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Tesi di laurea

**Internet of Things e produzione del valore**

*Internet of Things and value generation*

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## Abstract

Nel presente elaborato viene analizzato il modo in cui l'Internet of Things, innovativo insieme di tecnologie che rende gli oggetti "intelligenti", permettendo loro di interagire con l'ambiente circostante raccogliendo dati ed informazioni che vengono poi scambiati con altri membri all'interno di un network, consente di creare valore. I cosiddetti "*Big Data*" sono diventati una risorsa fondamentale per le aziende, poiché hanno innumerevoli utilizzi e possono essere impiegati all'infinito senza alcun costo aggiuntivo. Fino a pochi anni fa, non c'era modo di raccogliere, archiviare ed elaborare facilmente questa immensa mole di dati e ciò limitava la capacità di estrarne valore. Con lo sviluppo delle tecnologie dell'IoT e del Cloud Computing, è finalmente possibile fare ciò in tempo reale ed a costi estremamente bassi. L'utilizzo combinato di Internet of Things, Cloud Computing e Big Data sta trasformando il modo in cui le aziende e le istituzioni prendono decisioni ed organizzano i propri modelli di business: per questo motivo nella relazione non si fa riferimento ai tradizionali settori, i cui confini appaiono ormai obsoleti, ma si preferisce parlare di "*Smart Environments*". Analizzando gli ambienti fisici in cui queste tecnologie trovano applicazione è infatti possibile cogliere una serie più ampia di benefici, individuando non soltanto il valore generato dalle imprese in termini di ricavi, ma anche quello di cui si appropriano i consumatori. Nell'elaborato è stato approfondito in particolar modo come l'IoT promette di rivoluzionare la customer experience, portando notevoli vantaggi ai consumatori e creando nuove fonti di profitto per le aziende. Affinché l'IoT si affermi a livello globale è però necessario superare alcuni ostacoli, legati principalmente alla protezione della privacy e dei dati ed al perfezionamento delle tecnologie e delle conoscenze necessarie affinché i dati raccolti possano essere sfruttati al meglio.

## **Introduction**

In a 2013 Report, the McKinsey Global Institute identified the twelve technologies with the greatest potential to have a massive, economic impact in the next years: one of these technologies is the Internet of Things. The IoT idea is not new: the phrase “Internet of Things” was first used in 1999 when Kevin Ashton, a British researcher and co-founder of the Massachusetts Institute of Technology Auto-ID Center, coined this new term to describe the network of physical objects connected to the Internet through embedded chips or sensors. By bringing the objects into the connected world, the IoT enables new ways of monitoring the object itself and the surrounding environment, generating impressive amounts of Big Data. Data have become a critical resource for businesses: they not only enable to optimize operations and resource management avoiding human errors, though they are also a gold mine of knowledge that permits an unprecedented in-depth understanding of customers.

As innovation has always been a powerful driver for growth, it becomes important to understand how technological innovations could be exploited to generate new sources of revenues. Approximately between 25 billion to 50 billion devices will be part of the IoT ecosystem in 2025, generating a potential value up to \$11.1 trillion per year. As this estimate comprehends an approximate economic equivalent for customer surplus, it is not comparable to any industry revenue or GDP. Actually, besides the gains that innovation could lead to businesses, also the value that can be captured by people is an important aspect that must be considered.

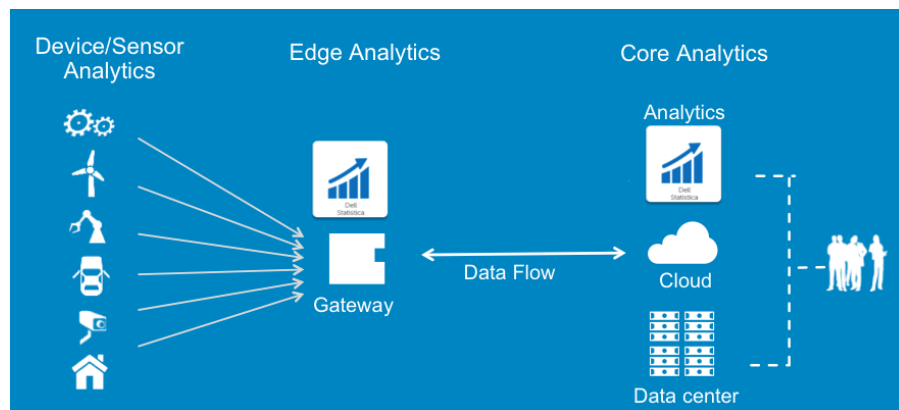
In the early 20<sup>th</sup> Century, the economist Joseph Schumpeter observed that innovation that leads to significant economic advances is often accompanied by a process of “creative destruction” that rearranges entire sectors, making old skills and strategies irrelevant and replacing incumbent business models. Both business leaders and policy makers need a clear understanding of how emerging technologies might shape the global economy and society in the close future so that they can identify the successful ones they should invest in. Entrepreneurs need to comprehend how their competitive advantages might be eroded or enhanced, while Governments must decide where to invest in order to support and accelerate the adoption of successful models, enabling their industries to actively participate and become leaders in a new economic environment.

The aim of this work is to understand how the employment of IoT systems can lead to value generation.

- The first part is dedicated to an overall analysis of the IoT ecosystem, retracing the mix of technology push and demand pull trends that have contributed to the increasing popularity and adoption of this technology and investigating the ways IoT systems enable to create value. In the last part of the first chapter, a picture of how Europe's IoT market likely appears in 2020 is presented.
- The second part describes both opportunities and challenges set by the employment of this new technology. As the use of IoT systems is changing traditional industries boundaries, in this chapter reference is made to the concept of "*smart environments*", identified starting from real-life use cases that have successfully exploited this technology. However, different obstacles must be overcome to achieve the described results; for this reason, this part also presents an overview of the major hurdles that businesses and policy makers must face, plus some suggestions given by stakeholders that Governments should consider to accelerate the adoption of such systems.
- Finally, the last part is dedicated to an in-depth analysis of how the IoT is changing retailers' approach to the customer experience. The chapter presents the case of OVS, Italian fast fashion leading retailer and winner of an international award for the most innovative customer experience.

## 1. A portrait of the IoT ecosystem

A proper definition of the Internet of Things is suggested by IDC, global leader in market research, analysis and consulting services, specialized in information technologies and digital innovation. *“The Internet of Things enables objects sharing information with other objects/members in the network, recognizing events and changes so to react autonomously in an appropriate manner. The IoT therefore builds on communication between things (machines, buildings, cars, animals, etc.) that leads to action and value creation.”*



*The IoT ecosystem components*

The IoT technology refers to a wide range of technologies, from simple identification tags to complex sensors and actuators, connected by networks to computing systems. The cheapest and probably most common identification tags are Quick Response (QR) codes. By taking a snap of the code with the smartphone, the customer is addressed to an application or a dedicated web page where he or she can find further information about the product. Although the communication is one-way, QR codes are a cheap tool that enables to store information in almost every object. More advanced are sensors and actuators: the former can transmit data about themselves and the surrounding environment to other members in the network, while the latter are also able to act on the object itself. Widely known sensors are RFID tags: they can be attached to almost any item, tagging it with a unique ID, and they emit a radio signal that permits to pinpoint the good location at any moment. In the early 21<sup>st</sup> Century, retailers and logistics companies pioneered RFID tags to optimize warehousing or track their packages: these examples of passive communication between things and people represent the first stage of the development of the IoT technology. The evolution of RFID tags has led to the creation of Near Field Communication (NFC) chips: while the former allow a one-way communication like QR codes, the latter enable two devices equipped with the chip to share data if placed nearby. Even more sophisticated are micro electromechanical systems (MEMS),



micro sensors embedded in objects that capture and process data and information from the environment, enabling the actuators to react autonomously.

### **1.1 The IoT revolution: technology push versus demand pull trends**

Although the term “Internet of Things” was coined in 1999, this technology has started to be widely adopted only recently. The main contributor to the explosion of IoT systems is the enhanced connectivity infrastructure: as the IoT is based on the communication between devices and people, they must be able to connect anywhere and at any time to share data and information. Secondly, IoT diffusion wouldn’t have occurred without the development of the technologies underlying Cloud Computing and Big Data. Sensors embedded in devices generate enormous amounts of data impossible to store physically. In the absence of platforms to store them and sophisticated software to analyze and transform them into a valuable resource, data would be useless. The introduction in 2012 of Internet Protocol Version 6 (IPv6) played an important role too: smart objects acquire their own identity in the digital world, so the extension of the number of unique Internet addresses available makes it possible to connect to the Internet an infinite number of devices. Finally, the dropping costs of sensors, actuators and WiFi routers have contributed to making this technology always more accessible.

Up until now, the market has predominantly been driven by supply, but today demand forces play an always more important role in the growth of the IoT market. The Public Sector has a central function in this shifting. On one hand, Governments exert a considerable influence on the IoT ecosystem evolution by providing financial resources and launching initiatives to raise awareness around the possible IoT applications. On the other hand, they invest in IoT applications for the development of smart cities, improving public transportation and enhancing public safety: smart sensors providing real-time data can help monitor the status of traffic and pollution or the behavior of people, in order to make better public management decisions. Thanks to the active support of EU in Europe and the Chinese Government in Asia, these two Regions play a foremost role in the creation of a global IoT market, while Government support in North America is the weakest among developed countries, although North America is the leader in the development of the underlying technologies.

Figure 1: Stage of IoT use by Region



Source: The Internet of Things Business Index, The Economist Intelligence Unit

Furthermore, opportunities offered by the Internet of Things begin to be clear also to businesses. Companies are excited to adopt new systems that permit not only to reduce costs and increase efficiency in existing organizations but also to develop new revenue streams and create new business models.

Finally, a series of socio-demographic trends is influencing the demand for IoT applications. In the whole Western World, the aging population in combination with the relevant costs of in-hospital care require more efficient health systems; a wide series of IoT solutions, such as remote monitoring, have emerged to meet this demand. The growing culture of eco-consciousness in the developed world plays its role too, as demonstrated by the growing number of IoT applications that can lead important results in terms of energy cost saving and waste reduction.

## 1.2 How the Internet of Things enables businesses to generate value

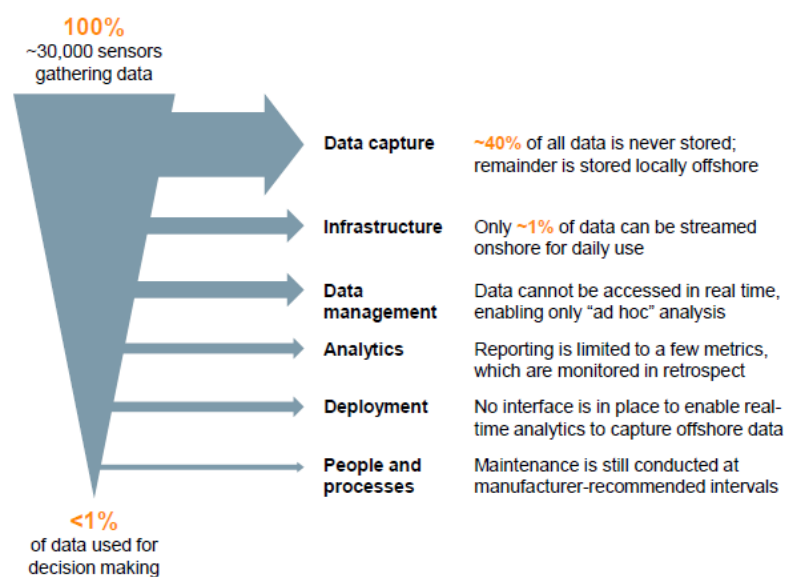
In the paper “*The Internet of Things: mapping the value beyond the hype*” (2015), J. Manyika, M. Chui, P. Bisson, J. Woetzel, R. Dobbs, J. Bughin, d. Aharon, the McKinsey Global Institute analyzed more than 150 IoT use cases across the global economy, with the aim of examining how the Internet of Things can create value. They estimated the economic impact of these applications by the potential benefits they can generate, such as better resource management, time saving, reduced accidents and improved health. About \$6 trillion are expected to be invested in building IoT systems between 2015 and 2020<sup>1</sup>; in the face of this level of investment, the potential economic gain could be up to \$11.1 trillion per year

<sup>1</sup> Source: BI Intelligence.

globally by 2025<sup>2</sup>. As these estimates about the value created by IoT applications comprehend an approximate economic equivalent for customer surplus, they are not comparable to any industry revenue or GDP, so it is difficult to understand how businesses financial results will be concretely improved.

The Internet of Things is a key source of big data that can be exploited to create value for the entire economy, enhancing companies' productivity and performances, improving Governments' resource management and creating a considerable surplus for customers. However, in order to create value, IoT applications should not only be able to collect these data, but also to analyze and synthesize them into a format that can easily be understood by decision makers. Although the increasing number of people, sensors and devices connected in digital networks has improved the ability to generate and share data, systems do not own the necessary capabilities to extract all useful information yet. Actually, just a small amount of the data collected are exploited. This is an issue in particular in B2B situations, where the greatest value is expected to be created. Data gathered are used by enterprises above all for anomaly detection and real-time control, although a larger value would be created employing this information for predictive analysis and operations optimization. MGI analyzed, for example, how data generated by the 30,000 sensors on an offshore oil rig are used: it discovered that of the 60% of the data stored, approximately just 1% can be streamed and less than 1% is currently employed to make decisions, while the other 99% is lost before reaching operation managers.

Figure 2: How data collected from 30.000 sensor on an oil rig are used



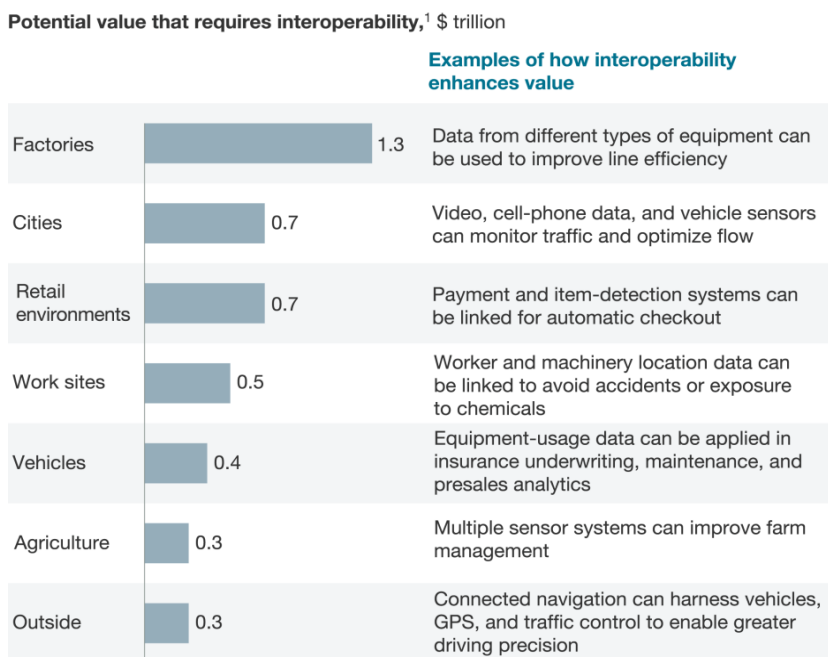
Source: McKinsey Global Institute analysis

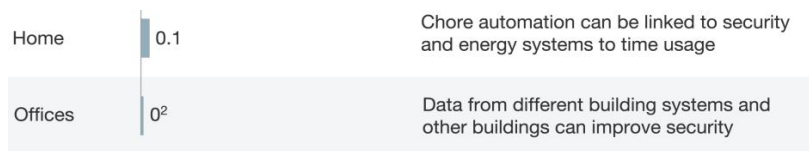
<sup>2</sup> Source: McKinsey Global Institute.

In order to embrace data-driven decision making, it is necessary to improve the underlying technology and refine the way data are transmitted and analyzed in the network. Data need to be timely accessible by knowledgeable workers able to gain precious insights to support decisions; in some cases, systems will automatically adjust processes to reach the greatest efficiency possible. This will contribute to creating transparency avoiding information asymmetries, optimizing operations and improving products and services quality.

An indispensable element that must be further improved to enhance the value generated by IoT applications is interoperability. The McKinsey Global Institute estimates that about the 40% of the total value that can be released by the Internet of Things is created in situations in which two or more systems interact; in working settings, where the interconnectedness of the equipment is more complex, the percentage can reach 60%. Interoperability would significantly improve performances by combining sensor data from different objects and systems to provide decision makers with an integrated view of performances across the entire environment. For example, a centralized traffic-control system in a smart city would need to take into account data from sensors on roads, cars, parking meters and buses, plus non-traffic data such as weather reports. Achieving integration across multiple systems requires important efforts: they need a sort of “common language” to communicate, but the development and adoption of widely accepted IoT standards are still in the early stages.

*Figure 3: Potential value that requires interoperability*





<sup>1</sup>Includes sized applications only; includes consumer surplus; figures have been rounded.

Source: McKinsey Global Institute

Almost two-thirds of the value originated by the employment of IoT systems is estimated to be created in business-to-business situations. However, customers are expected to gain as much as 90% of the value created by 2025 due to better features, higher quality, lower prices and better services<sup>3</sup>. In fact, taking advantage of data about individual users and product usage gathered by IoT applications, companies are able not only to better respond to customer necessities but also to discover new needs. The continuous stream of real-time data enables a deeper understanding of customers' behavior and desires. This means that it becomes easier for enterprises to cluster them into micro-segments so that customized pricing models can be employed and tailored products and services can be designed. Actually, always more businesses, especially in the retail environment, exploit data to create one-to-one offers shaped on the specific preferences, in order to affect loyalty and build stronger long-term relationships.

Besides the benefits that companies can gain from employing IoT systems in their current businesses to raise efficiency and improve existing products and services, some companies are already exploiting new technologies to create completely new models trying to get a sustainable competitive advantage. The IoT, for instance, enables “anything as a service” business models for all kind of products. In many companies, there is a shift from selling products to selling services based on those products. This provides benefits for both consumers and service providers: the former can avoid large capital expenditures and pay only for the effective usage, while the latter can have access to continues flows of data that can be used to constantly improve products while in service, avoiding the depreciation of their value over time. Moreover, data generated by IoT applications can become a profit center itself. Data describing customers' behavior are actually a gold mine for companies as they can be “monetized”: in other words, a company can decide not only to use them for its purposes but also to sell or trade them with other companies.

<sup>3</sup> Source: McKinsey Global Institute.

### 1.3 Alternative scenarios for Europe's IoT Market by 2020

Europe has demonstrated to be ahead of both in exploiting IoT solutions to improve internal operations and in taking advantage of this new technology to design new products and services.

Figure 4: Stage of IoT use in Europe compared to the average global level



Source: The Internet of Things Business Index, The Economist Intelligence Unit

In the report “*Definition of a Research and Innovation Policy leveraging Cloud Computing and IoT combination*” (2014), S. Aguzzi, D. Bradshaw, M. Canning, M. Cansfield, P. Carter, G. Cattaneo, S. Gusmeroli, G. Micheletti, D. Rotondi, R. Stevens, entrusted by the European Commission to IDC EMEA, leading market intelligence company specialized in the ICT sector, and to TXT e-solutions Group, an international software products and solutions vendor, IDC forecasted revenues that could be generated by IoT applications for the 2013-2020 period for the 28 EU member States.

The model is underpinned by 22 key relevant factors that can affect the IoT market in the next few years. They can be grouped into four areas: macro-economic, technology developments, regional growth influencers and ICT market trends. Each assumption was rated on whether it has a high/medium/low impact upon the development of the IoT market; in the list, IDC identified the state of the economy measured by GDP growth, the proliferation of embedded computing, the number of Internet users and Government support as the four factors with the greatest impact on the creation of a Europe's IoT Market.

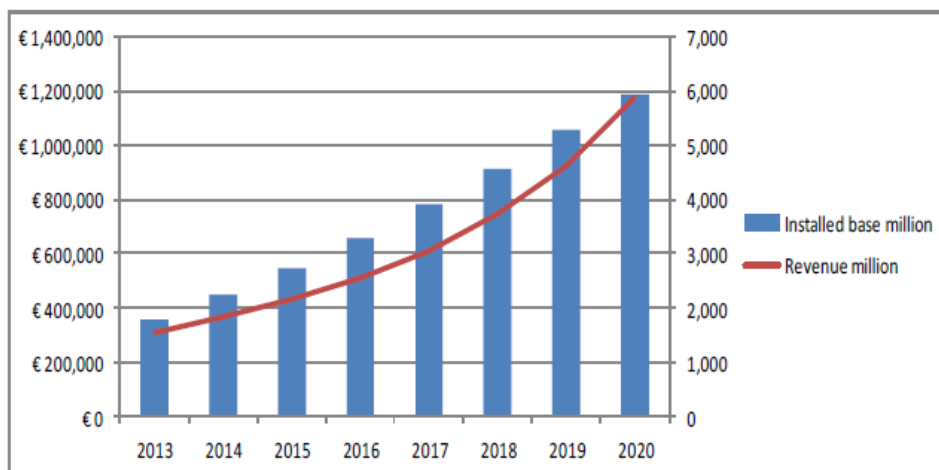
In addition to this key assumptions, it also considered the differences in the dynamics and economic performances of the member States, and divided them into four clusters: fast growth Countries (Denmark, Finland, Germany, Sweden, UK), good growth Countries (Belgium, Ireland, France, Luxemburg, Netherlands, Poland), low growth Countries (Austria,

Czech Republic, Italy) and very low growth Countries (Portugal, Spain, Bulgaria, Croatia, Estonia, Hungary, Latvia, Lithuania, Romania, Slovakia, Slovenia, Greece, Malta, Cyprus).

In this study, IDC presents three alternative scenarios. In the base case, the authors have assumed that all members State will return to modest GDP growth – 1.7% annually on average – by 2020; for the alternative scenarios, they suppose that Countries will perform differently in terms of percentage and speed of growth.

In the baseline scenario, the volume of IoT connections in Europe is expected to increase from approximately 1.8 billion in 2013 to almost 6 billion in 2020. As more things become connected, the installed base is expected to increase at a Compound Annual Growth Rate (CAGR) of 18.7% over the period, and revenues follow suit: IoT revenues will grow from approximately €307 billion in 2013 to more than €1,181 billion in 2020. However, in the first part of the considered period, the increase in the installed base is more pronounced than the increase in revenues. This is in part due to the fact that an enhanced number of connected devices is the necessary starting point for the creation of an IoT environment; furthermore, at the entry-level stage, IoT applications will be relatively simple. As more sophisticated devices are employed, revenues will increase at a faster rate; this is expected to happen after 2016.

*Figure 5: Expected increase in installed IoT devices and revenues in Europe*



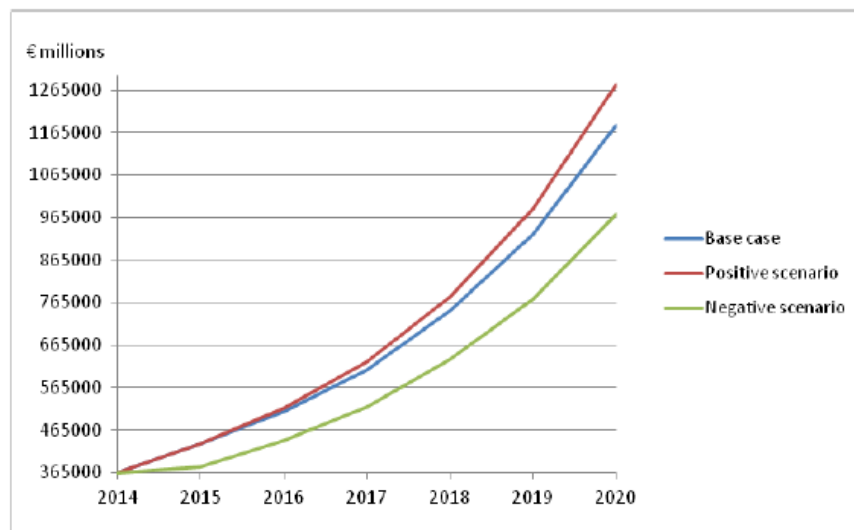
Source: IDC 2014

It is necessary to consider that several factors can influence the described scenario. A more optimistic scenario would be created if Europe's economy recovers more strongly than expected. Embedded computing and Internet users could grow at a faster rate and Government policies could have a more positive effect than anticipated. All in all, in this case, States belonging to fast growth Countries and good growth Countries will have a stronger

influence on EU economy, and will produce a general economic growth higher than 1.7% annually, with an increase in IoT revenues of approximately 5% with respect to the baseline scenario.

In a more pessimistic case, EU economy continues to stagnate and regional influencers do not exert a significant effect due to a tepid and not meaningful Government support. This could lead to a much more negative picture for the development of the European IoT market: the influence of low growth and very low growth Countries – that suffer from high public debt and unemployment – will be stronger than the influence of high growth and good growth Countries, producing a global economic growth lower than the modest 1.7% assumed in the baseline scenario. In this situation, IoT revenues could decrease by 18% by 2020 compared to the baseline scenario.

*Figure 6: Differences in expected revenues in the different scenarios*



Source: IDC 2014

Although the study is focused on the European Region, it demonstrates how different factors could influence the expected results from the development of the IoT market.



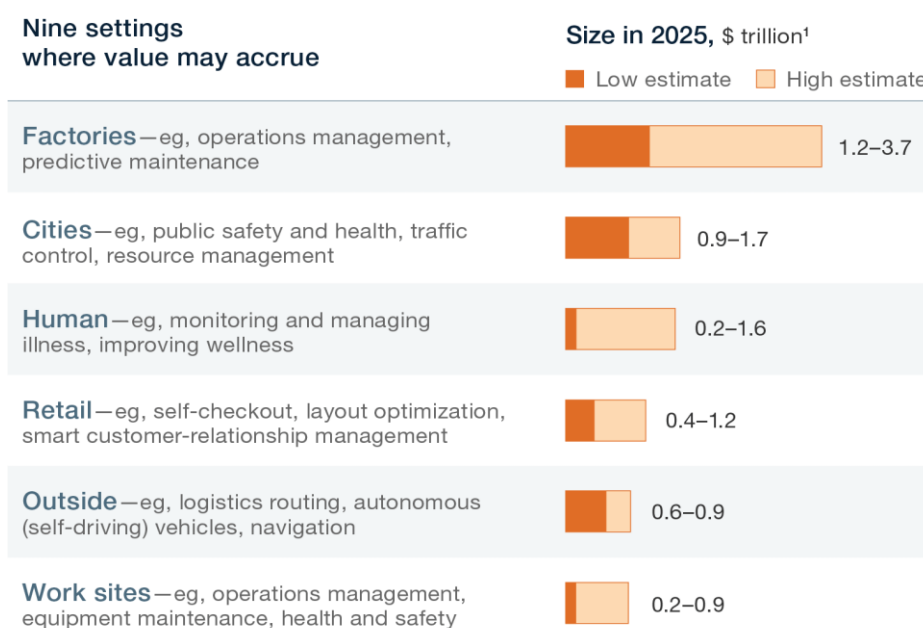
## 2. IoT as a disruptive technology: opportunities and challenges of the new Smart Environments

As IoT, Cloud Computing and Big Data are reshaping traditional industries boundaries, examining only individual industries or sectors to identify the potential of IoT in terms of business opportunities would not be adequate. A change in the point of view is necessary: for this reason, it is better to talk about “smart environments” or “settings”. Analyzing real-life use cases that involve IoT, Cloud and Big Data and the settings in which they are deployed permits to better perceive the complexity of those use cases that stretch across several sectors. This approach enables to capture a broader set of effects and make it easier to understand all the ways in which IoT systems could create value, in particular when they interact with each other.

### 2.1 Business Opportunities in Smart Environments

The McKinsey Global Institute identified nine “settings” in which the Internet of Things is expected to have the greatest economic impact in the next years: Human, Homes, Offices, Retail environment, Factories, Worksites, Cities, Outside and Vehicles. The Institute analyzed how these settings have evolved – or are likely to evolve – to embrace this new technology, and estimated that IoT applications will create a total potential value of between \$3.9 trillion and \$11.1 trillion per year in 2025.

Figure 7: The nine settings where the IoT is expected to have the greatest economic impact





<sup>1</sup>Adjusted to 2015 dollars; for sized applications only; includes consumer surplus. Numbers do not sum to total, because of rounding.

Source: McKinsey Global Institute Analysis

“Human” setting is one of the most profitable environments. Two types of applications belong to this category: health and fitness devices, whose primary purpose is to improve health and wellness, and augmented-reality devices. The use of such tools is growing rapidly: analysts estimate that their number is expected to overpass 1.3 billion units in 2025. Health applications can be constantly worn or carried periodically, allowing patients to be monitored in-home. As they are steadily controlled, it is easier for doctors to make sure that they adhere to the prescribed therapy and, in case of issues or complications, to intervene in a proper manner; this unconventional monitoring tool enable to avoid unnecessary hospitalizations, reducing in-hospital costs by about 8%. Wearable fitness devices have a limited utility, but they have become a trendy fitness tool in the last few years: they measure indicators such as heart rate or skin temperature, control sleep, or work as pedometers calculating steps and distance covered by the owner during a running. Based on this data, the device can suggest how to improve workout or offer diet tips based on measured food consumption. Actually, it seems that today much of the hype around these devices has already gone. Augmented-reality devices, such as goggles, have become popular too since the launch of Google Glass project in 2013. Most of them are still in development, but they are expected to overpass 1 billion unit sold in 2020, surpassing smartphones sales by 2025<sup>4</sup>. All in all, IoT applications in “human” setting are expected to have an economic impact of \$171 billion to \$1.6 trillion per year in 2025.

Numerous are also the opportunities for IoT applications in smart homes. Although the economic impact of such applications will be lower than the one in other settings – \$200 billion to \$350 billion per year in 2025 – they will strongly affect the way people organize their lives. The automation of domestic chores, for example, significantly reduces efforts and

<sup>4</sup> Source: AugmentedReality.org

time spent for household activities. IoT devices also have a positive effect in energy management: sensors can capture information from the outside environment and automatically adjust temperature and lighting, optimizing the use of energy based on the real need. Sensors and cameras can be employed to monitor suspect or harming activities, alerting users in case of danger. Interoperability is the key factor that fosters the widespread adoption of smart home systems, so it is necessary to develop easy-to-use systems that allow users to simply manage multiple devices to promote acceptance by potential users.

In offices, settings in which knowledge workers perform, the benefits of IoT usage are related above all to security and energy management, like in “home” setting. These applications are expected to have an economic impact of \$70 billion to \$150 billion per year in 2025.

Most of the value that can be unlocked by IoT applications in 2025 will be created in factories. The Internet of Things plays a critical role in the so-called “Industry 4.0”. Sensors enable to constantly monitor production processes, and actuators can automatically adjust machines performances and asset utilization. In this way, it is possible to optimize operations and maximize the efficiency of standardized processes, eliminating human errors that might reduce productivity and quality. In addition, sensors are precious for predictive maintenance: if machinery can automatically understand when an inspection is necessary, breakdowns can be avoided and routine maintenance costs can be cut down. Finally, sensors can be used to identify hazardous behaviors, preventing accidents and injuries and improving safety in the factory environment. According to MGI estimates, IoT applications in this setting can generate an economic impact of \$1.2 trillion to \$3.7 trillion per year in 2025.

In worksites, like in factories, the employment of IoT systems promises to lead to important changes. In such settings, like mines or oil and gas extraction sites, work is done outside, in unpredictable and dangerous environments. IoT sensors permit both to improve operations and enhance safety. In mines, for example, self-driving vehicles are helping to reduce costs, avoiding at the same time workers to be put in risky situations. Moreover, sensors can be used for condition-based maintenance – as in factories – reducing breakdowns and cutting down costs. All in all, McKinsey estimates that these applications could yield to an economic value of \$160 billion to \$930 billion per year in 2025.

Retail environment – defined by MGI as “*all the physical spaces where consumers engage in commerce, considering or purchasing goods or services*” – is constantly changing since the introduction of information technologies about two decades ago. The IoT has the potential to

further revolutionize it, with a possible economic impact of \$410 billion to \$1.2 trillion in 2025. IoT promises to provide the necessary tools to finally guarantee the coexistence of online and offline shops, transforming customer experience: data collected both from online and offline channels can be used to create customized promotions and to send special coupon as customers walk into the store, raising their willingness to purchase. IoT also enables not only contactless payments, exploiting NFC technology, but also totally automated check-out payments thanks to innovative systems that automatically charge the sale to the customers' mobile payment account, allowing them to avoid the queue and save time. The analysis of in-store customers' behavior contributes to optimizing store layout to make it more alluring, while automatic shelf and inventory monitoring allow to better manage inventory, avoiding out of stocks.

Vehicles will also be affected by the IoT revolution: the way they are serviced, maintained and designed is expected to change. Smart applications can improve safety and security of cars, trains and planes, thanks, for example, to the vehicle ability to auto-diagnose malfunctions. Furthermore, always more insurance companies will offer premiums based on drivers' behavior, that is constantly monitored through embedded sensors. But these are not the only ways in which data collected can be employed. They can help the manufacturer to create more reliable automobiles, or enable them to develop new services that foster revenues, such as apps for connected cars providing real-time traffic track. The use of these systems in vehicles is expected to have an economic impact of \$210 billion to \$740 billion per year in 2025.

The focus of numerous innovative IoT applications is the city environment. A great number of IoT-based systems is employed in transportation: sensors permits to better control traffic flows, while other IoT applications enable new and smarter ways of transport. Many cities all around the world have already experimented shared bikes or shared cars projects, and the number of such services available is expected to grow in the next years. IoT will also have a considerable impact on public health, thanks to sensors that constantly control pollution and water quality, in order to improve citizens' life quality. Finally, intelligent systems such as smart meters can constantly monitor power and energy consumption in order to ensure that they are managed efficiently, reducing wastes; this could mean an annual saving of \$69 billion per year globally. MGI estimates that IoT applications in smart cities are probably going to have an economic impact of \$930 billion to \$1.7 trillion globally in 2025.

With “outside setting”, the McKinsey Global Institute means all use cases that happened outdoor and don’t belong to the other smart environments, such as package delivery or shipping. With the raise of e-commerce and the develop of global trade over the past few years, IoT technology has spread in delivery and logistic thanks to its ability to track packages in real-time: this can enhance efficiency and reduce costs associated with damaged or lost goods. IoT applications to connect vehicles to outside systems and road infrastructure can improve car and truck routing between cities, saving time spent travelling and reducing fuel consumption. All in all, they have the potential to create value of between \$560 billion to \$850 billion per year in 2025.

## **2.2 Barriers and challenges**

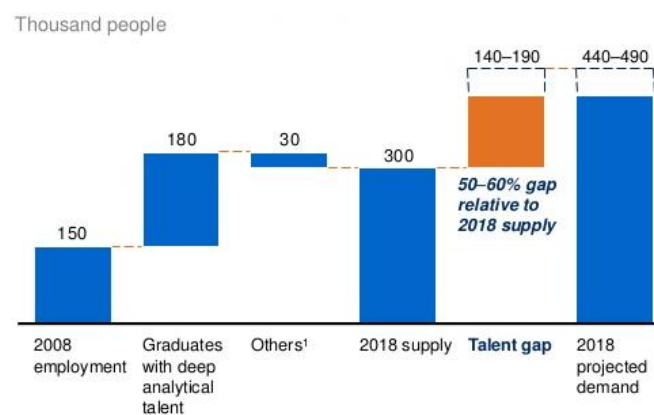
In order to achieve the described results and gain all the potential value that the Internet of Things promises to generate, there are significant challenges that must be overcome.

On the technology side, some factors must be in place to guarantee the widespread adoption of IoT systems. First of all, there should be a further reduction in components prices to make them more affordable, even though sensors prices and storage costs have decreased drastically since 2010. In order to maximize the utility of installed devices, their performances must be improved. Progress is needed in the development of low-cost, long-lasting batteries which must provide reliable power sources for sensors. Ubiquitous connectivity – which is yet not available – is necessary to share and process complex information that comes from different sources. One reason that so much of the data collected is not used is that existing analytic software have limited capabilities, and they are not able to easily process all information that comes from different sources, so data cannot always be employed for trustworthy predictive analysis. There are also many obstacles in interoperability that must be resolved: technology suppliers, companies and policy makers have to cooperate to create common technology standards and formats, fundamental to manage communication among different devices and capture all the value that integration of data provides. Otherwise, interoperability can be achieved by implementing platforms that enable different IoT systems to communicate with each other.

As the Internet of Things combines for the first time physical and digital world, companies are obliged to rethink their traditional organizations. As technologies and software are improved, they require to develop the skills and mindset to embrace data-driven decision making, but many business leaders still underestimate the skills they need to deal with Big

Data and do not have a clear idea of what benefits IoT could lead to their enterprises. The shortage of knowledgeable workforce will be a dangerous hurdle in the development of successful business models: MGI forecasts that in 2018 demand for deep analytical positions – the so-called “data-scientists”, people with advanced training in computer science, statistic and business – in the United States could exceed supply by 50% to 60%, while there would be a lack of 1.5 million additional managers and analysts who can profitably exploit the results of the analysis<sup>5</sup>. A significant amount of the talent actually employed need to be retrained, but as the production of the necessary abilities takes years of training, companies are likely to strongly compete to attract new skilled workers with these aptitudes.

Figure 8: Supply and demand for deep analytical talent by 2018



<sup>1</sup>Other supply drivers include attrition (-), immigration (+), and reemploying of previously unemployed deep analytical talent (+).

Source: US Bureau of Labor Statistics; US Census; Dun & Bradstreet; company interviews; McKinsey Global Institute analysis

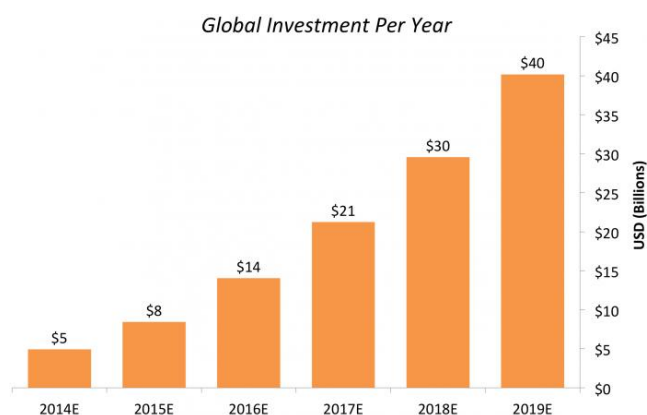
Another critical question that emerges when thinking about how to rebuild existing organizations in order to maximize benefits of IoT applications, is what level of investment decision makers want to make in smart systems. On one hand, companies tend to be careful: early adopters who invest in innovative infrastructure and in the development of new capabilities can get a competitive advantage, but the risk of betting on the wrong elements is high. On the other hand, later adopters could gain the same benefits at a lower price, but waiting to see how the market is likely to evolve and what the successful business models will be before investing in could be too late.

Achieving the potential of the Internet of Things requires significant efforts for policy makers to ensure data protection and privacy and regulate new forms of activity in the public sphere. The lack of trust in policy makers and businesses is hampering customers to embrace IoT applications. The devices, particularly these related to health or finance, collect sensitive

<sup>5</sup> Source: McKinsey Global Institute.

personal data that consumers might be hesitant to share, although they are often those that can offer them the greatest benefits. It is a trade-off between privacy and utility. For example, insurers claim that they can reduce premiums by 10% to 15% for the majority of customers if they can exploit automobile use data or have access to data about drivers' behavior<sup>6</sup>. If the perceived benefit is larger than the perceived risk, people will probably use the technology without many concerns about potential dangers. However, consumers need more transparency: businesses should make them sign clear agreements where they declare their consent on how data about them are gathered and used. Policy makers must work together to develop standard terms and conditions, because if every single actor defines his own, market growth could be slow and, probably, unsustainable. The IoT is also creating new worries about cyber security. Every sensor is a potential entry point for hackers and criminals, and interoperability expands the scope of breaches. The damages are not only related to the threat or inappropriate use of personal and confidential users information: hackers could exploit IoT devices to entry to corporate and government databases. Breaches could also lead to massive security issues: alterations in self-driving cars sensors, for instance, could harm physically many people.

Figure 9: IoT cybersecurity market



Source: BI Intelligence 2015

IoT applications need a high level of security before they can be widely adopted: this explains the expected extraordinary growth of investments to ensure data protection, from \$5 billion in 2014 to \$40 billion in 2019 globally<sup>7</sup>.

The burgeoning importance of IoT and Big Data also raises a number of legal issues. Big data proved to be a precious resource for today's businesses, but they are not comparable to other

<sup>6</sup> Source: McKinsey Global Institute.

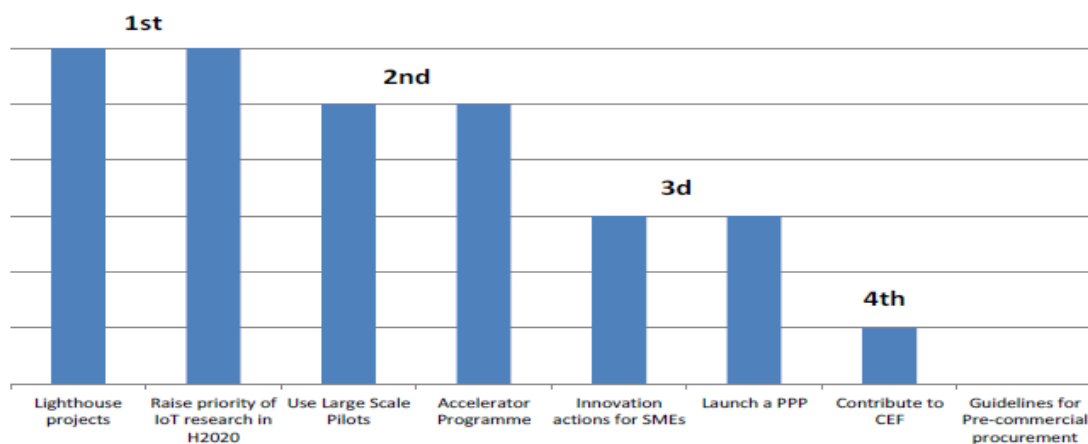
<sup>7</sup> Source: BI Intelligence.

assets. To be meaningful, a single piece of data have to be combined with other data from different sources, and the same piece of data can be copied and used by multiple actors. But who owns the piece of data and can exploit it? In the majority of cases, this is still not perfectly clear. In B2B, the ownership issue must be solved in the contract phase of an IoT implementation: only by establishing who has the right to exploit a database, businesses can maximize the value deriving from the employment of IoT systems. Finally, sensitive IoT applications, such as self-driving cars, raises further questions about liability. If an autonomous vehicle crashes, for example, it is still unclear who is responsible for it, if the human driver or the manufacturer. This is a critical theme that, if not faced in the right way, could slow down the evolution of the market.

### 2.3 The role of Governments and Institutions

Governments and institutions have a crucial role not only in regulating smart environments but also in encouraging and supporting the development of the IoT market. In the early stages of technology deployment, it is not clear how the market is likely to evolve and the return on investments may not be encouraging: for this reason, Governments must intervene with incentives that let companies explore the potential of new technologies with the aim to generate innovative solutions. During a workshop held in Brussels on September 25<sup>th</sup> 2014, IDC asked European stakeholders – industry leaders, professors and researchers, policy makers and end-users – to evaluate different research and innovation strategies to identify the priority actions to create the necessary conditions for the development of an IoT market.

Figure 10: Cumulative ranking of main actions to promote IoT



Legend: ranking by number of votes by workshop participants, multiple answers, number of participants: 44

Source: IDC



Obviously, the necessity of focus more on IoT research was ranked among the top actions; training and research programs – especially in collaboration with Universities – are necessary to develop the required technical and entrepreneurial talent in order to guarantee competitiveness and accelerate market growth. Participants also believed that Lighthouse Projects providing innovative and replicable use cases could contribute to raising awareness around IoT potentiality and inspire other businesses to take action.

At second place, there are Large Scale Pilots and Accelerator Programs. LSP are a double-edged sword: on one hand, they are considered the most powerful tool in the development of an IoT ecosystem, because they act on the whole value chain, with different groups working on specific areas of the same project; on the other hand, their complexity might create significant difficulties in managing the project. Accelerator programs that help SMEs and digital entrepreneurs with innovative ideas to realize their solutions are not usual in Europe, but stakeholders felt they are a winning solution that could help to spread adoption of innovative technologies.

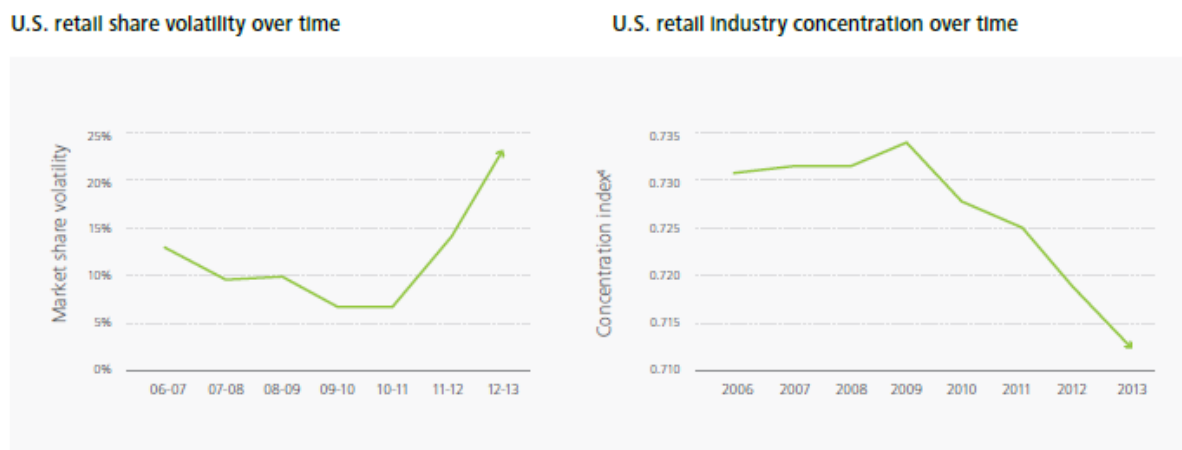
The third set of priority actions includes the need for innovative actions for SMEs to enable them to actively participate in the market and the launch of a PPP. The PPP is considered a powerful instrument to manage IoT, Cloud and Big Data innovation, because it involves both public and private actors in the development of open platforms that enable interoperability among different systems in the emerging IoT ecosystem. However, such projects require a long preparation phase, so they may not be the right solution for an environment in constant evolution.

Although the research was focused on the European market, these results can be taken into account by Governments and Institutions worldwide as possible solutions to promote digital innovation and create prosperous smart environments.

### 3. The revolution of the Smart Customer Experience: OVS case

Since the introduction of the IT technologies, retailers are struggling to defend their position against the proliferation of thousands of new competitors. Profitability has decreased, and customers have become always more demanding, due to the limitless selection offered by the net: retailers today need to differentiate themselves with the aim to attract customers and achieve growth.

Figure 11: How IT technologies have influenced competitive intensity

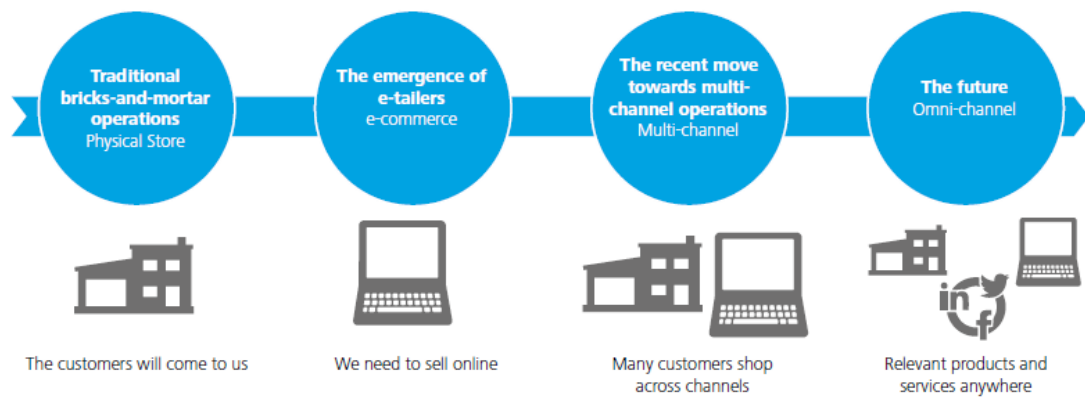


Source: Deloitte Development LLC

#### 3.1 The “Internet of Me”: from the customer to an omni-customer strategy

In this scenario, IoT solutions applied to retail environment promise to help companies not only to reduce costs but also redefine their business models, blending for the first time online and offline and leading customers to a completely new experience that revolve around them. Now shopping is all about the experience: 89% of companies believe that a unique customer experience is now their primary basis for competition, versus 36% just four years ago<sup>8</sup>. How an organization interacts with its customers has become more important than products themselves. To become the leader, a retailer must give customers what they want: better service, high availability of products and fast delivery. Businesses need to intercept customers in every moment, with the awareness that they easily move from one channel to another, from online to offline: today, they expect all products to be available at the time of the purchase, regardless of the channel they are using.

<sup>8</sup> Source: Gartner.



*The shift to an omni-channel approach*

Source: Deloitte

The strength of an omni-channel approach is in its ability to know the whole story of the relationship between customer and retailer, integrating data about customers’ past with real-time data about customers’ current behavior and tastes generated by IoT applications and Cloud-based systems. The aim is to take all data available and employ advanced analytics to obtain a comprehensive picture of the customers. Retailers can gain multiple benefits: they can improve decision-making process, in order to enhance the value proposition for customers by offering them solutions that satisfy their expectations. Researchers estimate that a customer-centric approach could increase revenues of 5% to 10% and reduce costs by 15% to 25% within two or three years<sup>9</sup>.

### 3.2 OVS evolution to the Concept Store 2.0

OVS, created in 1972 as part of the Coin Group, is the leading apparel retailer in Italy, creating and developing fast fashion for women, men and children. The brand birth is the result of an unsuccessful operation: in 1968, the Coin Group, leading Italian retailer at that time, founded “Coinette”, a series of small shops located outside the city center where the unsold stock could be sold. The operation was a disaster: after just three years, all the stores worked at a loss. In 1972 the operation was interrupted and substituted with “Organizzazione Vendite Speciali”, OVS. OVS stores took the place of Coinette shops, but with a substantial difference: while Coinette stores were designed as small boutiques for a medium-high income target – like Coins’s – OVS ones were planned like “clothes supermarkets” for low-income families and young people. The brand slogan was, not by chance, “everything for everybody”. The idea was so successful that, at the end of the 1970s, new brands besides COIN started to be sold; in 1980s, customers could find in OVS stores not only clothes, but also perfumes,

<sup>9</sup> Source: McKinsey Global Institute.

toys and household items. In the mid-1990s, the Group changed its strategy and took a step back. It felt that customers started to behave in a different way: they didn't walk into the store with a specific idea in mind anymore, but they wanted to be guided into the purchase process. While the main competitors remained tied to the "variety shop" model, OVS restarted to focus only on clothes, though improving the variety of articles in order to always be able to tempt customers' tastes. In 2007, Coin Group decided to bring the brand to the level of international ones like Zara and H&M, experimenting with the fashionable "concept store" model, whose aim is to improve customer experience in-store in order to increase the number of visitors, raise their stay into the shop and, as consequence, their willingness to purchase. In order reach a larger number of customers, in 2013 OVS launched its e-commerce site.

OVS has done a step further with the opening of its two concept stores 2.0 in Milan in May 2014 and September 2015. Here, OVS focuses on digital, interactive experiences where the customer is the central point to strengthen his relationship with the brand: "*infotainment*" and "*gamification*" have become the key words of the innovative strategy. The digital evolution is set by the partnership with Google Enterprises: with the involvement of its partner, OVS has pioneered the most advanced IoT technologies trying to blend online and offline in a unique interconnected environment. For many years, online channel has been treated separately, with almost no connection with the traditional brick-and-mortar store. Now, the use of IoT-based systems to connect smartphones, tablets, computers and intelligent objects to integrate digital and physical world has a double goal: on one hand, in a world where nearly everyone is always online and there is no offline, it becomes important to offer customers a seamless experience and place them at the centre of the shopping process. On the other hand, it allows the implementation of a lean and interconnected environment for the business.

The partnership gives OVS the necessary technological capabilities to engage with customers in an integrated way so that the information generated through one channel is recorded and shared across all channels available. Important is the service Google Cloud Platform, defined by Google as "*the best place to build IoT initiatives*". It is made up of four applications: Google App Engine to support the business in the creation of innovative apps, Google Compute Engine to create a network of connected objects, Google Cloud Storage to storage IoT data on the Cloud, and the analytic platform BigQuery that analyze the data to find meaningful insights.

Fundamental is OVS app, defined by Monica Gagliardi – OVS e-commerce, CRM, Digital and Social Marketing Manager – as "*a passport to the digital experience*". It gives the

customer multiple advantages: it works as a smart digital card, gives access to the online catalog, allows to create wish lists and enables to get further information about the product by scanning the QR code. As the customer walks into the store, he is invited to connect to the store WiFi to download OVS app. Once he accepts to connect to the WiFi service, he implicitly agrees to be tracked along his shopping journey. With the smartphone working as a sensor, the retailer is able to gain precious information about customers' behavior: 80% of shoppers use their mobile devices to help shop while in an apparel store, and almost 46% of them use the mobile to get inspiration and information about products<sup>10</sup>. Data from smart appliances allow the brand to understand customer tastes and test new collections in order to design successful strategies.

Based on data gained about the shopper's preferences, the retailer resorts to proximity marketing strategies to tempt him. When the dedicated app is opened, the customer is solicited to turn on the Bluetooth. This simple action allows the devices that have installed the app to receive notices with personalized offers and coupons using the iBeacon technology. Beacons are small devices capable of transmitting information to smartphones and tablets through the Bluetooth low energy technology: when an electronic device is close to a Beacon, the transmitter can send to it information and insights. In the proximity marketing logic, Beacons are used to send customers messages with promotions when they are still outside the store, so the chances that they enter and purchase an item increase.



*iBeacons and proximity marketing*

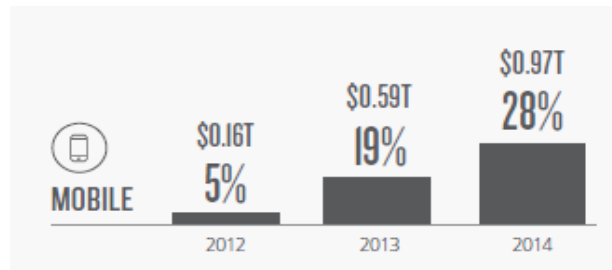
Source: Accenture

All in all, 28% of customers who use the mobile while shopping is influenced by the use of such devices, and 25% end up spending more<sup>11</sup>, due to the fact that they are tempted to purchase complementary or high-priced items saw while browsing, or because they take advantage of special discount or coupons.

<sup>10</sup> Source: “*Mobile In-Store Research: how in-store shoppers are using mobile devices*”, M/A/R/K Research in collaboration with Google Shopper Marketing Agency Council (April 2013).

<sup>11</sup> Source: Deloitte Development LLC.

Figure 12: Percentage of in-store retail sales influenced by the shopper's use of a web-enabled mobile device



Source: Deloitte Development LLC

In July 2016, OVS has introduced the digital contactless payment in its stores: shoppers can now take advantage of coupons and pay directly from the smartphone if equipped NFC chip. The growing adoption of NFC payments is due to customers' desire for quick, safe and simple payments; actually, queues and the lack of available payment solutions often influence shoppers' purchase decisions. Moreover, the passage to such payments is convenient also for retailers that need to cut down costs: in this way, they avoid payment processing costs that can be up to 5% per transaction.

### 3.3 Smart devices to transform the shopping experience into a game

OVS has pioneered innovative IoT features to develop a highly desirable experience focusing on a young target. Millennials, especially, are attracted by the idea of experimenting with digital technologies because they are familiar with them, and they are not afraid of adapting their shopping behavior to embrace new technological solutions.

In Milan main stores, visitors can play with the "Magic Fitting Room", an Internet-connected mirror able to interact with the customer. Thanks to embedded webcams, the shopper can have a complete vision of how the dress fits both from the front and the rear. By scanning the item QR code, the mirror shows the availability of sizes and colors and suggests similar items or new clothes and accessories to complete the look. Furthermore, by pressing the dedicated icon on the mirror touch screen, the client can send a message to the assistant's tablet asking for a different size or color or a new article. OVS also thought about the "social" part of the shopping journey: by scanning the QR code on the mirror using the smartphone, the customer enables the mirror to take a photo of the complete look; the photo appears on the smartphone, and the owner can share it directly from the app on his social profiles.



*The Magic Fitting Room*

Innovative is also the use of interactive kiosks to allow customers to move more freely between online and offline channels. By placing the QR code near the reader, the kiosk recognizes the item and load the correspondent page of the e-commerce site where the shopper can find further information and reviews about it. If an article is not available in store, shoppers are given the possibility to verify availability in other stores in the same area, or they can buy the article directly from the e-commerce site; in this second case, they can choose to pick up it in store or to receive it at home. Giving that possibility, the probability of purchase increases. As the kiosk also works as contactless pay terminal, shoppers are enabled to pay straight from the smartphone using NFC wallet apps.



*The interactive kiosk*

A digital customer experience has the purpose of entertaining customers and strengthens their loyalty to the brand. For this reason, OVS has decided to schedule special appointments in its main stores and to employ Google Glasses and augmented reality for treasure hunts. The shopper wears the Glasses and scans the QR code with the smart lens, and immediately the sight and the description of the item to find appear. An assistant follows and supports the player during the search, changing the object of the hunt once an article has been found and monitoring the time employed. The aim is to encourage shoppers to walk around the store searching for clothes and accessories from the new collections: over 15% of apparel shoppers

are not aware of new products until the brand resort to advertisements or commercial actions inside the store that make them want to buy these new items<sup>12</sup>. At the end of the game, the counter elaborates a ranking where the players position themselves based on time employed and the number of items found. The prize for the winner is a free OVS Card – if he does not own it yet – and 200 points that allow him to enter the “loyalty program”.



*A woman experimenting with Google Glasses*

Following the “*gamification*” philosophy to make shopping a pleasant experience, OVS has developed a dedicated digital corner for kids where they can experiment with IoT technology. The purpose of the project “*Play Your Look*” is to turn clothes into musical instruments: as the kid places an article on the digital table, it scans the QR code, activates a musical sensor and starts to play a melody. As he adds more items on the table, a background music is created while the complete look appears on the monitor on the wall; if the kid stamps, the music gets louder. In this way, OVS aims to attract and support parents with young children, who are often reluctant to try on clothes in-store and whose shopping experience is not always comfortable.



*The "Play Your Look" corner*

### **3.4 An international award for a successful business model**

OVS has not improved single touch points of customers’ journey, though it has reshaped the entire end-to-end experience from the search of inspiration and information about products to

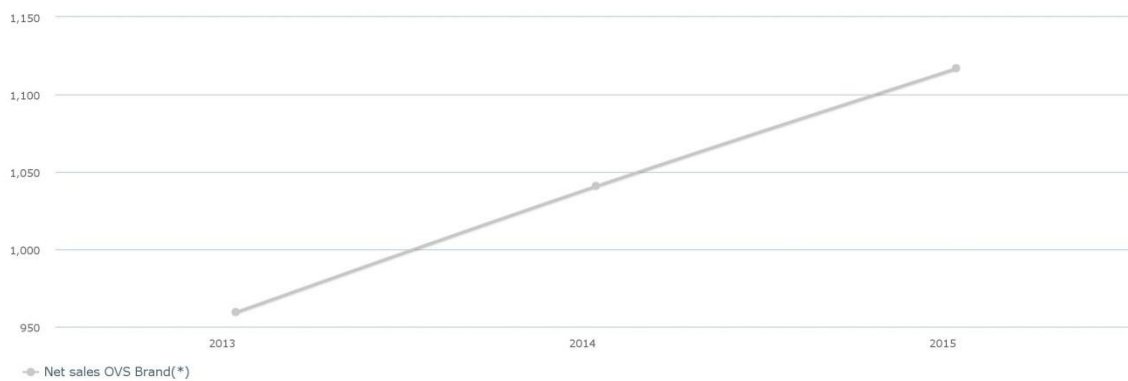
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<sup>12</sup> Source: Deloitte Development LLC.



the moment when customers chose and try on clothes, till the payment process. The retailer's ability to engage customers in an integrated way through the use of the most advanced technologies and innovative features has been awarded: in 2015, OVS has been the recipient of the *"Innovative Customer Experience Award"*, an international prize conferred every year by Demandware, leader Cloud Platform provider, beating other celebrated participants such as Adidas and GoPro. Its omni-channel strategy and captivating customer experience have led to important results: net sales in 2015 reached €1.319,5 million, with an increase of 7,5% compared to the previous year.

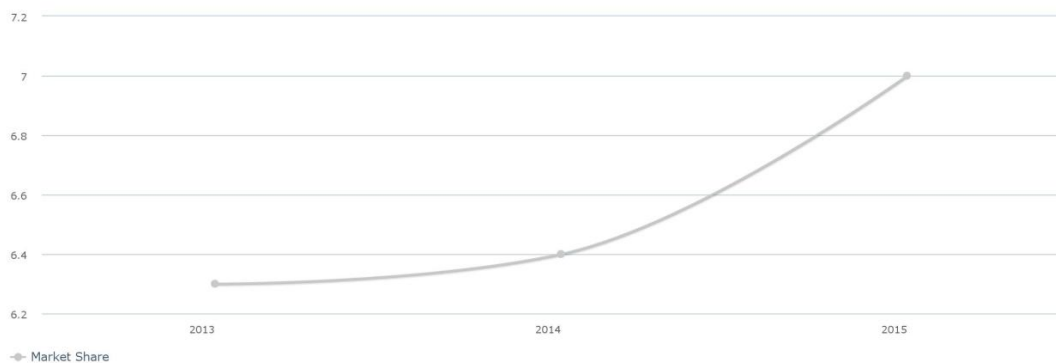
*Figure 13: OVS net sales*



Source: OVS S.p.A.

Since 2013, OVS has experimented an 81% increase in the site traffic and a 44% increase in conversion rate, an increase in the number of Facebook fans of 345% and an increase in the number of Twitter followers of 70%. Today, the brand awareness on the Italian market equal to 97%, and its market share has reached 7%.

*Figure 14: Percentage of Italian market share*



Source: OVS S.p.A.

## Conclusions

Focus of this work is the Internet of Things, innovative technology based on the communication between smart objects connected with each other in a network. The importance of the IoT is in its ability to generate impressive amounts of Big Data, which have become a precious resource for organizations. Together with Cloud Computing, that allows storing data generated, and the analytic platforms to analyze them, the IoT enables innovative ways of generating value for both businesses and people.

Although real-time data are actually used by enterprises especially for operation optimization, they are expected to give the maximum benefit when employed for predictive analysis. These analyses are going to be a powerful tool to support decision makers in their choices about how to efficiently manage resources, but managers need to learn how to properly handle data to successfully exploit them. IoT deployments will also lead multiple advantages to final users, because they help to design higher quality products and improved services tailored to personal needs and desires. Moreover, IoT systems' ability to improve people's safety and health – thanks, for instance, to sensors that constantly control pollution or wearable devices for patients' monitoring – should not be underestimated.

As always happens when a disruptive technology becomes widely adopted, the implementation of IoT systems is leading to a process of “creative destruction”. Sectors boundaries are changing rapidly, and traditional business models and capabilities are becoming obsolete. In order to better understand the opportunities offered by the IoT, it is better to analyze real-life use cases in the physical setting in which they are deployed rather than focus on the effects of this technology on a specific sector. This approach enables to comprehend not only the best opportunities where businesses should invest in, but also all the implications that they must face to make the most of this technology. Although the majority of businesses has started to understand IoT potentiality only recently, some of them have already successfully implemented this technology in their business models, as demonstrated by OVS case in the third chapter.

However, the way to the creation of a strongly interconnected IoT ecosystem is still long. Improvements in the underlying technologies are necessary to enable IoT systems to better communicate and analyze data to gain meaningful insights. Besides, the most important step that policy makers need to take to achieve the expected results is the development of common standards shared by all actors to ensure privacy and data protection.

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