the most widely recognised Auto-ID system is the barcode system developed in the 1970s, which also accounts for the biggest share of the worldwide Auto-ID market (Vivek, 2001).

In 1969, the NAFC (national association for continence) asked Logicon, Inc. to develop a proposal for an industry-wide barcode system. The result was Parts 1 and 2 of the Universal Grocery Products Identification Code (UGPIC) in the summer of 1970. Based on the recommendations of the Logicon report, the U.S. Supermarket Ad Hoc Committee on a Uniform Grocery Product Code was formed. Three years later, the Committee recommended the adoption of the UPC symbol set still used in the USA today. It was submitted by IBM and developed by George Laurer, whose work was an outgrowth of the idea of Woodland and Silver. Woodland was an employee at the time of IBM. In June 1974, one of the first UPC scanners, made by NCR Corp. was installed at Marsh's supermarket in Troy, Ohio. Following that, the first product with a barcode was scanned at a check-out counter on June 26, 1974.

Radio Frequency Identification (RFID)

The basic idea of RFID is a tiny computer chip placed on pallets, cases, or items. The data on the chip can be read using a radio beam. RFID is a newer technology than barcodes, which are read using a laser beam. RFID is also more effective than barcodes at tracking moving objects in environments where barcode labels would be sub-optimal or could not be used as no direct line-of-sight is available (Claudia, 2005).

RFID technology is relatively new and it works by having a tag that emits information that can be collected by a reader from a distance. RFID can be active or passive. Active RFID technology uses fixed tag readers assigned throughout a warehouse such that anytime an item with an RFID tag passes the reader, the movement of the item is recorded in the inventory management software. Active systems work best in environments that require real time inventory tracking or where inventory security problems exist. Passive RFID technology requires the use of handheld readers to monitor inventory movement. RFID technology has a reading range of up to 40 feet using passive technology and 300 feet using active technology. This greatly increased the accuracy of moving inventory around a warehouse using the RFID technology (Hamlett, 2006).

Barcode as an inventory control system.

The major use of barcode identification system is to track inventory automatically. A barcode combines several sequences to create a unique set of numbers or characters that identifies the item (Microsoft Corporation, 2009). All major retailers in developed nations use barcode technology as part of an overall inventory control system. This is because it increases the accuracy and efficiency of inventory management. When a barcode is read at the point of sale, inventory sales data is immediately read and sent to a broader system that maintains usage statistics. Barcodes manage inventory at the warehouse level where it facilitates movement of inventory within the confines of the warehouse (Kenneth, 2002).

Categories of Barcode

There are two categories of barcode namely: Linear or one dimensional (1-D) and two dimensional (2-D) barcode.

Linear or One dimensional (1-D) barcode: use a series of thick and thin lines to represent characters. The barcode reader (usually a laser device) scans across the lines and distinguishes the transitions from light to dark and decodes the thick and thin bars into the

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characters they represent. These include some of the traditional or most well recognized barcode types such as the UPC and EAN code types. The linear barcode shown and described has been the standard for many years.

Fig 1:UPC barcode:

Two dimensional (2-D) barcode: 2-dimensional codes requires an image to be processed by a computer. Many product labels, magazine, etc. have these and you can find them on airline tickets. A cell phone can take an image and decode the image in 2 dimensions

and get product or document information. These include some newer barcode types such as the QR or VR Code and PDF417 code type's etc.

Fig 2: QR codes

There are over a hundred of different barcode types invented. Originally they were designed to identify moving rail cars and their cargo and destination. Now they are used widely for product inventory and serial number tracking. The most universal one is the UPC code, which is used by most manufacturers and retail stores to track inventory.

Types of Barcode

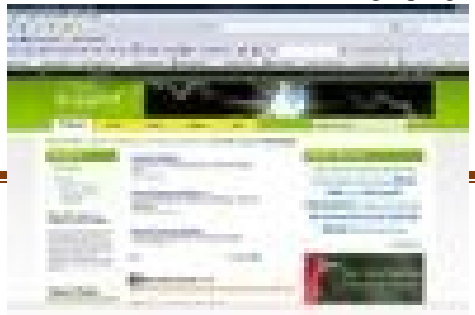
The types of barcodes and their description are shown in table 1.

Table 1: Types of barcodes and their uses

Uses	Bar Code Standard
Retail stores for sales checkout; inventory, etc.	Uniform Product Code (UPC)
Identification, inventory, and tracking of shipments	Code 39 (Code 3 of 9)
Encoding zip codes on U.S. mail	POSTNET
A superset of the UPC that allows extra digits for country identification	European Article Number (EAN)
Similar to the EAN, used in Japan	Japanese Article Number (JAN)
Based on ISBN numbers and used on book covers	Bookland
Based on ISSN numbers, used on periodicals outside the U.S.	ISSN bar code
Used in preference to Code 39 because it is more compact	Code 128
Used in the shipping and warehouse industries	Interleaved 2 of 5
Used by Federal Express, in libraries, and blood banks	Codabar
A special font used for the numbers on the bottom of bank checks	MICR (Magnetic Ink Character Recognition)
The optical character recognition format used on book covers for the human readable version of the ISBN number	OCR-A
Used for the human readable version of the UPC, EAN, JAN, Bookland, and ISSN bar codes and for optional human-readable digits with Code 39 and Interleaved 2 of 5 symbols	OCR-B
Used by the United Parcel Service	Maxi code
A new 2-D type of bar code that can encode up to 1108 bytes of information; can become a compressed, portable data file (which is what the "PDF" stands for)	PDF417

How to track items using barcodes

To track an item using barcode, you need to install the Barcode Scanner software. Figure 3 shows a sample interface of a barcode tracking program from



Brothersoft.
Fig 3: Barcode tracking software

How barcodes represent the numbers zero (0) to nine (9)

Figure 4 shows how the numbers one to nine are represented by the barcode. When the barcode scanner scans the product on which the barcode is printed, it reads the barcode, the electronic cash register (ECR) receives the number and sends it to the store's central database. The central database looks up the number scanned from the barcode and sends the information on the search back to the electronic cash register and bills the customer if there was price embedded in the barcode. This technique of embedding prices in the barcode allows the store owners to change the pricing of their products as often as necessary and with ease.

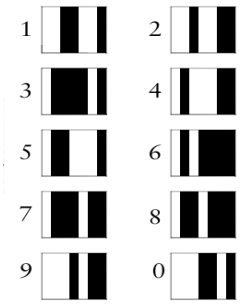


Fig 4: Representation of barcode lines

Most times in linear barcodes it is not black or white bars that determine whether it's a 0 or a 1 it's the *width* (UPC is an exception). As the scanner moves across the barcode, it measures the time it takes each bar to pass, and sorts these into narrow and wide bars. The pattern of narrow and wide bars determine the character represented by the partern, regardless of whether any particular bar is black or white. Obviously, to distinguish where a bar starts and ends it has to be a different colour from its neighbours, so white must always be followed by black and vice versa. Consequently if you want to represent the binary code '0001' it has to be done in black-white-black-white format, so the first and second black bars and the first white bar all represent binary 0, while the second white bar represents binary 1. This can only be done by width, not colour.

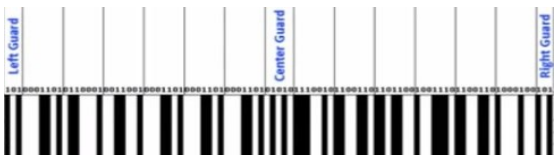


Fig 5: Pattern of a barcode

The pattern shown in figure 5 for the right side is similar except that it has even number of 1s. This helps the computer to figure out which side is left/right, in case the product has been turned upside down! There is one more check for this. All the codes for the left side begin with a 0 while for the right side they begin with 1, leaving the guards.

Barcode readers/scanner and their operation

Barcode scanners can be extremely simple devices made up of a light source, a photo diode and a simple decoder. They can nevertheless be a complex charge coupled device (CCD) or camera based device. There are currently four different types of barcode scanners available. Each uses a slightly different technology for reading and decoding a barcode. These types include:

1. **Pen type readers:** Pen type readers use a photo diode to measures the intensity of the light reflected back from the light source and generates a waveform that is used to measure the widths of the bars and spaces in the barcode. Dark bars in the barcode absorb light and white spaces reflect light so that the voltage waveform generated by the photo diode is an exact duplicate of the bar and space pattern in the barcode. This waveform is decoded by the scanner.

2. **Laser scanners:** Laser scanners work the same way as pen type readers except that they use a laser beam as the light source and typically employ either a reciprocating mirror or a rotating prism to scan the laser beam back and forth across the barcode. Just the same as with the pen type reader, a photo diode is used to measure the intensity of the light reflected back from the barcode. In both pen readers and laser scanners, the light emitted by the reader is tuned to a specific frequency and the photo diode is designed to detect only this same frequency light. Pen type readers and laser scanners can be purchased with different resolutions to enable them to read barcodes of different sizes. The scanner resolution is measured by the size of the dot of light emitted by the reader.

3. **Charge Coupled Device (CCD) Readers:** CCD readers use an array of hundreds of tiny light sensors lined up in a row in the head of the reader. Each sensor can be thought of as a single photo diode that measures the intensity of the light immediately in front of it. Each individual

light sensor in the CCD reader is extremely small and because there are hundreds of sensors lined up in a row, a voltage pattern identical to the pattern in a barcode is generated in the reader by sequentially measuring the voltages across each sensor in the row. The important difference between a CCD reader and a pen or laser scanner is that the CCD reader is measuring emitted ambient light from the barcode whereas pen or laser scanners are measuring reflected light of a specific frequency originating from the scanner itself. Bar-code scanners use Light Emitting Diodes (LEDs) to scan the bar code, and reflect the image onto a Charge-Coupled Device (CCD). The CCD transmits the information to a computer that retrieves information about the product from a database, and also adds information to the database that the product was scanned.

4. **Camera Based Readers:** This is the newest type of barcode reader currently available, they use small video camera to capture an image of a barcode. The reader then uses sophisticated digital image processing techniques to decode the barcode. Video cameras use the same CCD technology as in a CCD barcode reader except that instead of having a single row of sensors, a video camera has hundreds of rows of sensors arranged in a two dimensional array so that they can generate an image.

Interfacing a Barcode Reader to a Personal Computer
All application programs support barcode reading as long as one you has the right equipment. Barcode readers usually come with two types of connectors these: keyboard wedge" output or RS232 output. Typical barcode readers/scanners are shown in figure 6.

Keyboard wedge: The barcode readers with keyboard wedge output provide a pigtail connector so that you can plug in your keyboard at the same time. Keyboard output also is limited in that you cannot modify the data in any way before sending it into the program that is to receive the data. For example, if you needed to parse a barcode message into multiple pieces or remove some of a barcode message or add in a date or time stamp you would not be able to do that with a normal keyboard wedge reader.

RS232 output: The other possible output option is to get a barcode reader with an RS232 or "Serial" interface. With these types of barcode readers, you connect the reader to an available serial port on the back of your PC. You would then need a program called a "Software Wedge" to take the data from the barcode reader and feed it to the application where you want the data to go. The disadvantage to this approach is that it is a little more complex however you gain much more control over how and where your data ends up when you read a barcode.

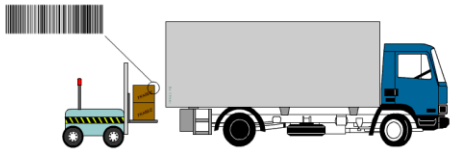
Fig 6: sample barcode readers or scanners
(source: http://www.dciscanning.co.za/Dci-Scanning/ctl/Show/mid/594/ProductID/7/GRYPHON-MOBILE-GM4430-2D)

3.0 Discussion

Areas of application of Barcode use in product, marketing and distribution

Distribution Line: The computer system with a barcode technology allocates the products or boxes of products to a 'lorry' for distribution. Each barcode will be allocated the correct address for a retail outlet or for an individual customer. As the product is transported, its location is monitored and recorded.

Fig 7: Barcode in a distribution line



Retail shops management and catalogues: A checkout operator in a supermarket scans a product barcode as the customer passes through the checkouts. The price will be automatically displayed and as more products are checked out the total cost will be calculated. This means the checkout operator does not need to manually type in the price of each product. This makes the checkout procedure less time consuming and it is less likely that mistakes will happen.

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Fig 8: Barcode at the checkout stand in a supermarket

Stock Control: As products are scanned at the checkout point in a supermarket, the where computer system the barcode reader is attached will automatically determine whether more products needs to be ordered. This necessitates replacements are placed back on the shelves. This saves time and manpower as it does not require an employee to constantly check the shelves or to manually order replacement products. Stock control is much more efficient as a result of the introduction of barcodes.

The prospects of the use of barcodes in Nigeria

1. Barcodes eliminate the possibility of human error. The occurrence of errors for manually entered data is significantly higher than that of barcodes. A barcode scan is fast and reliable, and takes infinitely less time than entering data by hand.
2. Using a barcode system reduces employee training time. It takes only minutes to master how to use the hand-held scanner for reading barcodes. Furthermore, employees do not have to gain familiarity with an entire inventory or pricing procedure. This also makes employee training less expensive, since they do not have to be paid for extra training time, and another employee does not have to be compensated for training them.
3. Barcodes are inexpensive to design and print. They can be customized economically, in a variety of finishes and materials.
4. Barcodes are extremely versatile. They can be used for any kind of necessary data collection. This could include pricing or inventory information.
5. Additionally, because barcodes can be attached to just about any surface, they can be used to track not only the products themselves, but also outgoing shipments and even equipment.
6. Inventory control improves. Because barcodes make it possible to track inventory so precisely, inventory levels can be reduced. The location of equipment can also be tracked, reducing the time spent searching for it, and the money spent replacing equipment that is presumed lost.
7. Barcodes provide better data. Since one barcode can be used for inventory and pricing information, it is possible to quickly obtain data on both. Furthermore, barcodes can be customized to contain other relevant information as needed. They provide fast, reliable data for a wide variety of applications.
8. Data obtained through barcodes is available rapidly. Since the information is scanned directly into the central computer, it is ready almost instantaneously. This quick turnaround ensures that time will not be wasted on data entry or retrieval.
9. Barcodes promote better decision making. Because data is obtained rapidly and accurately, it is possible to make more informed decisions. Better decision making ultimately saves both time and money.
10. Both inexpensive and user-friendly, barcodes provide an indispensable tool for tracking a variety of data, from pricing to inventory. The ultimate result of a comprehensive bar coding system is reduction in overhead.

Challenges of using barcodes in Nigeria

The challenges with barcodes lie in its failure as well as its dependent on the human user. Every human system no matter how robust can still fail. Barcode is a man made security system; though very robust, it still fails especially given Nigerian situation where technology adoption is still very low due to underdevelopment. Violation of the quiet zones is a frequent cause of barcode failure. All linear barcodes and most 2D symbols require a quiet zone to be readable by a scanner. The reasons barcodes fail can be classified into two broad categories namely: poor image quality and flawed/ data quality. Within these broad categories, there are the seven most common reasons that account for the failure of barcodes. Other reasons are listed below:

1. Shrink wrapping and lamination: Because shrink wrapping and lamination can course a barcode to fail, it is important that verification be conducted on a barcode in its final form with all post production operations such as shrink wrapping in place. Shrink wrap or lamination often causes barcode scanning problems, especially when the over-wrap heat seal impinges on the barcode or quiet zones.
2. Poor print quality: Due to excessive press gain is a common cause of barcode failure. The bars and

spaces in a barcode can tolerate a certain amount of gain or loss in width, but when the printing process exceeds that tolerance, the barcode will fail.

3. Colour combination: Certain colour combinations will cause barcodes to fail—red bars against a white background or black bars against a green background are but two examples of toxic colours for barcodes.
4. Clear or translucent subtrates: Barcodes printed on a clear or translucent polybag can fail when the colored contents of the bag are inserted and cause a color contrast problem.
5. Reflective characteristics of metallic substrates: the reflective characteristics of metal or metalized substrates such as beverage cans, bare aluminium visually appears to be highly reflective, and would seem to be an ideal background for a barcode. In fact it has very low reflectance and makes a better bar color than a background or space color.
6. Labels that are peeling off as a result of extremes of heat, label degradation through age or simply the wrong adhesive for the application.
7. Distortion due to greese: Greese Labels that have been applied with creases in them will distort the barcode and make it unreadable.

CONCLUSION

Before the advent of barcode technology, many businesses relied on clerks to manually enter information about products that pass across their desks in and out of their shops, stores and warehouses. Barcode technology has become so widespread due to its ability to offer a reliable way to accurately read encoded information on products and decode them. The technology eliminates the possibility of the human error. Workers can instantly identify packages and products with a high rate of accuracy. Barcodes significantly speeds up the process of registering products by reducing the act of reading and keying identification numbers to little more than pointing a scanner at the barcode. In a retail environment, for example, clerks use barcode technology to ring up dozens or even hundreds of products within minutes. In the transportation industry, sophisticated barcode scanners can instantly read package information from hundreds of coded packages as the boxes make their way down conveyor belts. In networked economies, the path of products can be closely monitored along distribution line by simply reading and decoding the barcode fixed on the products' packages.

Nigeria as an underdeveloped economy has the challenge of interconnectivity to fully deploy the benefits of barcode technology. Also shop lifters have continued to beat whatever technique deployed to track them down. The issue of instability in power supply also posses a great challenge to the deployment of barcode technology since the barcode readers are all dependent on electricity.

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