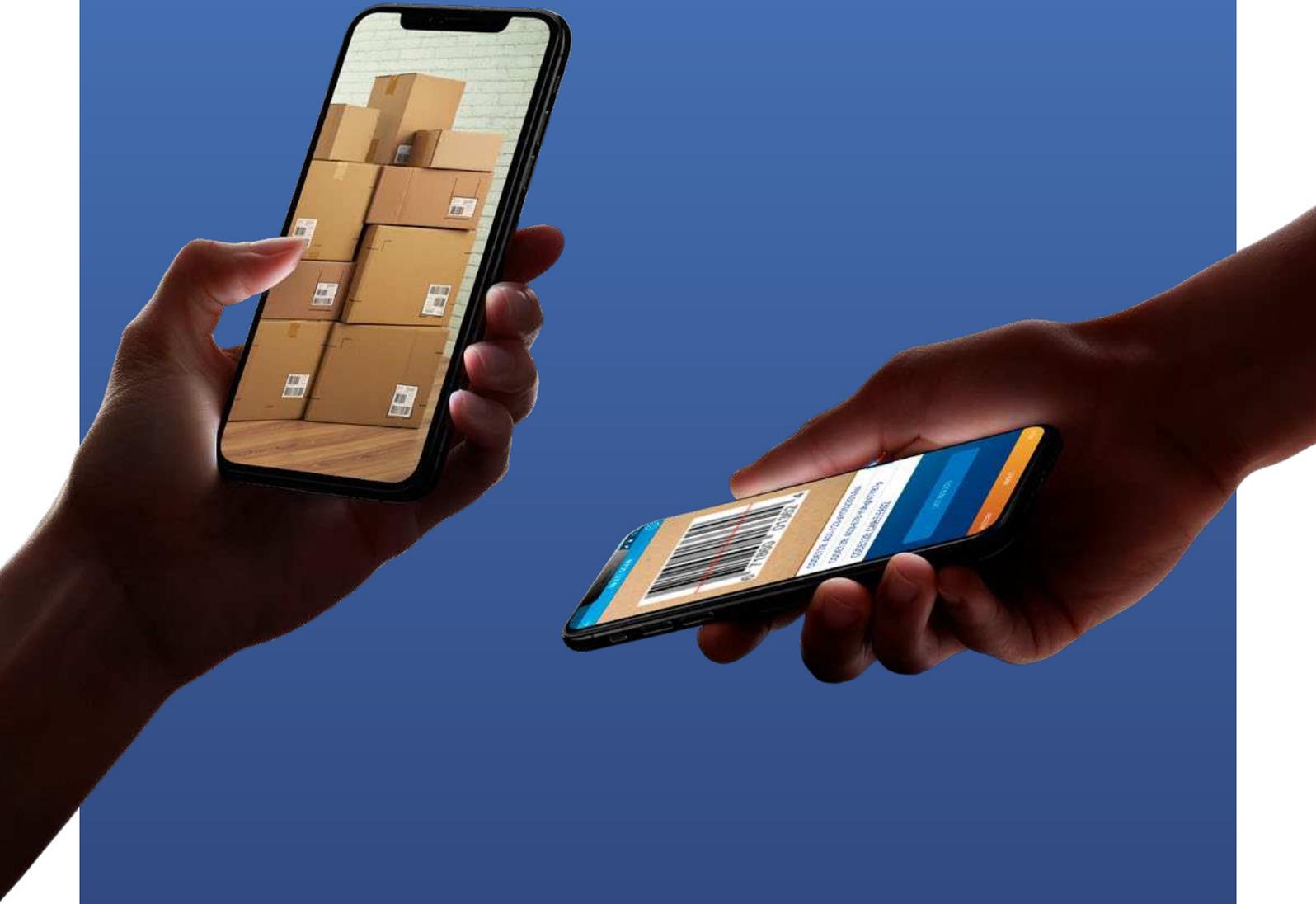


BARCODE SCANNER



WOOPTIX

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EXECUTIVE SUMMARY

This document describes the theory behind barcode reading. In addition to describing the enabling devices that read and decode barcodes. Lastly, there is also a discussion about the markets in which they can be applied.

It is not new that barcodes can be read from smartphones (\$400 billion market), tablet PCs (15 billion units of \$15 billion market), DSLR, and other devices with a built-in camera and a processor. However, barcode reading is needed in many markets such as retail (\$5 trillion value in the US, €2 trillion in the EU, etc. in which IoT for retail is worth \$94 billion), logistics, medical, etc. US and EU spend more money than any other region on IoT for these markets and that is without considering the needs from e-commerce. Every clothing brand today with their own app usually have barcode reading built on it.

With barcode reading, we are entering the ADC market: Automatic Data Capture, also known as Automatic Identification Data Capture (AIDC). Total revenues in this market jumped from \$6 billion in 2014 to \$6.3 billion in 2017 and is forecasted to reach \$7 billion in 2021.

AIDC refers to the methods of automatically identifying objects, data collection and automatic data entering into computer systems.

Barcode reading has a huge market potential, even with the big competition faced from other technologies such as RFID. However, many companies are not willing to pay the extra cost, or change their entire logistics system, just to establish RFID as a main technology enable in their business/logistics.

The price of a retail barcode scanner is between 30€ to 800€ per unit. The most sold scanner costs 200€. It is wired (because of the high battery consumption) and it has omnidirectional scanner, meaning that the user does not have to focus the scanner on the barcode, with automatic sensor. In logistics the prices go around \$1.000 to \$2.500, depending on their needs (battery life, range, wireless communications).

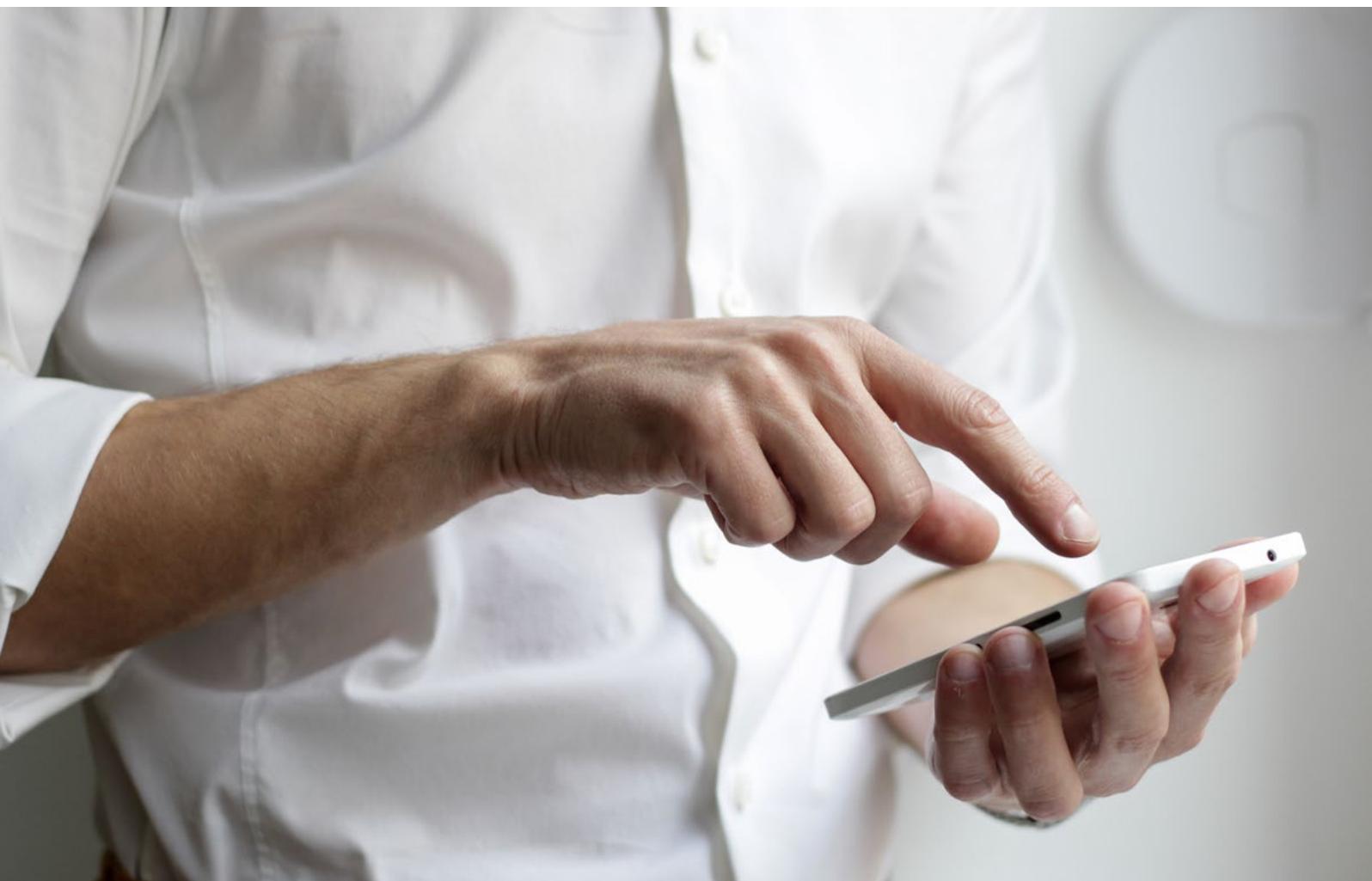


MOBILE SCANNER APP VS LASER SCANNER

Today, large stores, logistic centers and factories are using laser scanners to scan barcodes. A company considering getting laser scanners for all logistics workers, even for small stores or franchises, is looking at investments of thousands of barcode readers. The IT department has two choices: on the one hand, keep buying and using traditional barcode readers (laser scanners) that not only is more expensive but also has limited capabilities; or, on the other hand, thanks to new technologies, you can go for smartphones apps.

Retailers spend thousands, even millions of dollars in barcode reading technologies, annually. For many years, people have been trying to find an alternative to the commonly used barcode laser scanner. The smartphone was considered unfeasible to read 1-dimensional barcode (1-dimensional barcode is perfect for laser reading). For this reason, QR codes, which are 2-dimensional codes than can be read by mobile cameras (2D), were developed.

Is it possible to beat laser scanner's performance with a smartphone scanning 1-dimensional barcode?



MOBILE SCANNER APP BENEFITS

SPEED

It is very hard to beat a laser scanner in terms of speed, they were built for that purpose, they only read codes. However, thanks to the camera of new smartphones and their last generation processors, mobile devices can read and decode very fast.

ACCURACY

The difference in accuracy between laser gun and smartphone currently depends only on the APP you are using inside the smartphone. There are apps working as good as a conventional laser. And you can improve it using AI algorithms to provide better accuracy in codes even lasers cannot read.

PORTABLE

In this aspect, laser scanners are very old and outdated. Most laser scanners we see in stores today are fixed onto the front desk and they cannot be moved. However, with a smartphone, you can scan a product anywhere in the store, even if it is a large department store or even if the store will let the customer scan on its own without store personnel help.

UPDATES/REPARATIONS

In a mobile device every software update is made using a wireless internet connection. If the mobile device fail, there is no need for expensive replacement of a new laser scanner. If the laser scanner breaks, repair or getting a replacement device is time-consuming and expensive, not to mention the lost productivity when the front desk cannot process orders.

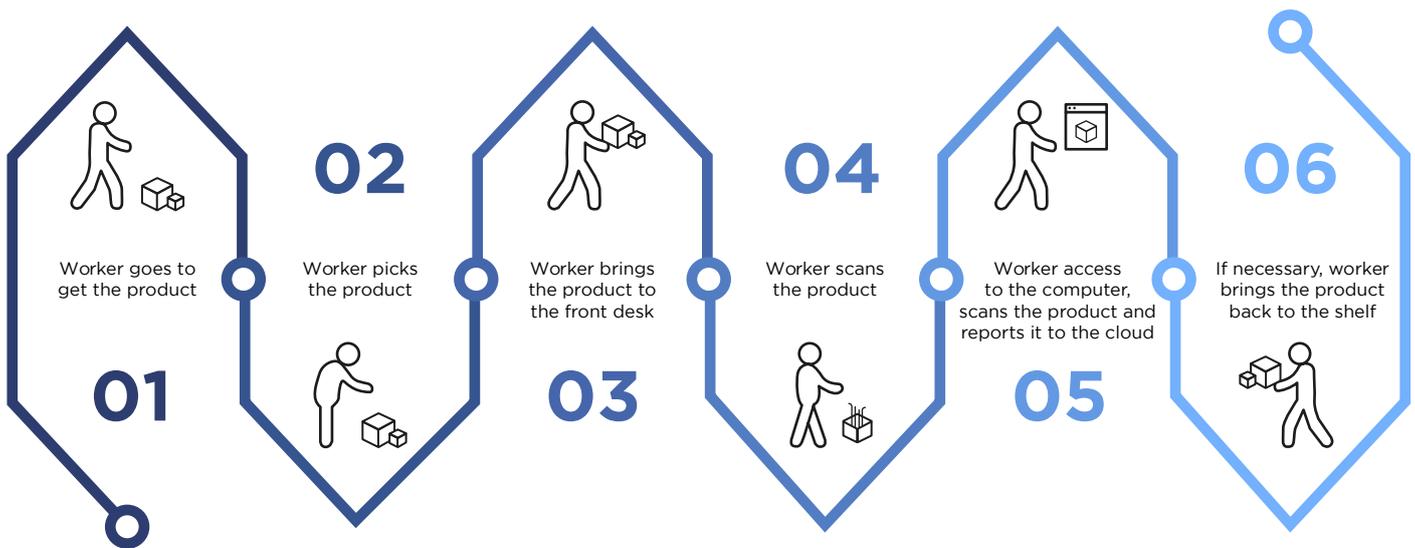
MULTIPLE SCAN/Different types and orientations

Conventional Barcode reading methods allow for 1 dimensional barcode reading at high speed. However, a smartphone can read 1D, 2D and 3D codes (if such a thing as 3D barcode existed) all at the same time. A mobile scanning app can read even if the barcodes have different orientations or belong to different barcode families.

SPEED VS INFORMATION

The process of reporting an issue using laser scanning vs a mobile device is compared in the graphics below:

LASER SCANNING



MOBILE SCANNER APP

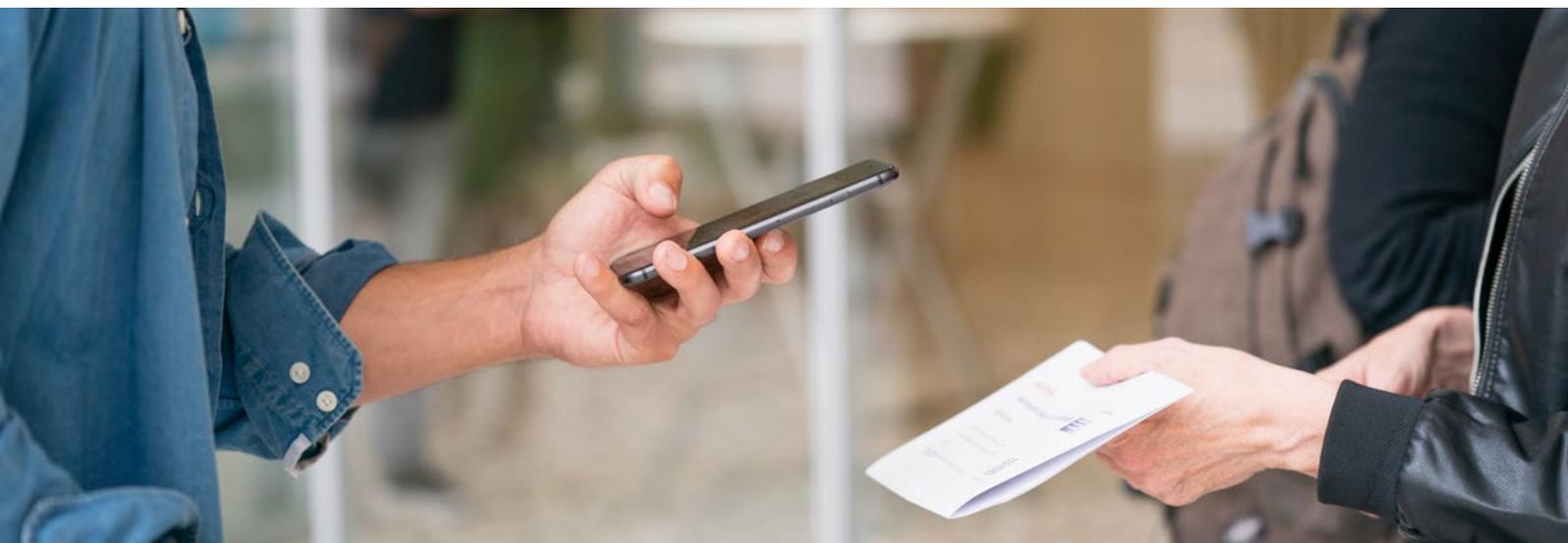
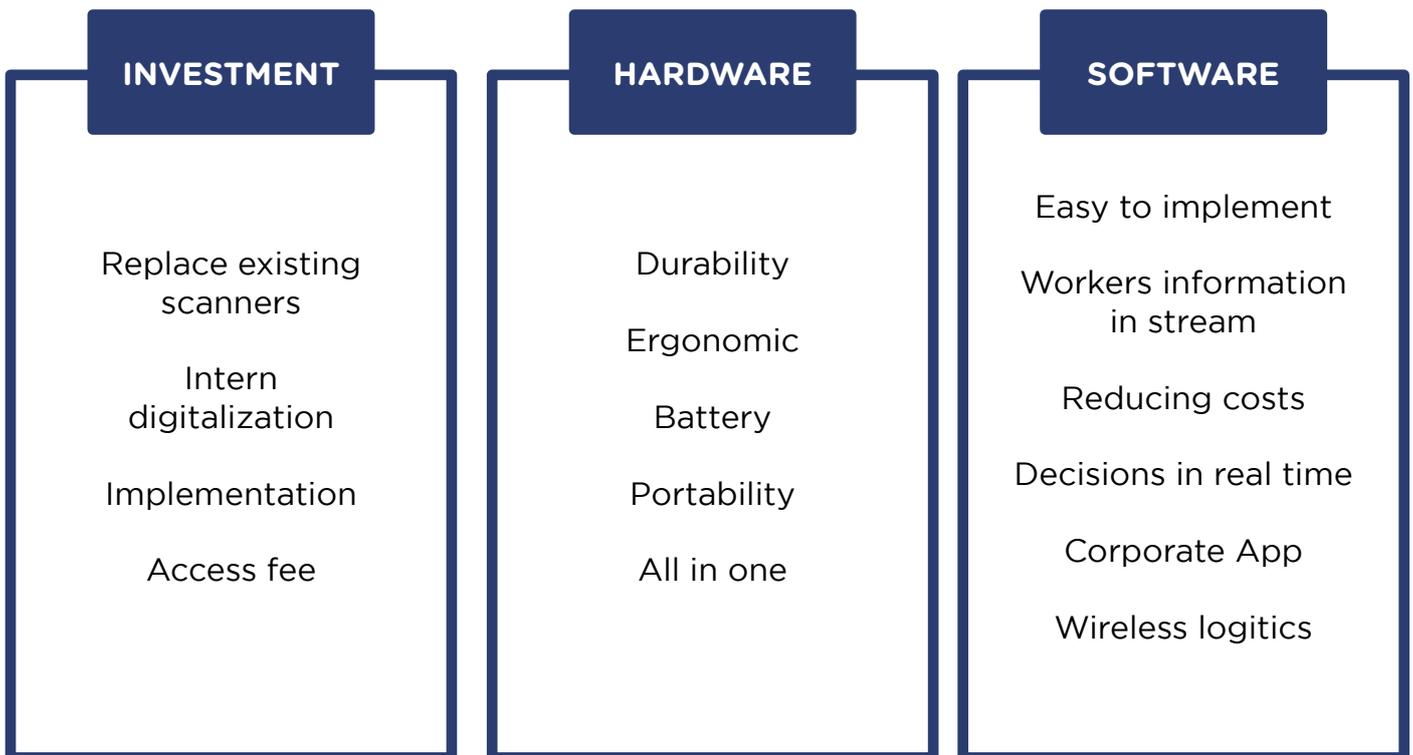


What a smartphone lacks in speed (milliseconds), is compensated by overall time saving during its lifecycle in addition to a wide range of added applications

ANALYSIS OF MOBILE SOLUTIONS FOR ENTERPRISES

Bibliography by Scandit

Deploying mobile solutions for companies is not an easy task, however, a strong understanding of common IT concerns can help you make safer purchasing decisions. Knowing what things to look for upfront will simplify the hardware and software evaluation process and help with the transition planning. The various areas of importance of each critical evaluation item can be seen below



THE COST OF OWNERSHIP

In every business, reducing maintenance costs is always one of the top priorities for IT professionals. It is important to be aware of the two key cost centers:

- 1) The cost of purchasing a scanning device and the software solution.
- 2) The cost of training, in addition to lost productivity during training and reduced downtime.

With the high-speed processors found in today's smartphones, they offer equivalent scanning performance at a fraction of the cost of dedicated barcode scanners. Smartphones can often save companies a significant amount of fixed costs related to the initial capital investment in scanners as everyone already own a smartphone (daily, monthly, and annually). It will also reduce the time for user with direct access to all the capabilities that smartphones can already offer.

THE HARDWARE REPLACEMENT CYCLE

Since a smartphone is hardware that experiences wear and tear, smartphones tend to be replaced on a semi regular base. However, the regular introduction of more advanced smartphones offers a new tool for IT departments, by increasing the control over their software solutions they will experience an easy implementation of new hardware. Departments can update the smartphone software quickly over the air, or if needed easily replace the hardware in a very cost-effective way.

MAINTENANCE

As mentioned, maintenance is an ongoing concern for IT departments. With conventional barcode readers, the devices can break leading to a loss of productivity, and in some cases, they need to be replaced entirely which again can result in an additional cost and downtime.

Smartphone devices also face the same reliability issues as laser scanners. It is important to note that any mobile solution will require some level of ongoing maintenance and repairs to work effectively.

Smartphone solutions make it easier to perform maintenance. Fixing software bugs is much easier on a mobile device due to the quick software employment to all devices simultaneously through its internet connectivity.

INFORMATION AND ANALYTICS

Everything related to digitalization, gives the IT departments tools to work with for current and future flexible improvement. Nowadays, the smartphones provide all this data in real time. Since one cannot predict what is going to happen with future technology adoptions, smartphone solutions are flexible and can adapt to any new logistics system. Currently, most devices are Android or iOS based (familiar platforms), and their software platforms are continually evolving to better address the company needs.

PORTABILITY

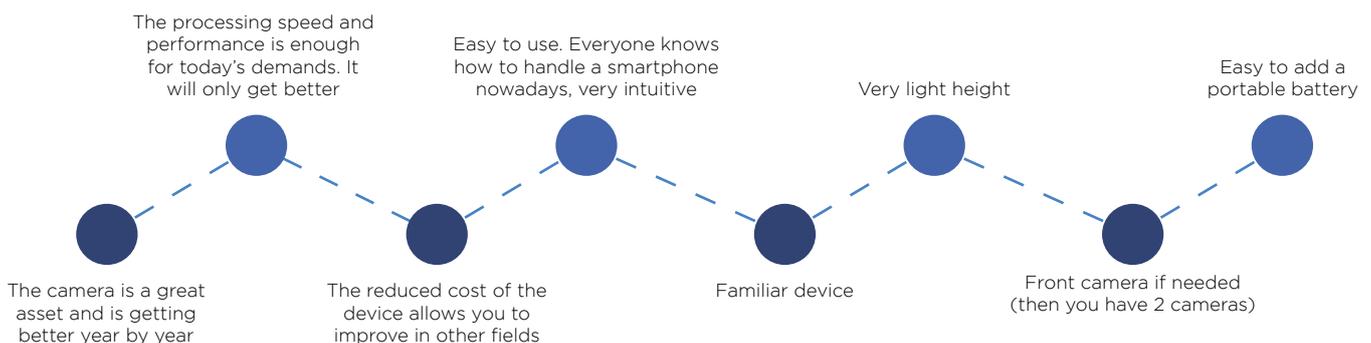
Being a portable solution is one of the most important advantages of using mobile devices versus conventional scanners. Portability is essential nowadays. In the same way that landlines evolved to mobile phones and then to smartphones, now is time to evolve from fixed scanners to smart scanners.

Companies want their workers to be productive. The best way to improve productivity is mobility, to improve the workflow in an effective way. As said before, one major advantage of smartphone scanning solutions is that it is convenient and easy to carry the device.

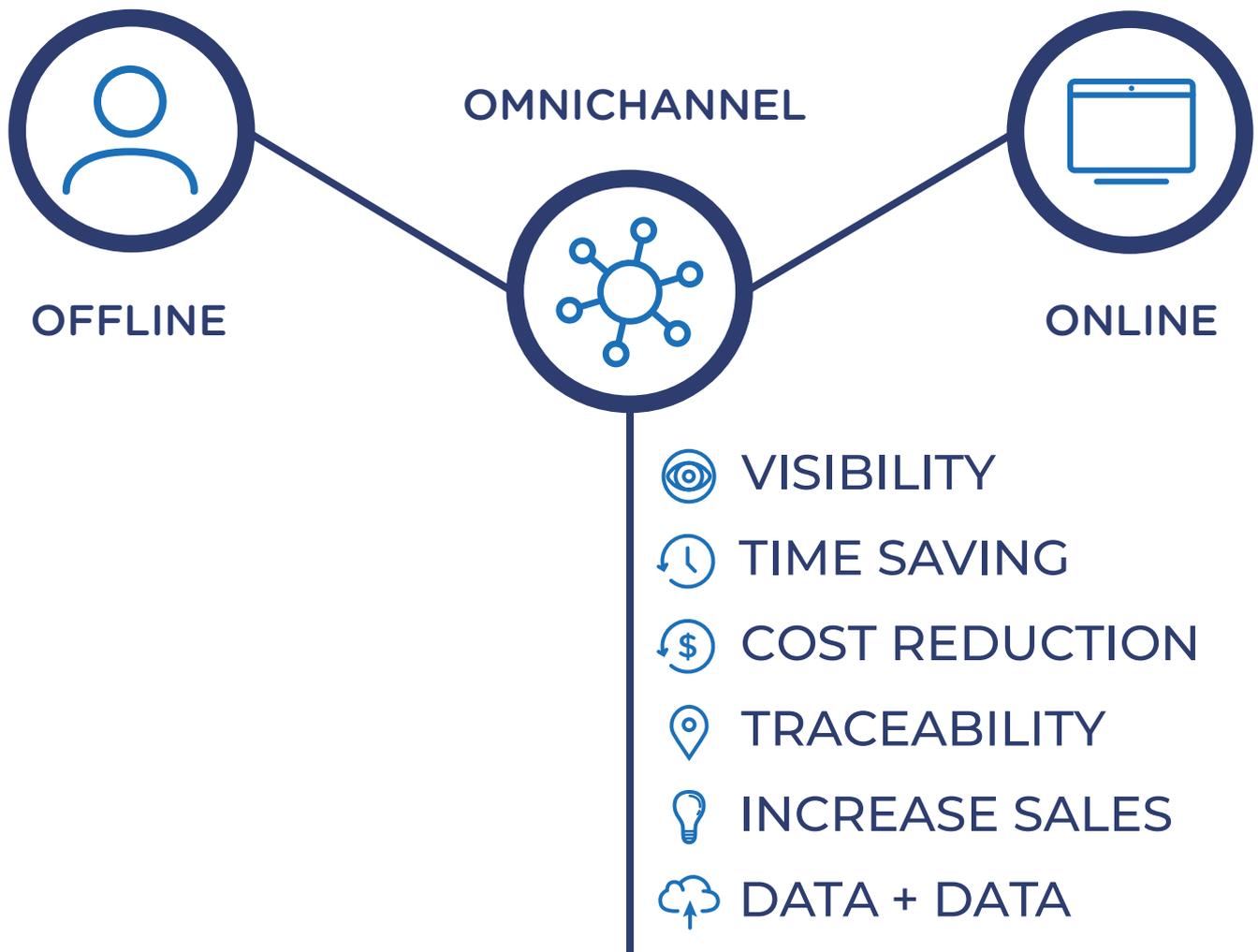
POWER EFFICIENCY

It is very important to keep in mind how many hours the device is going to work autonomously and how often it needs to be in charging mode. Wootpix barcode scanner can assure more than 2000 codes on a single battery charge.

Understanding a device's battery size can help determine how long it can last in a demanding working environment.



OMMNICHANEL



VISIBILITY

Smartphone barcode scanning will be a new benefit for brick and mortar retailers for data collection on customer behavior, something online stores have had access to since its e-commerce inception.

Monitoring customers and getting data on what they look at vs what they purchase, is very useful information currently only available to online retailers.

The key in getting such data from each store is a customized tool (app) the customer will use while in retail stores allowing the retailer to gain the same advantage in terms of data analytics at their offline stores as they already have in their online stores.

In a nutshell, with better understanding of customer behavior, the retailer can get much more information about what's happening inside its retail stores and at the same time providing its customers with new and better in-store experiences.

TIME SAVING

In the 21st century, knowledge is the most powerful weapon as most successful companies are driven by knowledge and advanced data management.

With barcode scanning using the smartphone, corporations are able to get access to information on everyone that enters the brick and mortar retail stores; what users do, what they like, what they see, what they want to buy, what they usually buy and what they didn't buy. By adding artificial intelligence (AI) to the app, the corporation will be able to learn what the user is expected to purchase into the foreseeable future.

COST REDUCTION

A common discussion in corporate board meetings is how to reduce fixed costs within their retail stores.

Imagine that 50% of the people going to your retail store are using your own custom enterprise app to get information of the products they are looking at, see if there is a discount, check if the price tag has flawed information etc.

TRACEABILITY

Location tracking is a critical investment for corporations. They want to understand the walking patterns their customers are following inside the store/mall, in addition to which products they catch their interest.

Companies are investing in WIFI networks, beacons, optical flow cameras to be able to gain the shoppers' location within their store real time. However, these solutions must be implemented via hardware and software in multiple locations inside the shopping center which makes the installation very expensive. Therefore, most of the companies will not make this initial investment in location tracking.

Using the customer's smartphone scanning app, the company will know the location of every person that is scanning a barcode in real time. Not only will they know in which location of the shopping center the customer is at any time, but also which product they are looking at. Furthermore, you can also analyze all the products they have scanned, and then get the map that the customer walked inside the shopping center.

INCREASE SALES

It is important to predict how a software solution will evolve. The evolution of the smartphone scanning app can be controlled by the shopping center with enormous possibilities to provide custom data on customers.

We have explained what you can do by just scanning in-store products with a smartphone. Next, we want to go through three examples that would be desirable solutions not currently available in brick and mortar stores but are available online:

- 1. Clothes.** See matches with other pieces of clothing: At online stores, when you purchase a product, the company automatically shows you “similar products” or “people also look at”.
- 2. Food.** If you chose pasta, you may also need tomato, onion, pepperoni and salt. It would be helpful if the app provided you with the recipe, so you could plan your meal.
- 3. Electronics.** Nowadays, customers shopping for electronics may have better knowledge about the product than the people working in the store. Internet has opened a new era of information. The company app could work in multiple ways:
 - (1) **for the employee**, they could pull up a product as soon as they are asked and appear to be knowledgeable.
 - (2) **for the customer**, if the employee is busy, they can do a detailed comparison between the products scanned that will lead to a well informed decision when purchasing the product.

These situations happen every day and every minute at online stores. This could be the evolution of the brick and mortar stores: collecting data like an online store but provide the shopping experience that physical stores provide.

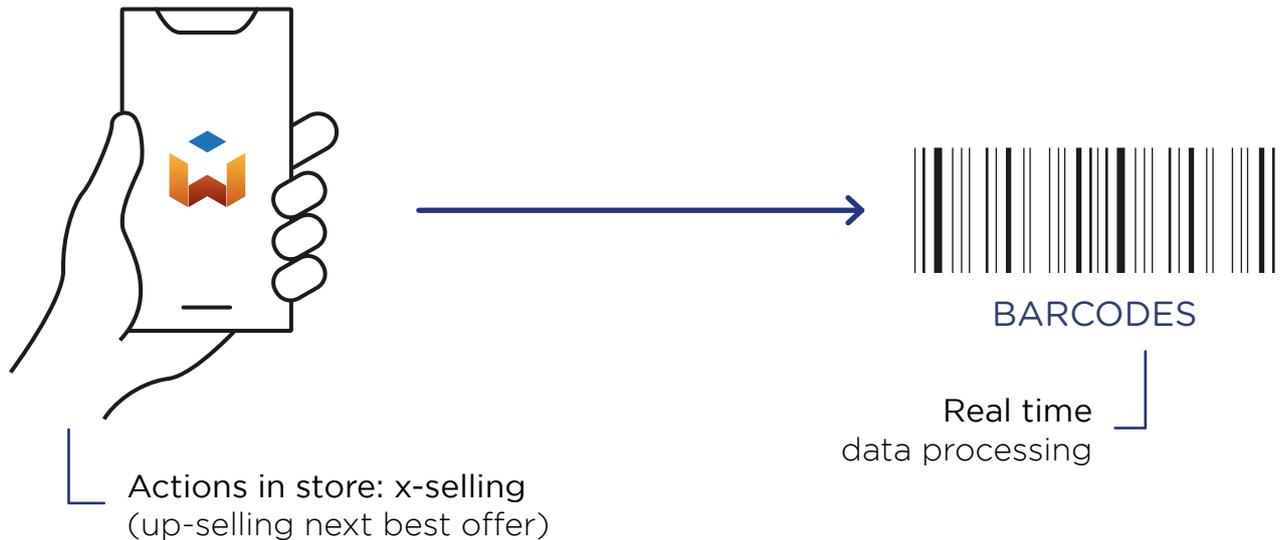




DATA + DATA

BARCODE SCANNING

Controlling, monitoring and learning about sales, customers and workers in real time



CLOUD INFRASTRUCTURE

Machine learning
Real time batch processing Int.
Ext. data sources enrichment
CRM advanced segmentation
Recommendation engine

USE CASE DISCOVERY: (advanced analytics)

Basket analytics
Demand prediction
Customer adv. segmentation
Interest Vs purchases (conversion rate)
Trends analysis and personalization
Inventory management

Key benefits:

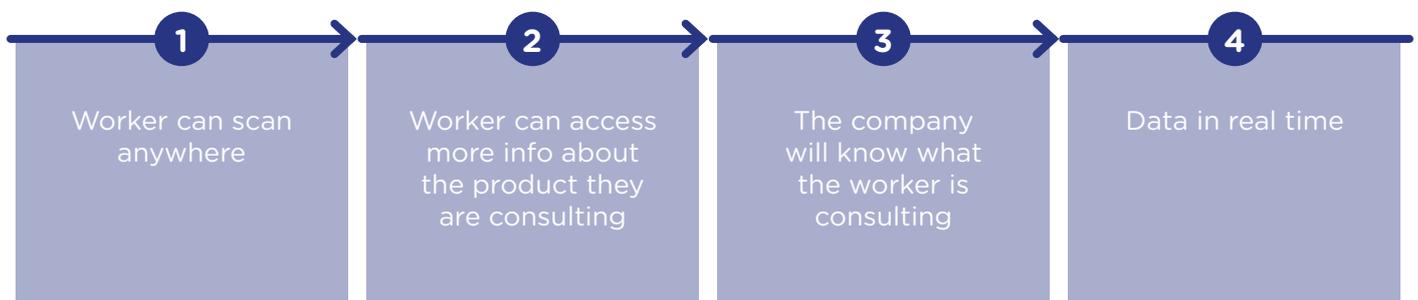
- Improve CX: Omnichannel
- Push traffic to stores
- Drive customers flows through the stores: customer tracking
- Average ticket increase
- Increase conversion rate
- New services release: browse offline, click and collect in store

BARCODE READING FOR WORKERS

APPLICATIONS

One of the big differences between conventional barcode scanners and smartphone scanners is the versatility offered by the mobile device. On the other hand, corporations can develop a customized app where the worker can get more information about the product at the same time they are scanning, all while the company will know what the worker is scanning.

Let us emphasize some facts about a scanning app:



With a simple mobile scanner app, like the one developed by Wootpix, companies can rapidly build a custom Android or iOS app at a much lower cost. Those apps can run and be deployed at thousands of devices simultaneously and are easily adjusted to the corporations own internal user experience.

Unlike past solutions, today's smartphone capabilities address multiple business applications controlled from a single, familiar, and easy-to-use mobile device.

UPDATES

Current laser machines are not capable of getting software updates at real time. The drivers need to be updated or a new device is needed. For smartphones, updates come by software and updated over the air. Every software solution requires updates through its lifetime, however the ideal way of doing this is to be able to quickly scale with the growth of the company.

BACKEND INTEGRATION AND INFORMATION

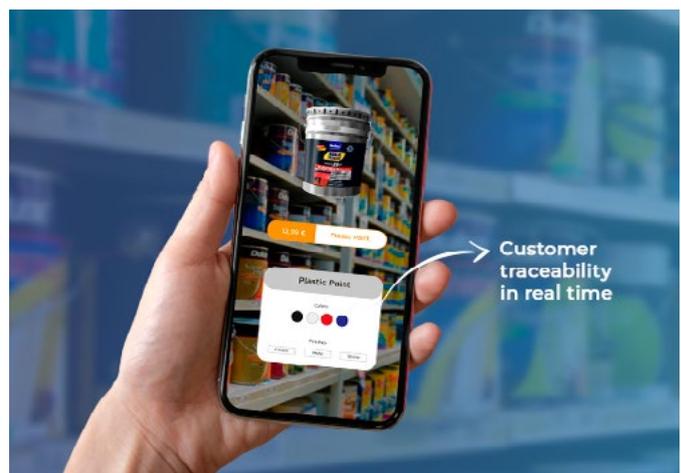
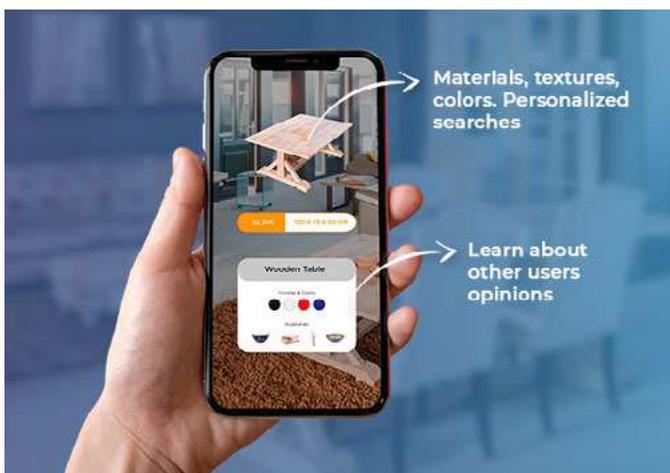
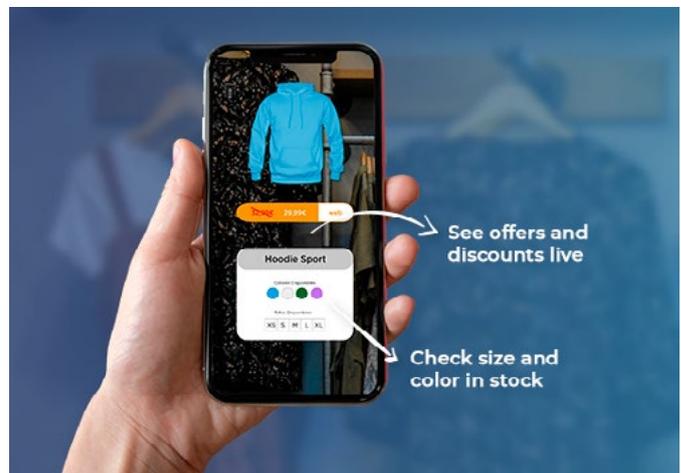
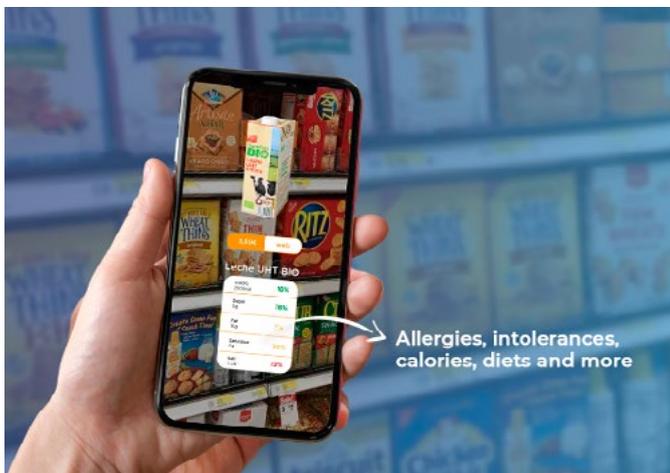
System integrators and software vendors like Wootpix may need to integrate mobile solutions with existing systems through REST, SOAP, API, Email/Smtip, FTP, etc. This means that it is easy to be implemented in any system.

BARCODE READING FOR CUSTOMERS

So far, the discussion in this paper has been about the benefits for the corporation when implementing mobile device barcode scanning into its logistics system. However, the true benefit to the corporation is when the customer get access to barcode scanning from their mobile device, the corporation can gain access to the customer’s behavior. With logistics optimization the corporation can get valuable information about the customers and their sales behavior.

The customers play a key role within the retailer’s sales chain. With the use of smartphone barcode scanning, retailers can use the same data analytics tools in their brick and mortar stores as Amazon is using in its online store.

When retail and online meet. The perfect tool to help retailers and create new user experiences inside the store. Now is possible to enjoy online benefits while shopping



CASE SCENARIOS

Waiting to ask the staff if they have “an item” in a different size. If standard wait time is around 5 minutes, there is a high probability the customer will leave the store without asking. At online stores you don't have to wait, the information is all in front of you.

Conclusion: Scan the item using your mobile phone, select the product and pick size you want, then instore personnel will pick the exact item up for you from the back storage and bring it to you. The customer nor the store staff will not waste time.

Asking store personnel if there are similar products but cheaper or different, or requesting recommendations, other brands, etc. People working in the store provides great customer service, perhaps even more than any apps can offer. However, when staff short or already busy taking care of other customers, a customer service app can be very valuable for the in-store experience.

So: You are in the store buying a blue shirt, but its more expensive than what you are willing to spend. You then seek out the store assistant to see if they have a similar type of shirt at a lower price point. The store assistant may be busy, so you leave the store without buying anything. Now imagine that the employee is free, but they don't know about another shirt because the store is too big to know about all items they have. With a smartphone barcode reader, you can scan the product, search for similar products and then compare price in addition to styles and colors. It's always better to get in person help, however most of the times a smartphone can help answer the simple questions without having to wait for the store personnel to be available.

Discounts. How much money does the company invest in plastics, papers, stickers and all material involving discounts? Now, compare this with the investment made by online retailers for the same discounts; almost none. And more importantly, someone must physically place the price update on EVERY product. The cost of discounting can be significantly reduced. Another type of discount that is not easy to implement today because of its cost and its timing is a temporary discount, if discounting were cheaper there would be more limited time sales events. A store offering product with limited shelf life, stores can run temporary discount campaigns, thereby avoiding giving away all of the fresh products without labor cost and or material cost.

So: you go to the store and you want to pick a shirt that says 42% discount. How are you going to calculate the price? Or you go to the store and you only see stickers in some of the clothes but not in the one you specifically want. Are you going to ask the staff for every single item you want to check? With the barcode app you would be able to know the prices and discounts immediately.

Drive workers to the red-zone. If the people in your store are using the scanning app you will be able to know their locations and you can know the areas of the store with higher density of customers. This will allow the store manager to relocate staff to the “busiest” zones to give customers the best quality service.

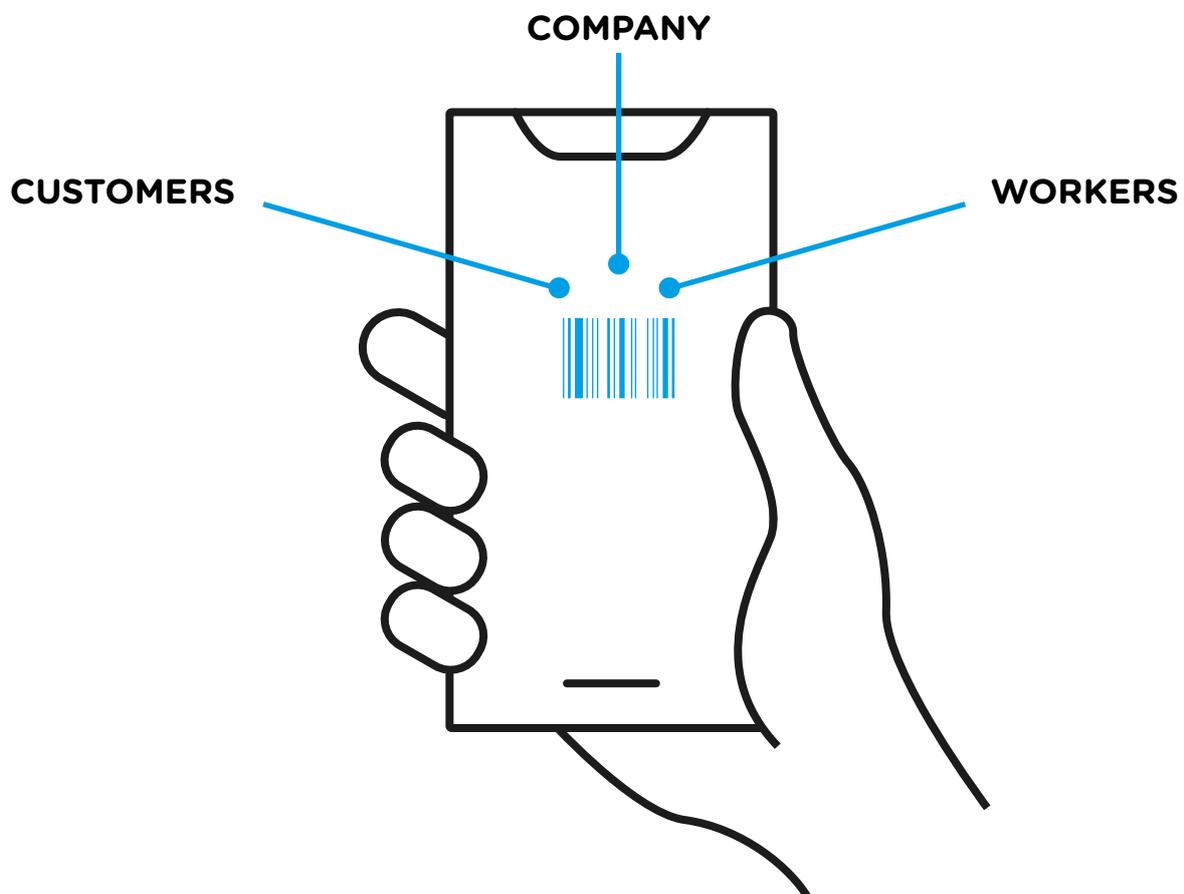
Reduction of the number of laser scanners is one cost a company needs to evaluate. This topic will be more important in the future. As we are educating the customers to scan their own products, one can eventually implement mobile phone payment directly from the app as they are scanning the products. No need to wait in line at the checkout counter.

So: if you scan two books and there is a long line to pay at the counter, you can pay directly through the app and leave the store. No need to wait in line. The receipt will be sent to your email account instantly. These are the next steps in the digitalization.

Scanning barcodes using the smartphone in shopping malls offers the same benefits for data analysis as online stores already have.

The evolution of online shopping has lowered the retail sales in physical stores over the years since the e-commerce introduction. Online stores have less staff and do not pay rent for expensive store fronts located in central areas and yet online stores can still record every action taken by the customers visiting their online stores.

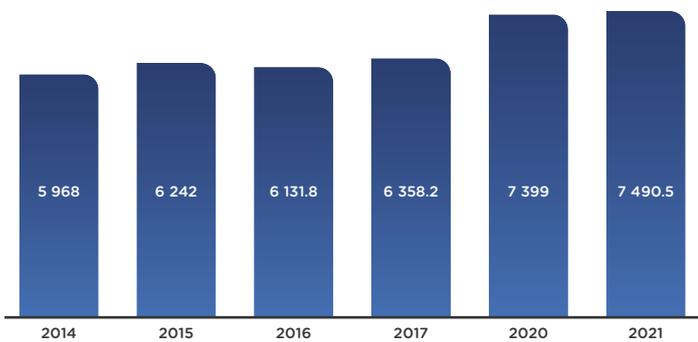
IN CONCLUSION, with just a simple smartphone, we can help retailers to keep growing with more data, more dynamic tools and the ability to generate more efficient analytics models. Online stores are not going away, so let's take the advantage of acquiring the same data in physical stores as online stores currently do.



BARCODE MARKET ANALYSIS

The global market for barcode readers passed \$6 billion on 2017 and the first two quarters of 2018 show continued growth with \$3.5 billion for the ADC (Automatic data captures and barcode readers) market (www.statista.com).

Value of automatic data capture (ADC) solutions market worldwide from 2014 to 2021 (million U.S. dollars)

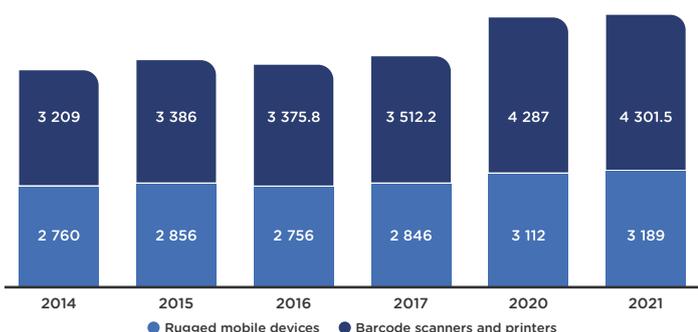


The statistics show the revenue from automatic data capture (ADC) solutions market worldwide from 2014 to 2021. In 2011, revenue from the global market for automatic data capture solutions reached \$6.36 billion. Automatic data capture solutions are regularly deployed for factory, warehouse, and logistics applications, and include both handheld and stationary barcode scanning in addition to imaging devices.

As we can see from the graphs, barcode readers are expected to stay in the market for the foreseeable future, the market is even growing today.

From this market data, we will also research the pure barcode readers and mobile barcode reader devices were sold in the past years as there is a clear differentiation between mobile laser barcode readers and mobile scanner apps. Smartphone readers are not captured in this data set as it is a new, but fast growing, market segment. Mobile readers are, as the bulky standard laser scanner, a mobile rugged device but portable and developed specifically for logistics and warehouses.

Value of automatic data capture (ADC) hardware shipments worldwide from 2014 to 2021, by type (million U.S. dollars)



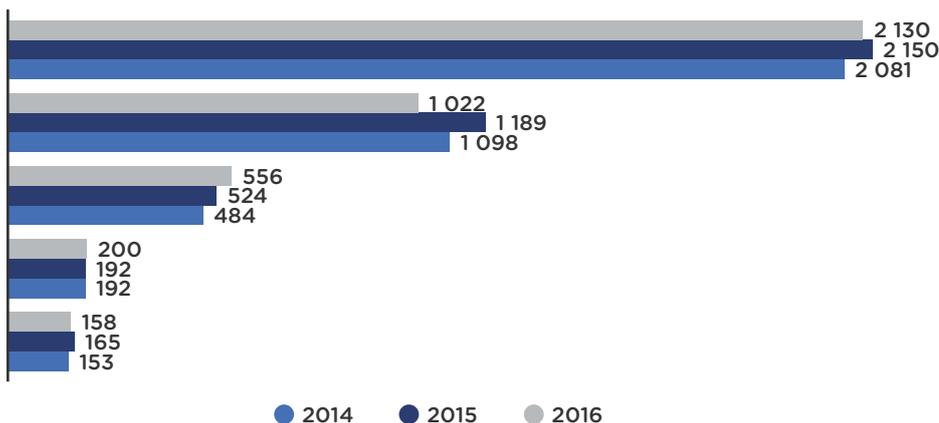
This data shows the revenue from automatic data capture (ADC) hardware solution shipments worldwide from 2014 to 2021, by hardware type. In 2017, revenue from the shipment of barcode scanners and printers were estimated to reach \$3.51 billion worldwide. Automatic data capture solutions are regularly deployed for factory, warehouse, and logistics applications, and include both

handheld and stationary barcode scanning and imaging devices, as well as barcode printers, and mobile computing solutions that have been ruggedized for factories and warehouses.

More than half of the worlds barcode scanners are developed/sold by US corporates like Zebra and Honeywell and are consumed/used all over the world.

In 2016, Zebra was the leading supplier of ADC solutions globally, generating \$2.13 billion in revenue. Automatic data capture solutions are regularly deployed for factory, warehouse, and logistics applications, and include both handheld and stationary barcode scanning and imaging devices, as well as barcode printers, and mobile computing solutions.

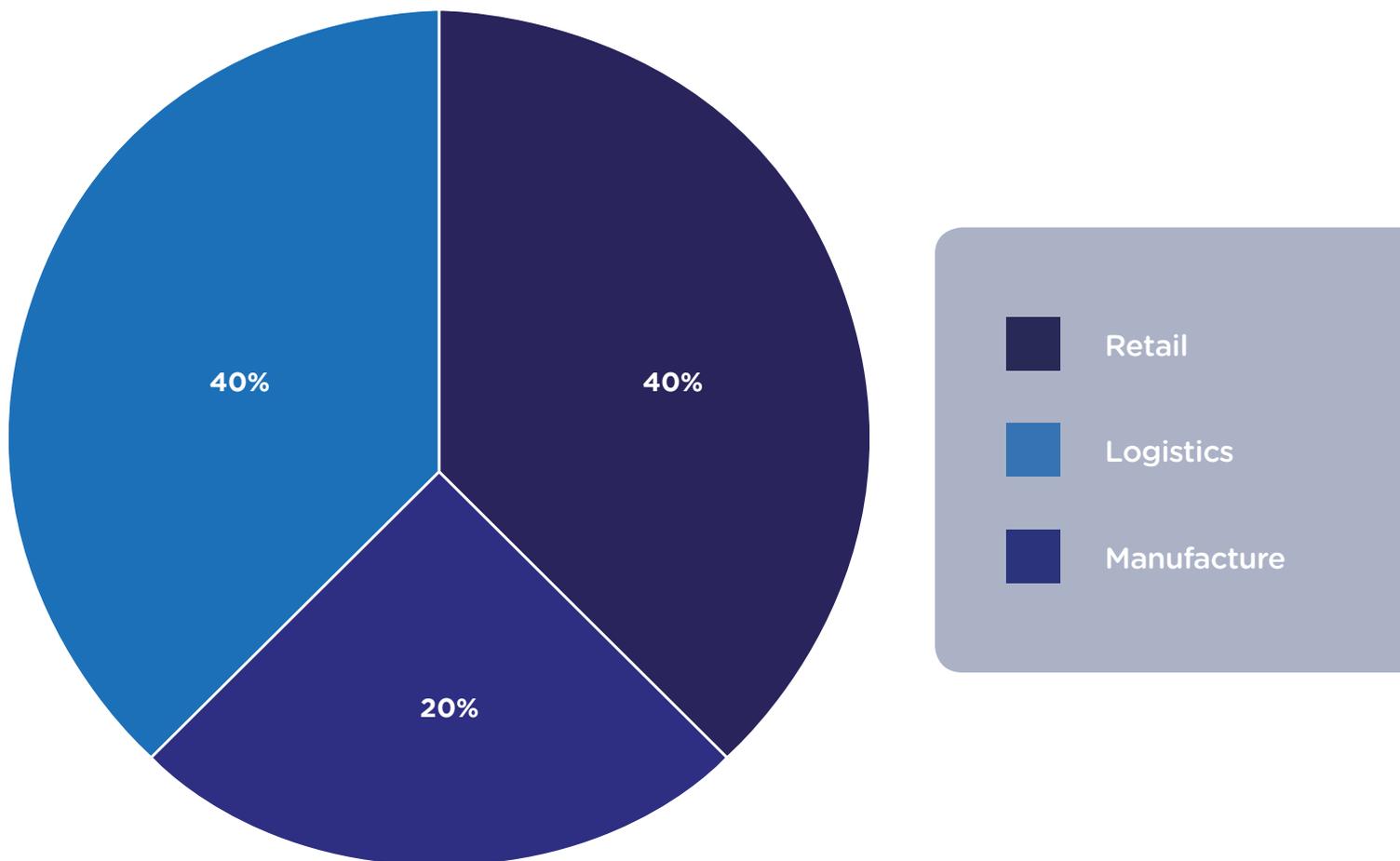
Revenues of leading automatic data capture (ADC) solutions suppliers worldwide between 2014 and 2016 (million U.S. dollars)



The statistic shows the revenue of the leading suppliers of automatic data capture (ADC) solutions worldwide between 2014-2016.

MARKET OPTIONS

As mentioned before in the “Analysis of mobile solutions” and use cases, we have found three principal target markets: Retail, Logistics and Manufacture. As of today, Logistics and Retail are the two first market we will approach. In terms of barcode scanning, there is not a lot of innovation needed within the manufacturing market segment.



There are many ways to enter the barcode reading market:

- 1) Through the retailer: We will approach the retailers and educate them on the benefits of smartphone barcode scanning. Next step will be to work directly with their “solution provider” for software implementation. This is easy for Wootpix as our solution can work on any operating software platform.
- 2) Through the mPOS: mPOS providers are not common, is a very “new” product and is being implemented in almost all the retailer stores slowly. mPOS providers work with their own devices (smart devices), on Android and

on Windows. The idea is to be implemented in their devices offering scanning options instead of using a laser scanner.

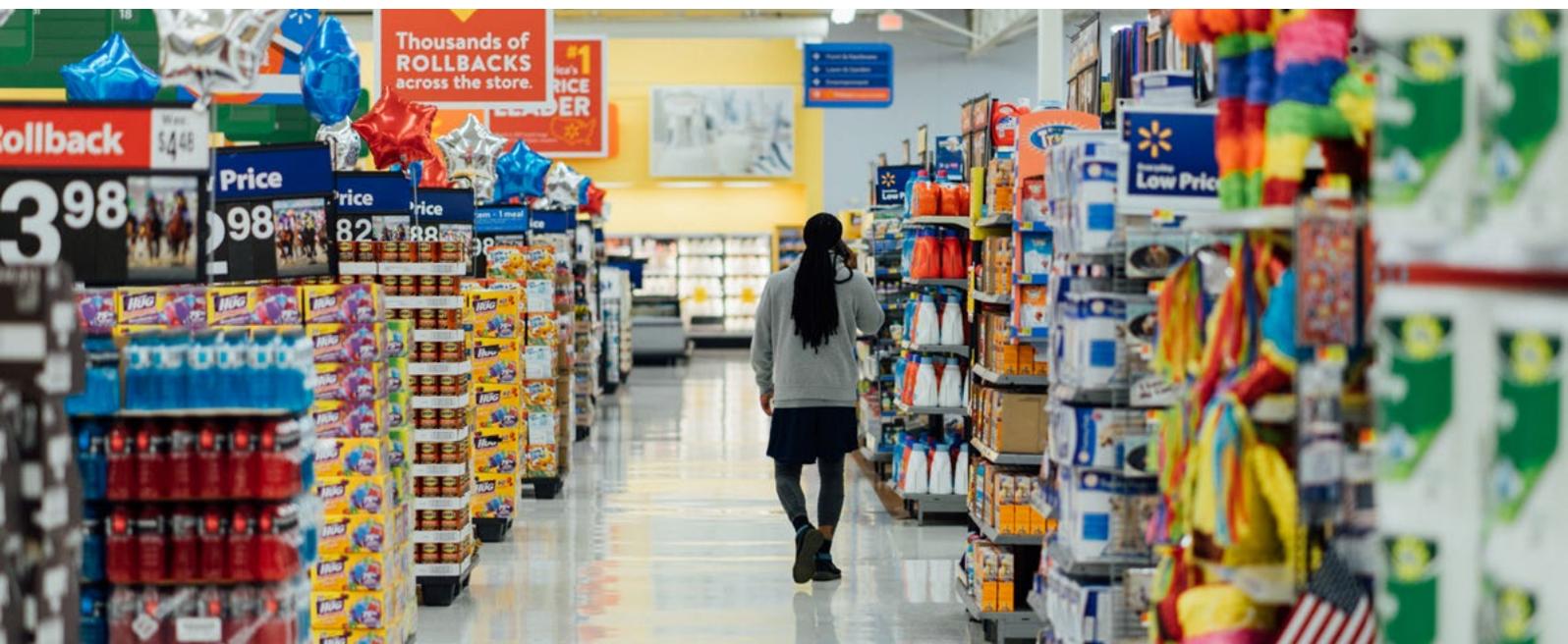
3) Though the POS: POS is a large market segment and the same players have been in the market for decades. Currently these players are challenged by innovation and mPOS and few are ready to take the needed risks associated with these investments. One option offered to the customers in this segment is close partnership, allowing them to have our barcode scanning included in their sales offering.

4) Though the Software Solution provider. This also includes introduction to new technologies by companies like IBM, Accenture, Oracle, etc. Wootpix barcode scanner solution could provide them a considerable advantage.

5) Partnering with a Logistic's Software solution provider: For Wootpix this is a good way to enter the logistics market to minimize the risks. Wootpix will be the technology provider.

6) Independently: To enter the market with no partners we have realized this to be a huge undertaking. Developing an app in addition to promotion and computer scientists is too much for a small company to do while being in direct competition with large market players.

After evaluating all 6 ways to enter the barcode scanning market, we have tested going through the retailer (now with several conversations with El Corte Ingles and with Leroy merlin); through the mPOS (several discussions with Aava mobile, the global leader of mPOS) and we partnered with the Logistic Company named Kaleido, that is developing the app for the logistic market and expected to be released Q1 2019.



TECHNOLOGY: MOBILE SCANNER APP

WHY WOOPTIX BARCODE SCANNER?

It is important to note that there are other companies already reading barcodes from smartphones and some of them are free. However, we will focus on 1D barcodes usually reserved for laser scanners and Wooptix has a solution that is faster and more accurate than the competition.

Wooptix long experience from optics in astrophysics provides a competitive advantage in image computation using light information with its associated direction of the optical paths. Therefore, Wooptix can localize and decode any image pixel in 1D codes from any position related to the phone and with any orientation of the barcode.

They may also operate with less restrictions and can accept any image where the barcode is visible with enough resolution. In the latter there is a stage of localization of the barcode within the image, so that the line of pixels where the intensity profile of the barcode has been imaged need to be established previously to the decoding stage. In case of just decoding, the region to be decoded normally is a raster line in the center of the picture.

The localization stage can be even more computational expensive than decoding of the barcode. The barcode localization is typically achieved by filtering, detecting and/or clustering image characteristics that give cues of the presence of barcodes such as concentration of corners, relative magnitude of gradients in two orthogonal directions, preeminence of bi-level features. Those characteristics normally impose tight restrictions on what inclination the barcode and the camera can have to be detectable

With a smart mobile device, such as a smartphone or tablet, equipped with a camera and the appropriate processing power, and making use of the algorithms defined in Wooptix patented technology, it is possible to compute in milliseconds the Wooptix computation of the gradients of the image being captured. This achievement enables various applications.

Typically, 1D barcodes, defined in the ISO15417, ISO15420, ISO15424, ISO15426-1, and ISO16390 standards [6]–[10], are read by laser scanners, which require pointing the laser scanner directly at the barcode (data carrier, in the terminology of the standards) with an appropriate orientation and distance between the scanner and the code. We developed our own algorithm to analyze “N” displacements of the image gradient and decode the intensity profile across the center of the barcode

In other words, we are able to make use of our astrophysics algorithms to patent a fast algorithm that allows smart devices, like smartphones, to localize and decode one dimensional barcodes from any angle and any orientation than the commonly available laser scanners.



Wooptix is a developer of light field and wavefront phase imaging platform designed to acquire all information about the light, using a single lens utilizing the full sensor resolution. The company's technique enables everyone to achieve their vision with more data points at high frame rate and volumetric images and video.



Javier Elizalde Huarte-Mendicoa
José Manuel Rodríguez Ramos
Jan Olaf Gaudestad
Santiago Basallo Diez
Javier González Moreno

More technologies in www.wooptix.com



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