UNIVERSITY OF MACEDONIA
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DEPARTMENT OF APPLIED INFORMATICS

Master of Science Thesis

DIGITAL ENTREPRENEURSHIP TWINNING

"How incumbent organizations watch and copy digital startup practices to survive in their industries. In-house development VS acquisition strategies

Case Study from relevant organizations"

Maria A. Michailidou

Supervisor: Dr. Konstantinos Fouskas

Thessaloniki, January 2022

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Submitted for the Qualification of the

MASTER'S DEGREE IN APPLIED INFORMATICS

Supervisor: Dr. Konstantinos Fouskas

Approved by the three-member examination committee on …/…/….

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Maria A. Michailidou

Acknowledgements

"The journey is the reward"

The past year has been challenging for everyone in terms of personal endurance in situations that have been unprecedented. This master's degree is not just a proof of knowledge, although knowledge should never be underestimated, but it is more of an insightful journey through study, research, exchange of ideas and cooperation with different people.

For me, it was a dream come true after more than twenty years of telling myself that I wanted to explore the field of informatics in an MSc level. That time came at the most bizarre for humanity year, but it has been the most wonderful for me. Knowledge and education don't have the condition of right timing, they happen effortlessly, and they cannot be restricted by any lockdown.

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Dedicated to me and to people like me who think that knowledge should be obtained while you are young. Knowledge is a commodity that has no boundaries, exploit it.

Περίληψη

Η παρούσα διπλωματική είναι ουσιαστικά ένα μικρό ταξίδι στη σύγχρονη επιχειρηματικότητα στηριζόμενη σε βιβλιογραφικές αναφορές και μέσω μελέτης περίπτωσης και πως αυτή έχει εξελιχθεί μέσω των τεχνολογικών εξελίξεων και της ψηφιακής οικονομίας.

Από τις ψηφιακές εφαρμογές και το ίντερνετ των πράγματων, προχώρησε σε πιο εξελιγμένα εργαλεία όπως αυτό της τεχνητής νοημοσύνης και των νέων εφαρμογών του ψηφιακού διδύμου. Αν και το τελευταίο χρησιμοποιείται εδώ και πολλά χρόνια σε πολλούς τομείς των κατασκευών και της βαριάς βιομηχανίας, δεν παύει να είναι ένα πολύ ιδιαίτερο εργαλείο στη χρήση της επιχειρηματικότητας.

Μέσω των μέχρι τώρα βιβλιογραφικών αναφορών θα προσπαθήσουμε να παρουσιάσουμε, το τι είναι ψηφιακό δίδυμο στους περισσοτέρους τομείς και πως αυτό μπορεί να εφαρμοστεί στην εξέλιξη της σύγχρονης επιχειρηματικότητας και τι προκλήσεις μας κρύβει το μέλλον του.

Επιπρόσθετα δε θα μπορούσε να λείψει η μελέτη μεταξύ των μεγάλων οργανισμών που λειτουργούν συστημικά μέσα στον επιχειρηματικό κόσμο και θα μπορούσαν να εφαρμόσουν τεχνολογίες όπως αυτές του ψηφιακού διδύμου και των νεοφυών επιχειρήσεων που ήρθαν για να δώσουν μια νέα πνοή μέσω της καινοτομίας, της ευελιξίας και της εκρηκτικής ανάπτυξης τους. Μελετούμε μέσω πραγματικών παραδειγμάτων το φαινόμενο της αντιγραφής τους από τις μεγάλες εταιρείες και όχι μόνο.

Η μελέτη μας κλείνει με την περεταίρω ανάλυση της σύγχρονης επιχειρηματικότητας όπου συγκρίνουμε τις δυο στρατηγικές του in house με τις εξαγορές και αναφέρουμε μερικά πολύ ιδιαίτερα παραδείγματα εταιρικών κολοσσών και πως αντιμετώπισαν τις προκλήσεις της νέας επιχειρηματικότητας. Αυτά τα τρία στοιχεία της είναι που κάνουν την επιχειρηματικότητα ένα μεγάλο κεφάλαιο μελέτης και ανάλυσης και με προσμονή για το μέλλον της ακόμη μεγαλύτερων πράγματων.

Keywords: Economic evolution, digital innovation, digitalization, information technology, entrepreneurship, digital twins, digital twinning, start-ups, incumbents, in-house development, acquisitions.

Abstract

This dissertation is essentially a short journey into modern entrepreneurship based on bibliographic references and case studies and how it has evolved through technological developments and the digital economy.

From digital applications and the Internet of Things, it has moved on to more sophisticated tools such as Artificial Intelligence and new Digital Twin applications. Although the latter has been used for many years in many sectors of construction and heavy industry, it is still a very special tool in the use of entrepreneurship.

Through the current bibliographic references, we will try to present, what is a digital twin in most economic areas and how this can be applied in favor of the development of modern entrepreneurship and what challenges its future holds.

In addition, we look into the study of large organizations operating systemically within the business world and could apply technologies such as those of the digital twinning and start-ups that came to breathe new life through innovation, flexibility and their explosive growth. We study through real examples the phenomenon of being copied by large companies.

Our study concludes with a further analysis of modern entrepreneurship where we compare in-house strategies with acquisitions and cite some very specific examples of corporate giants and how they met the challenges of new entrepreneurship.

Those three elements (digital twinning, incumbents copying startups, and acquisitions) that make entrepreneurship a fascinating field of study and analysis and making us look forward for its future development.

Keywords: Economic evolution, digital innovation, digitalization, information technology, entrepreneurship, digital twins, digital twinning, start-ups, incumbents, in-house development, acquisitions.

Abbreviations

A.I. Artificial Intelligence

DT Digital Twinning

I.T. Information Technology

IoT Internet of Things

M&A Mergers and Acquisitions

Contents

Chapter Four

Digital Twin and Digital Twinning

Chapter Five

Digital Twinning in Business

Chapter Six

Incumbents and Start-ups

In the loving memory

of Bella and Moby

INTRODUCTION

Little did we know, when back in the ‘60s Apollo’s 13 mission, would have been the motive for many great things ahead and the initiation of economic and business breakthroughs.

What happened back then, or to be more precise, up there, was a life changing experience for many scientific fields. According to Forbes, an explosion in Apollo 13's oxygen tank had critically damaged the main engine and left oxygen leaking into space. NASA used 15 simulators to evaluate every aspect of the failure ultimately to physically maneuver the rocket to safely land in the Indian Ocean. To accomplish this, NASA converted a physical model of Apollo 13 to a digital one, which provided a continuous stream of data that led to recreating the event.

This very use of simulation was the opening door for many other sciences, and economics wouldn’t be left out. Simulation as a method is widely used in aviation, medicine, engineering, and statistics.

But what is the relation between simulation economics twinning and all the rest meanings that we want to analyze in this dissertation?

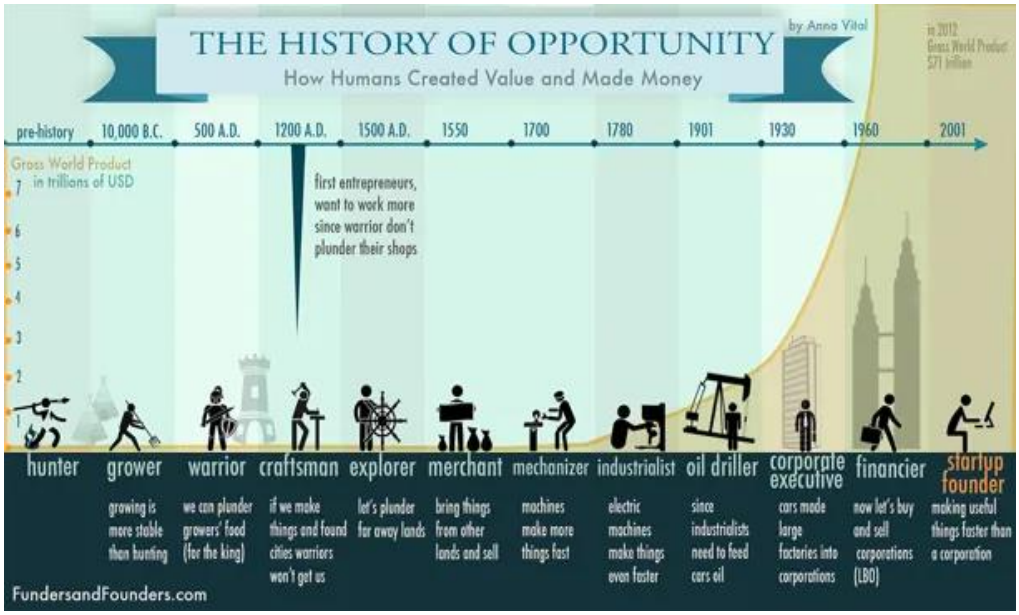
Let us take things from the very beginning and go back as far as Adam Smith inspired us and the entire economy in the “Wealth of Nations”, as far back as Karl Marx established the foundations of economy with the “Capital” and Oregon Milton Friedman’s “Positive Economic Theory”. Everything begins with our need to interact us humans, an hour instinct for development and evolution Through our contact in our everyday lives. As we can see and the picture below where the economic history of the

world and how it developed throughout the years, humans people started out as hunters and the product of hunting has been traded with other products from other people, they continued by exploring society's needs, realizing that exchanging also known as merchandise would be the core of economics.

Merchandise and the need to trade an exchange, would be the beginning of everything, would be the beginning of economics as we now know it. In 1836 the terminology of homo economicus was primarily introduced in bibliography which was indissolubly linked to the human being the person who would make rational decisions about transactions merchandise and economy.

As we can see in the picture below,

(source: News Yahoo) "**The Economic History of the World in One Simple Picture**"



Picture I : The History of Opportunity

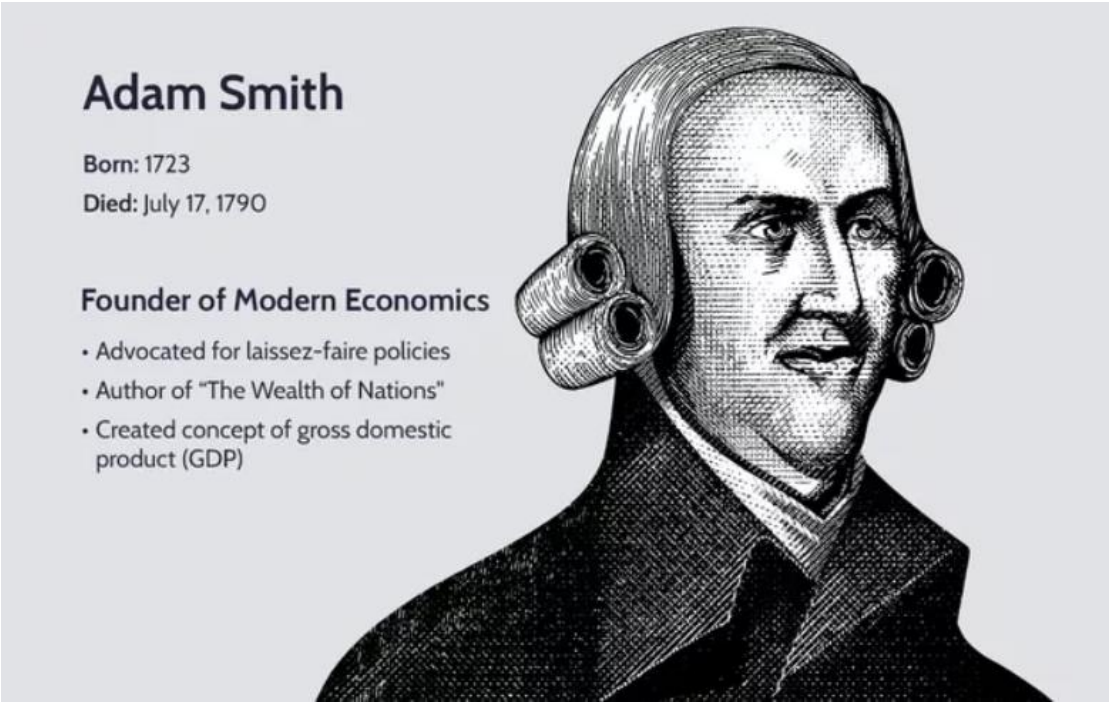
It reveals us in an extremely brilliant way how man and consequently his communions evolved through the economy. This picture merely represents the timeline of the evolution of the economy, how human beings were interacting within communities.

In the very beginning, people would exploit their hunting skills, and their soils to provide in the cycle of their families, or their small communities. When humans started to explore their environment and travelled, merchant was born.

Merchant was the foundation of transactions and probably without it, there wouldn't be the economy as we now know it. Then Adam Smith came along with his renowned quote "laissez faire, laissez passer", let it be, let it pass, implying that the freedom of the market itself to trade and exchange goods will be the ticket for everyone to benefit from it, besides the few privileged.

In the following years, industrial revolution occurred, monetary theories were established, and economy, a humanitarian science was evolving and developing rapidly.

CHAPTER ONE
ECONOMY IN GENERAL



1. What Economy Is.

Economic science revolves around the principles of distribution between the means and their alternative purposes. To be more specific as means we refer to the production factors or inputs. These are the exact sources in which the principles of economy has based upon for the output of goods industry services and last but more recent intrapreneurship.

Economics were created to solve a problem and that was the problem of distribution of scarce assets. Economic science is a part of social sciences and economists are interested in analyzing the behavior of different economic units. By economic units we refer to the individual, housekeeping or company. Economic behavior is based upon the decisions in which those economic units are willing to take. The analysis of the

behavior of a certain economic unit is important and it explains the social impact of economics.

Economics were divided in different sectors; John Maynard Keynes divided the economy in two major groups: positive economics and normative economics. Positive economics are trying to solve the problem of “what is” in the economy whereas normative economics is trying to give answers to the question of what it should have been.

Positive economic science is all systematic knowledge around the defining factors of price of pricing production labor income distribution investment consumption and many more important economic factors. It pursues to explain the fluctuation of prices and why most economic factors are volatile. Positive economics are not explaining why economic factors are volatile or what they should be according to objectives, and this is why positive economics are more like other sciences like physics or chemistry or mathematics.

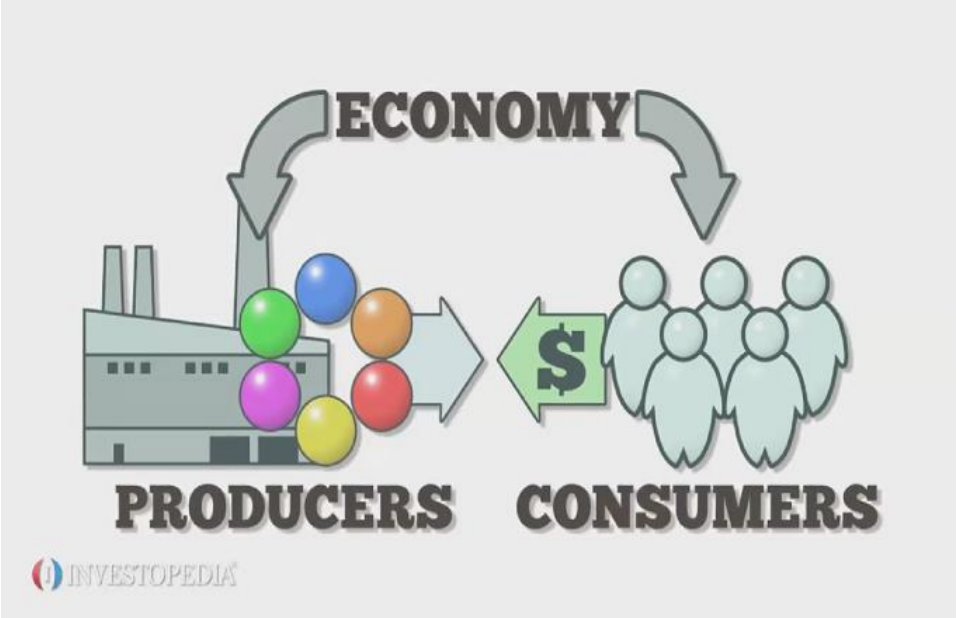
Normative economics on the other hand analyzes the criteria of certain economic behaviors and why those behaviors are occurring. For example, positive economics would take as granted the legal system of an economy it's industrial organizations and generally the entire structure of an economy. Normative economics would come to analyze what should have been the best structure for the society. Therefore, normative economics are being influenced by other political in social sciences and even philosophy.

Economic science could also be categorized as static economics or dynamic economics, where the variant “time” is the major concept in both categories. When we talk about entrepreneurship, time is a very important issue, a very important ingredient, when we

talk about economic growth and digital economics, dynamic economics examines the economic growth of different economic variables. It analyzes the circumstances under which an economy can be stable or unstable. In a digital world and more specific in a digital economy, stability and instability coexist. There is stability because digital economy can be precise and it can be fully analytic with a big range of information and data in hand, but it can also be imbalanced because digitalization itself, is a dynamic and evolving condition.

1.2 Economy in a Picture

What if, we could visualize the economy? If we could show in one or maybe two pictures and charts for the sake of simplification.



Picture II: What economy is (source: Investopedia)

According to the above picture, economy is the production and consumption activities that determine how scarce resources are allocated in an area and it includes everything related to the production and consumption of goods and services. An economy exists

to satisfy its participants needs. In a market economy producers and consumers determine what's produced and sold, producers own what they make and decide their own prices, while consumers own what they buy and decide how much they're willing to pay. Other economy types include command and traditional economies. In a command economy the government dictates all economic activities and in traditional economies each new generation follows the prior generations in how it works what it eats what clothes its members wear and so on. Economics analyzes the production distribution and consumption of goods and services; its major branches are microeconomics and macroeconomics, while microeconomics studies the behavior and interaction of individual consumers and firms, macroeconomics analyzes aggregates such as gross domestic product or GDP. The GDP represents the total value of everything an economy produces and it's usually a bad sign for a nation's economy when it's GDP decreases from one year to the next.

Most of economic decisions are made through some combination of market transactions and collective or hierarchical decision-making. Everyone, from individuals to entities such as families, corporations, and governments participate in this process.

The economy of a particular region or country is formed by its culture, by its laws history angiography and it evolves due to the choices and actions of the participants, and this is why no two economies are identical.

If we could analyze the origin of the word economics, then we would say that economy is a Greek word, and it means “household management”. Economics as an area of studies was approached by philosophers in ancient Greek Aristotle but the modern study of economics began in the 18th century in Europe and particularly in Scotland in France.

Important key points to that determine economy are:

- an economy is the large set of interrelated production and consumption activities that aid in determining how scarce resources are allocated.
- In an economy the production and consumption of goods and services are used to fulfill the needs of those living and operating within it. Market based economies tend to allow goods to flow freely through the market according to supply and demand rules.
- Gross domestic production is the market value of all goods and services produced in a country in one year and it's a very important measurement because it implies the tendency of a country's growth.

1.3 More About Economics.

According to Hick's theory *"The statics is that part of the economic theory where one does not need to worry about date"*. It assumes that economic incidents are not timeless, and that doesn't mean that economics are indifferent towards time, but what it implies is that they are with no specific order. Static is the state where the orders of events, do not matter, and they tend to be closer to traditional theories of explaining individual activities in order to evaluate changes of economic phenomena and if possible, forecasting future development. Whereas the dynamic characteristic of economy is usually linked with the Harrod-Domar theory of development.

The question here is how a static theory can forecast the future at all, or its trends without taking into consideration the factor of time.

It is also said that the theories of economy seemed more of a battleground of different opinions views and theories (Kuznets, 2013)

Economists around the globe agreed however, that most of the emerging economic issues such as economic cycles, distribution of goods, optimization, business adequacy etc., found barriers of classic economic theory would resolve them.

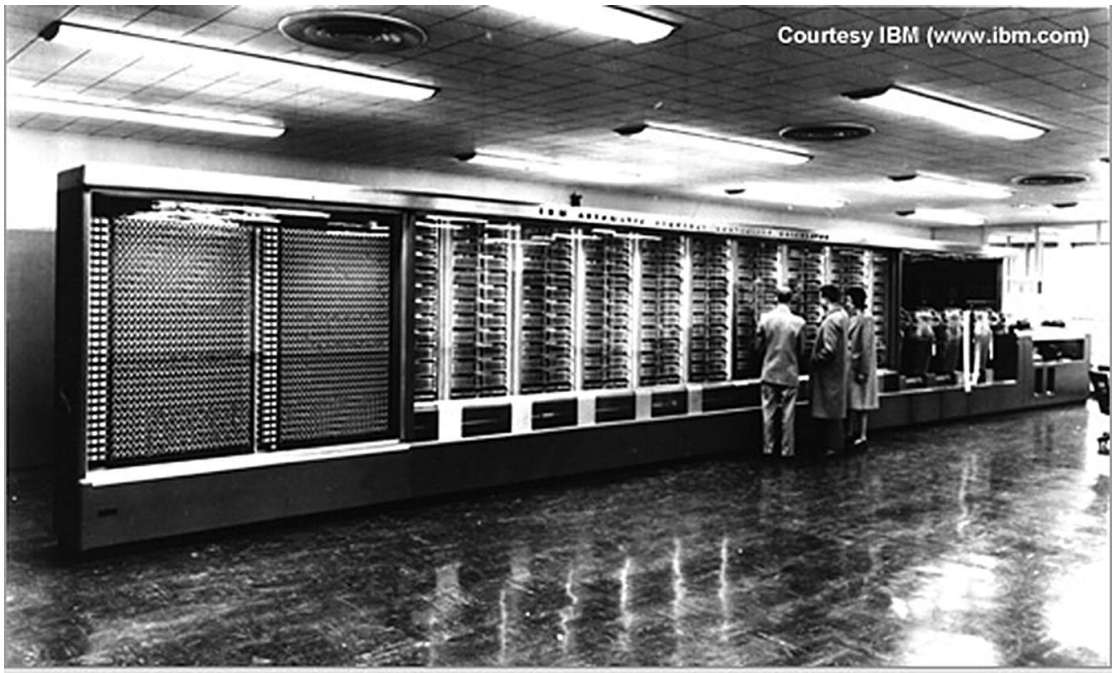
Additionally, technology development had started to emerge, so it became clearer than ever the necessity to expand the studies of economic changes in a wider prospect that included technology as well.

The continuous need to keep up with a more dynamic economic system lead to a reformulation of economic concepts and principles especially in countries like the US end Germany. This kind of reformulation would have been their weapon towards future growth and a powerful tool towards the challenges emerging from the digitalization of economy and the world in general.

CHAPTER TWO

DIGITALIZATION IN ECONOMY

(History and timeline of the greatest evolution)



The Harvard Mark I

2. I.T.

In 1994 information technology was already a well-known term. It was used in our everyday lives, and it includes all the work that has been done using technology and its applications. Actually, the term IT did not appear until mid-20t^{h} century, where office technology appeared. As a consequence, this led to the inevitable widespread of IT in almost all business areas. No matter the size of the company most businesses operations, such as communication, efficiency, mobility, have been affected by the introduction of information technology.

It is not so hard to realize why efficiency would have been the key advantage of IT. By utilizing technology, businesses save significant time during the day, hence there

is an increase in productivity levels. Digitalization in archives increases natural office spacing, reduces printing and paper costs and saves valuable time by simply clicking a button.

In the table below we present a timeline of information technology with its milestones.

Milestones in IT

1939-1944	• **Mark I the first Computer**
1951	• Whirlwind first personal computer with commands input
1963	• Invention of computer mouse by Engelbart
1963	• Cloud computing invented by Joseph Carl Robnett Licklider
1967	• Hypertext software invented by Andries Van Dam and Ted Nelson
1971	• E-mail invented by Ray Tomlinson
1984	• The first laptop computer enters the commercial market
1989	• World Wide Web (the internet) invented by Sir Tim-Berners Lee
1992	• Complete I.T. Founded
1998	• Google established
1998	• PayPal is launched, enabling large scale payment via the
2003	• WordPress, an open-source website content management

	system is launched by Mike Little and Matt Mullenweg
2004	• Emergence of Web 2.0 – Humans move away from consumers of internet material to active participation
2005	• Google Analytics established
2005	• YouTube is launched as a video platform
2006	• Twitter is launched to the public
2007	• Apple Inc. debuts the iPhone
2009	• Bitcoin is developed by unknown programmers under the name of Satoshi Nakamoto
2010	• Apple debuts i-pad
2012	• Quad-core smartphones and tablets are releases, offering faster processing power
2014	• The market for smart watches reaches 5 million
2017	• Mobile devices overtake wired devices as a means of using the internet

Table I: Milestones of IT

As we can see in the above table, there are some of the many important innovations that took place in the growth of IT worldwide. Each one of them and all of them combined, contributed to the overall expansion of technology in all aspects of everyday life, and scientific fields.

It was right after the WW2 where Harvard Mark I the very first computer was launched, and although his size and weight seems unreal now, then it was a revolt.

From 1939 to 1944 Aiken, in collaboration with IBM, developed his first fully functional computer, known as the Harvard Mark I. The machine, like Babbage's, was huge: more than 50 feet (15 meters) long, weighing five tons, and consisting of about 750,000 separate parts, it was mostly mechanical. For input and output it used three paper-tape readers, two card readers, a card punch, and two typewriters. It took between three and six seconds to add two numbers. Aiken developed three more

such machines (Mark II–IV) over the next few years and is credited with developing the first fully automatic large-scale calculator.

(https://www.britannica.com/technology/Harvard-Mark-I)

Another important invention happened in 1963, where cloud computing was introduced. Initially and as expected, it was used for military purposes, as a non-local data storage technology. This application could not leave the scientific community indifferent, especially in times when technology flooded the everyday life of the world and its possibilities of application seemed unlimited.

In Businesses and economy, cloud computing caught the attention of large companies looking for solutions to store and access their data. From then on, after the introduction of the first mobile devices, and later smartphones and tablets and their inevitable rapid use, the beginning of cloud environment in mobile devices for business purposes it was a part of our lives.

After that, the first laptop was invented and it gave us the possibilities of mobility in our data, e-mail was launched and people could communicate instantly (even viral marketing was then born, due to the existence of e-mails), world wide web, google, and then social media. A roller coaster of changes, new things, revolutionary ideas that could be implemented. Almost anything the human mind could think of achieving by using the technology, it could indeed happen. And all this due to the IT and its possibilities.

Decades passed and this beginning with large computer calculators was the trigger for a series of efforts for technology to evolve and serve the aspects of human activity.

This is how digitization came into our lives and with it, the constant effort to make things easier, faster with more access and more availability. None of the above

milestones are more important than others, or those emitted are less significant. Each and one of the events, were a steppingstone towards the growth of IT, of digitalization, and towards a rapid speed of the development of economy and consequently of societies and man.

When it comes to the economic science, IT managed to develop most sectors of economy, saving them time and money as we explained right above. What the chart tells us is more than just a date or a year and an event. The importance and the rationale under which technology and digitalization help and support economy easy to comprehend but what is the proper implementation that lead the business sector to grow because of it.

2.1. Benefits from IT & Digitalization

2.1 Expansion of IT and digitalization offered mobility.

Back in the day, one computer needed an entire team of people in order to operate them and adjust them, and more important they all had to do this at the same time, making this entire procedure expensive and immobile.

Information technology today can be easily transferred mainly because of the drastic reduction in the size of devices. They can also be operated by one person and can be easy to use regardless their digital educational level. Consequently, it helps increase productivity by allowing employees to a remote working space most likely away from office distractions. The ability to work anywhere can attract employees to a company only because they have less “going to the office” costs.

Aside from the mobility benefits to employees, a business can directly profit from the growth of IT and digitalization. An organization can establish a global presence easier than before and at a fraction of the cost by ascertaining small offices in several countries and keeping them connected by storin their data in a cloud (Cloud computing was initially invented in 1963 by Joseph Carl Robnett Licklider).

Many features including the entire development of technology for the sake of economy, include remote communications of the staff of a company through video calls, utilizing their valuable time. All these technological breakthroughs contributed to the rapid growth of companies and organizations enabling them to expand, quickly, and most importantly as safely as possible.

2.2 Change of culture and way of thinking.

This is a change in both personal and collective level, it implies a change of attitude as people towards technology and its conveniences in our everyday routine, from a simple communication that can take place instantly, from mining information to file sharing technologies that allowed collaborations from a distance. Employees do not have to wait for other members of staff to send them work, as work can be shared instantly using modern IT systems, removing inter-staff hostilities, reducing inefficiencies and frustrations.

Speed and pace of work has radically changed since the expansion of digitalization and IT, imitating more or less the evolution of actual computers, where initially were taking over an entire room, but as years went by, they became smaller faster, lighter, more compact, and easier to carry around. In addition, they now have massive storage

capacities whether it’s a personal computer or a tablet or a smart phone, making them a lot more useful in both business and personal environments.

That transformation effected the way everyone’s way of thinking and working. People followed the same path as computers; they became more flexible, completing their work faster and more adequate. That only, implies a growth both in terms of knowledge and soft skills but also in relation to our overall attitude towards the challenges of technology, digitalization, and the future of business.

2.3 Change of the overall quality in entrepreneurship.

Digitalization requires the infusion of internet-based tools and technologies into a company's processes, so that the organization can meet up and actually anticipate the wants and needs of its stakeholders. Many features of IT like cloud computing and mobility, offer secure and reliable access to different applications helping businesses getting their hands on information and doing their job faster and safer.

In the following chapter we will analyze the terms of digitalization, digital disruption, digital entrepreneurship, and innovation.

CHAPTER THREE
BASIC PERCEPTS OF THE DIGITAL ECONOMY

Digital Evolution Part I.

3.1 The Concept of Digitalization in Economy/Digital Economy

The digitalization and digital disruption issues has been the talk of the town for the past five years. The truth however is, that is has been a challenge for the business world, for at least 15 years. It's not the same as it was back then, but this adaptability and fluidity, is the element that made it important over the years and a fundamental part of the future in business strategies and the gear of business development.

According to Buckht and Heeks, "digitalization in economy is that part of economic output derived solely or primarily from digital technologies with a business model

based on digital goods or services" – consists of the digital sector plus emerging digital and platform services. (Buckht & Heeks, 2017)

Another concept was also given by Delloite as *"the economic activity that results from billions of everyday online connections among people, businesses, devices, data, and processes. The backbone of the digital economy is hyperconnectivity which means growing interconnectedness of people, organizations, and machines that results from the Internet, mobile technology and the internet of things".*

But the most interesting concept was given in 1996 by Tapscott who called it the "Age of Networked Intelligence" where it is *"not only about the networking of technology… smart machines… but about the networking of humans through technology" that "combine intelligence, knowledge, and creativity for breakthroughs in the creation of wealth and social development".* (Tapscott 1996)

3.2. Contribution of the Digital to the Economy

As we have already mentioned, the advent of the internet, was the one that led to the digitization of the economy and consequently to the application of technologies in business. Between the decade of 2000-2010 and the appearance of IoT, smartphones, laptops etc., and new digital models such as cloud computing, digital platforms, and digital services in general, have been the elements of the actual economic change.

Figure I gives us a visualization to understand the contribution of the digitalization in economy and industries.

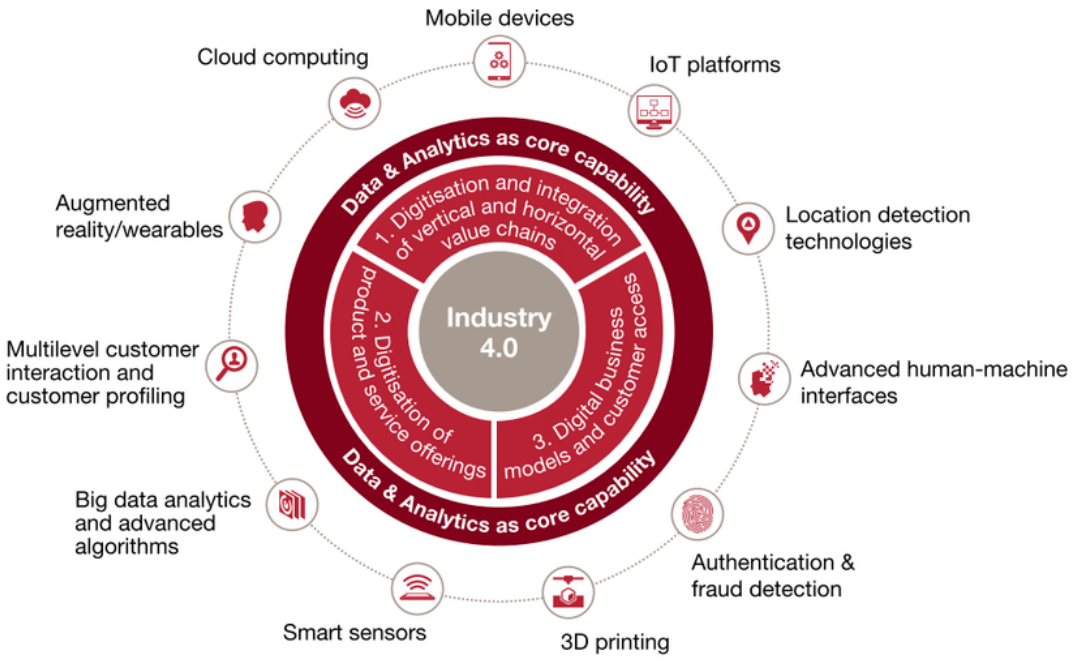


Fig. I Industry 4.0 framework and contributing digital technologies Source: Geissbauer et al. (2016)

Digitization in the economy and business world is not only a privilege for developed countries but has been a beacon of economic stimulation and support for developing countries as well.

According to the World Economic Forum, in 2015 digital economy grew at a rate of 15-25% per year in emerging markets and this is because digitization in this type of economy helps eliminate inequalities. For example, wages for digital work have risen above the average, offering a global income convergence (Beerepoot & Lambregts 2015).

Additionally, something that also took place in Greece the past years, developing countries have been a pole of attraction for start-ups and new digital platforms that seek in such economies a fertile ground for growth away from the already developed and sometimes corrupted markets.

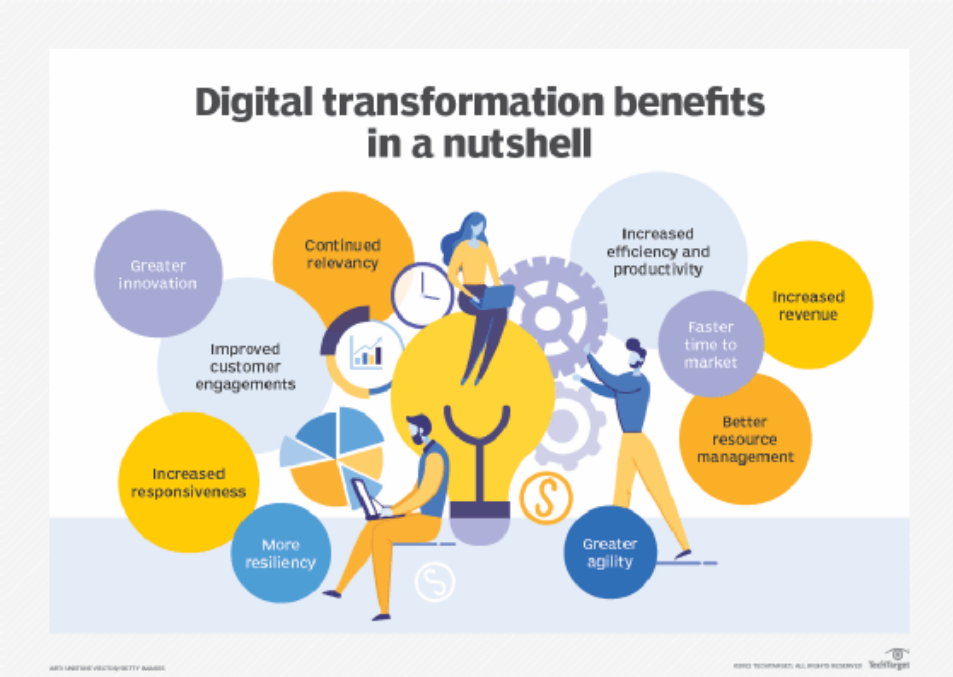
The 4th industrial revolution chart embraces exactly all the innovations that elevated the business world to all lengths and breadths of the earth. Starting from value chain automation and supply chain automation through IoT platforms and big data analytics, to new product and service offerings by using customer profiling and AI implementation. Digital business modelling, and what this thesis is all about, is achieved through advanced interfaces, big data analytics, cloud computing and algorithms.

3.3 Why do we benefit from digital adaptivity?

The contemporary digital reality pushed the business world to deal with things such as globalization, social media monopolies, cryptocurrencies, digital governance, and the cashless society.

Additionally, all economies in history have been premised on at least a minimum degree of trust, the digital economy requires a heightened level of trust-fostering in its structure in the absence of forging of relationships with physical presence, which has been historically relevant to trust-formation. Social influence is often necessary for the diffusion of digital goods, with more prominent social disseminators often leading the charge of adoption in new technologies and applications. But aside from the trust element, there is a newer experiential element that characterizes new digital

technologies, whereby the user must first experience the application before deciding on its adoption. (Chohan, 2020)



Picture III: Digital Transformation Benefits

The above picture illustrates the most important benefits from this implementation in the business world.

One of the most significant benefits is the efficiency in productivity levels. Robotic processes, automation, multitask completing in less time than ever before, is some of the few important advantages. Due to this efficiency, decision making becomes easier and this results in faster growth and transition to greater growth.

Greater innovation is another plus that digitalization has to offer in businesses and companies of all kinds of industries. In the past the creation of a new service or product had to overcome many obstacles until its implementation, and sometimes it

was impossible to occur in the first place. Digital allows companies to innovate and create new niches in no time.

And when we say in no time, we mean faster than ever. Digitization and the facilities it provides, offer another advantage to those who want to be market leaders. Through its applications such as simulation and virtualization they create what we call faster TTM (time-to-market). Therefore, from the moment that a team will formulate the idea until the final product, the time is significantly reduced, giving businesses the lead over the competition.

As companies change and aim to become more competitive, they want to achieve this transformation by adapting modern IT architectures to replace older systems. A very typical example was the Greek Banks. Through mergers they were found to perform day-to-day operations using multiple systems and platforms, many of them obsolete. As a result, most daily operations were hampered, employees were continually trained to use programs that were not in line with the culture of the new banking scheme, and customer service did not achieve the high levels desired by management. After the implementation of the “Digital Transformation” and use of modern and up to date architectures, the flow of data was enabled throughout the departments.

Experts said this end-to-end digital technology approach has helped CIOs and other executives eliminate duplicate and superfluous technologies, as well as associated costs. Furthermore, on-demand computing resources and as-a-service platforms have helped organizations optimize their technology spending by providing as much computing capacity as needed in the moment versus paying for excess capacity just to handle rare peaks in usage. (Tucci L. 2010)

In the above example for the Greek banks, we also mentioned the customer service and how it relates to the digital transformation. But it doesn’t only have to do with the facilities it provides to its customers, but also with the information that a company can use to learn more about its clientele. Companies can use data analysis and AI to gain greater insights, allowing them to create and offer products and services tailored to each customer's unique preferences and needs.

3.4 More benefits from Digital Adaptivity.

The list can get longer, considering the countless aspects of technological implementation throughout different scientific fields, but our main and most important focus here, is the application of technology in the business world and how it can serve to its best improvement. Whether technology and digitalization are used for investment purposes, or used for the best product outcome, the common denominator will always be the digital disruption for the survival and the maximum growth of businesses and organizations.

Figure II right below, visualizes how we can model tech implementation for organizations.

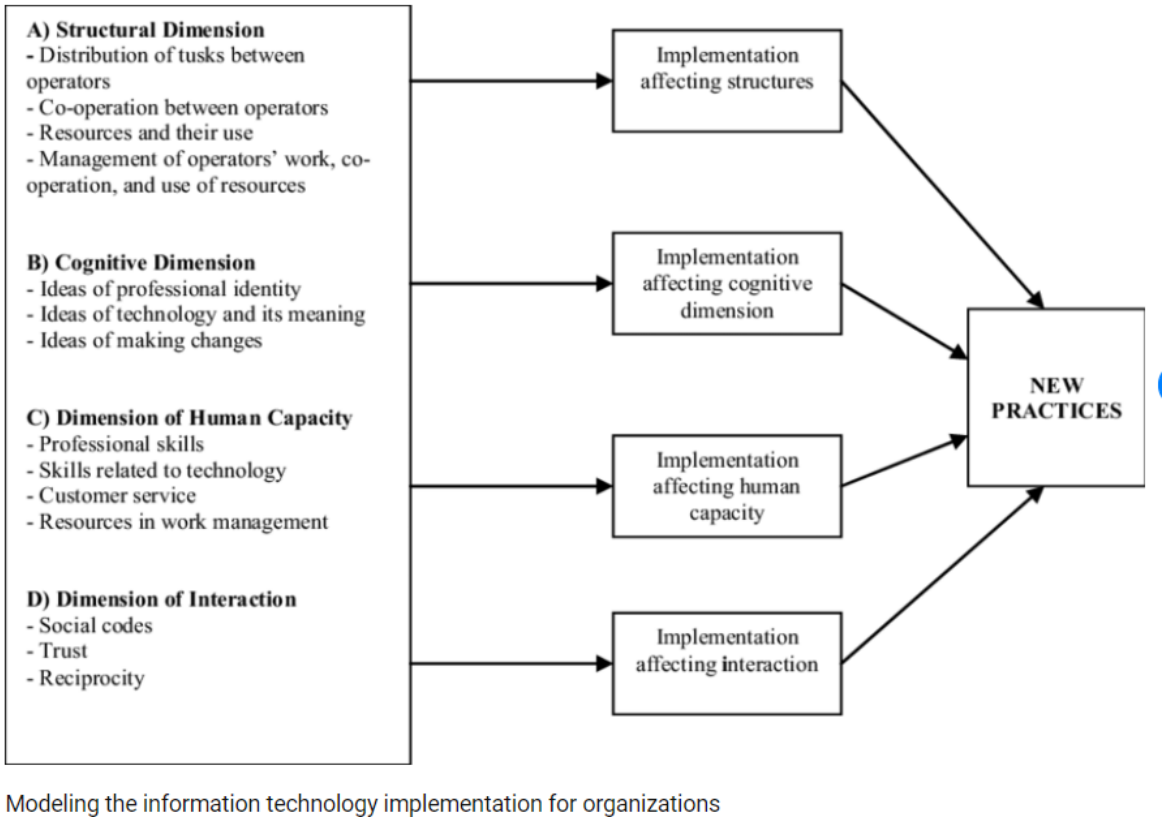


Figure II: IT Implementation for organizations. Source https://www.researchgate.net/figure/Modeling-the-information-technology-implementation-for-organizations_fig1_265148751

The most important part of the above figure is the outcome of "New Practices", which lead us to the desired meaning of specific digital tricks like the term and meaning of "Digital Twinning" which is now used as a new practice for most organizations. Everything comes down on how to face challenges, and or, how to solve smaller or bigger problems and therefore, IT and digitalization had become an essential weapon for the economy.

Executives use information technology and its digital applications, by modeling and using simulating sscenarios so that they can make the right decisions in critical strategies. So does production procedures, by maximizing quality, quantity with lower costs.

Human capital also improves their skills, through the comforts offered by digital technology (improvement in time distribution), assists to further development of its capabilities or even to acquire new ones (skills) that will help the organization grow collectively. It is certain that a well-trained and informed workforce adopts any changes occurring in a company faster as well as is more open to any growth strategy.

3.5 The Four "D's".

Digitalization- Decision Making – Data and the Digital Twin

But the main and foremost advantage of this implementation is the new practices used to help deal and overcome serious problems and decision-making issues. The use of tech in business operations and activities nowadays is indispensable. Technology avails information to all decision-makers, helps speed up processes, and increases efficiency. Furthermore, technology allows department heads to better collaborate with their teams in order to execute decisions while also affording the opportunity to update employees on how to carry out tasks that will benefit the company. Technology can speed up data collection to help company managers make decisions faster and more efficiently. (Cardinal R. 2020)

Collection of more data enables us through digitization to analyze them faster and to obtain direct results. Data often give us answers to the problems we may

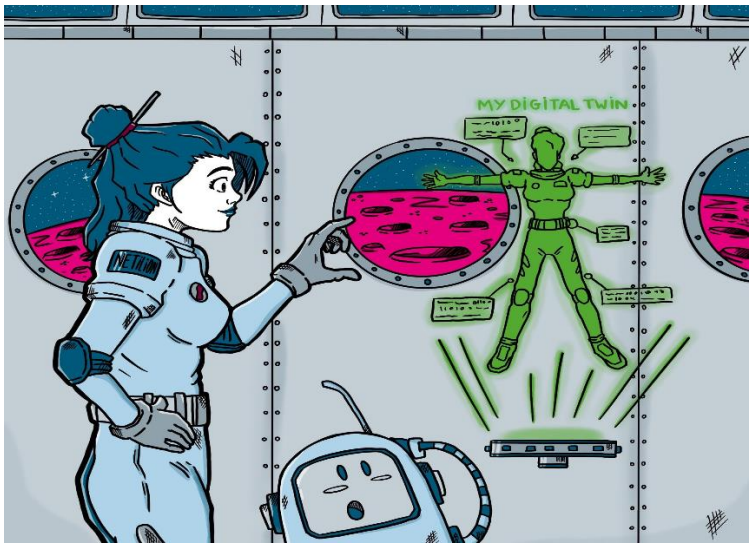
face as financial institutions, but is that enough in the end?

After all, the convenience provided by the digital world not only involves quick results, but it also has to do with resolving issues or even preventing them. We have

all heard of many such techniques, like simulation in problem solving, that has been continuously used in the business world too.

But since we are taking it a step further, the buzzword of the world now revolves around a new? term in problem solving and decision making in businesses, called Digital Twinning.

CHAPTER FOUR
DIGITAL TWIN
AND DIGITAL TWINNING
(From the general term to what businesses want)



Digital Evolution Part II.

4.1 What it is.

"*Houston, we've had a problem",*

is the actual beginning of what we now know as a digital twin. It is, however, less known to most, how the Apollo 13 mission is relevant to the digital world. Still, most applications and gadgets that are widely used today as technological tools were originally used or conceived on behalf of the military services or aeronautics.

What happened back then in this mission, would be the initiative of many wonderful things ahead. A sudden malfunction and an explosion of the spacecraft's main engine with the technology in hand fifty years ago, sounds an utterly catastrophic scenario.

With the technology and capabilities of that time, it seemed that little could be done to solve a serious and life-threatening problem. But the simulation technique was

already the mainstay of training for such missions, and so with the help of the simulation scenarios before the launch of Apollo 13, Nasa had good chances of dealing with this situation.

Although they obviously weren't called that at the time, it is considered that these simulators were perhaps the first real example of "digital twins". These high-fidelity simulators and their associated computer systems were crucial to the success of the Apollo program, and 50 years ago their flexibility and adaptability helped to bring three American astronauts safely home from the very brink of disaster in deep space. (www.siemens.com/simcenter/apollo-13-the-first-digital-twin/)

The various simulators were controlled by a network of digital computers, up to ten of them which could be networked together to simulate a single large problem. Most modern digital twins involve a remote physical asset that is connected to the digital model through a continuous stream of data. This connection is used to update the computer models in response to changes in the real-life object.

Although Apollo 13 obviously didn't use "the Internet of Things", NASA did use state-of-the-art telecommunications technology to stay in touch with its spacecraft. That data was ultimately used to modify the simulators in order to reflect the condition of the crippled spacecraft.

As years went by, the actual recognition of the Digital Twin method, wasn't until 2002 where it was presented in the development of a product life cycle management. The presentation involved a physical environment, a digital environment which was identical to the physical one, data and information flow between real and virtual environments. In other words what we have is the concept of creating a digital and

physical twin as one entity, connected with a continuous flow of data and resulting in different outcomes each time. (figure III)

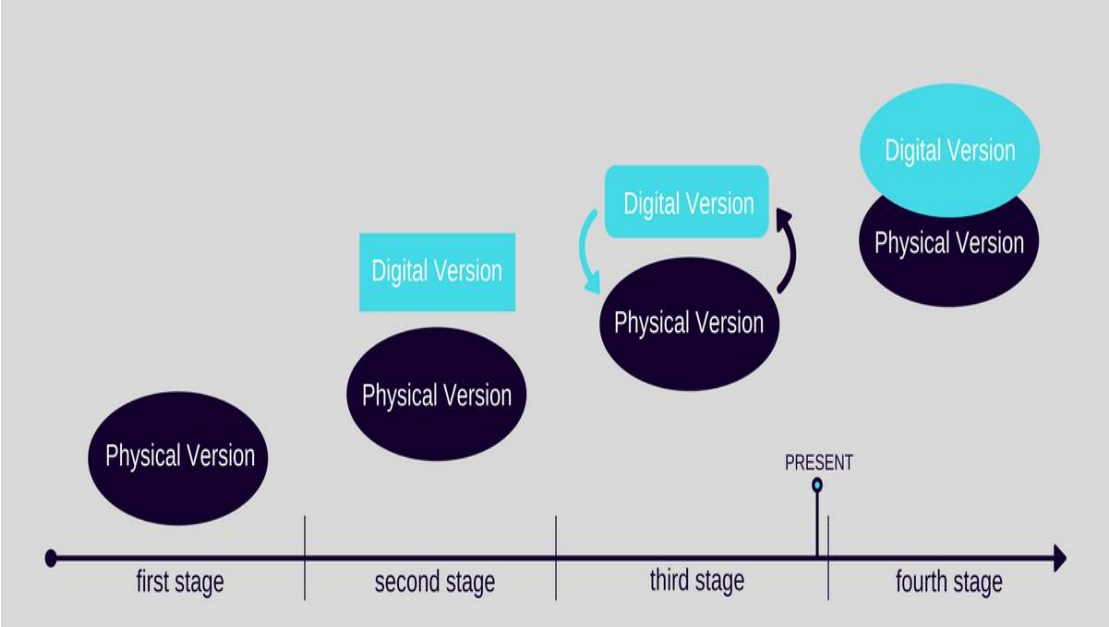


Figure III: Digital Twin Stages https://www.challenge.org/insights/digital-twin-history/

As we can see in figure III, there are four stages of how a digital twin works; initially there is the physical environment (first stage), in the second stage there is the creation of a digital duplicate of the real version (the twin), in the third stage where all the data are placed and processed there is an ongoing interaction between the reality and the digital copy of it. By the end of phase three, there is the present state where the desired result, the solution is revealed and finally the fourth stage is where we have the desired digital version of the physical environment ready to face any future challenges.

4.2 DT Characteristics.

Taking under consideration what has already being said, here's what the digital twin characteristics would have to include.

- **Physical:** Digital twins are most useful when they relate to physical assets that are (at least temporarily) out of reach of direct human intervention.
- **Connected:** Digital twins require constant feedback of data from the physical asset that can be used to update their condition
- **Adaptable:** Digital twins need to be flexible enough to react to changes in the physical asset
- **Threaded:** Contemporary digital twins consist of multiple interacting models that can be combined to account for different aspects of performance.
- **Responsive:** Any change to the physical version, has to be directly adapted and imprinted by the digital twin, giving immediate feedback and response.

4.3 What the world says.

Now that we have a picture and a real-life example of what a digital twin is, or could be, the literature behind it is quite interesting, since this concept was mainly implemented besides the obvious abovementioned, in civil engineering, mechanics, medicine, and very recently in business.

In the world of the fourth industrial revolution, the DT would be used as a method of the production line in order to optimize different parts of the procedure. According to M. Morháč, M. Lokšík (2017) digital twinning in industries would include "*a functional*

system of continuous process optimization, which is formed by the cooperation of physical production lines with a digital "copy". It creates the digital factory environment, in which the company can optimize the operation directly through the production chain, manipulate parameters and production

processes; adapting the product to market requirements. The data created during this time paints a comprehensive picture of a given product and the production process. A digital twin collects and evaluates the information continuously, allowing,

among other things, to shorten and streamline the production cycle, reduce the rise time of introducing new products, detecting inefficient settings of the underlying processes."

Another approach of this term implies that DT is the continuation of the simulation methods primarily used in many businesses and industries. It is also considered that DT along with big data analytics are the cornerstone of today's smart manufacturing.

> *"In simple terms, a DT is a digital virtual replica of a process, product, or service that allows analyses of data to monitor the processes, anticipate problems, prevent downtime, innovate, and simulate several what-if situations."*

Picture IV: Dr. Alex Ramirez's meaning of DT. Sprott School of Business, Carleton University

According to the World Bank, a definition of a digital twin, has to do with creating an entity that is realistic but with the ability to process more data that both helps transfer knowledge and generate a better decision-making process. WBI supports that the use

of DT enables organizations to gain access to managerial, financial, and technical skills

Another definition of what a digital twinning really is, is referred to as that which includes the functions of various software systems, processes, and continuous data collection, in a flow that is intended to produce results, understand situations, predict future conditions, prevent future failures, and optimizing return on investment or product production.

Considering the above DT definition, it can be argued that solutions in use today

such as model-based process control (MBPC) and predictive maintenance use DT technology, with the DT clients or users of this capability, ranging from low level equipment, components and processes up through high level manufacturing execution systems (MESs) and enterprise resource planning (ERP) systems. (Moyne et.al, 2020)

Data algorithms and artificial intelligence, along with big data analytics, are synchronized to create a fast DT reconfiguration. This in turn allows the digital copy to be in constant synchronization with the corresponding physical twin. Whatever change occurs in the physical prototype, automatically happens in the corresponding digital. In addition, the artificial intelligence algorithms in use, help reveal aspects of specific details and elements such that allow regulatory actions, auditing as well as forecasts to be performed with almost absolute accuracy. It can even help create mechanisms of self-awareness. (Tao et.al., 2018)

4.4 Simulation vs DT.

The rational question though is that someone would easily assume that the digital twinning method that so much has been praised over the last years, especially in Industry 4.0 and practically in any aspect of science, is actually an advanced level of the old known simulation experiment method.

It is, but there is a turning point in DT, that differentiates from simulation methodology, and that is the continuous flow of data in the simulated object, or situation.

Simulation on the other hand is being used for many years now, especially in the field of statistics using different methods and approaches. In simulation, there is a certain situation where we need to extract results as close to reality as possible, by imitating the initial hypothesis, and by using specific data, to get as realistic results as possible.

In other words, simulation is a modeling technique that mimics the operation of a real system as well, and as it develops over time.

In the beginning of this chapter, and the thesis overall, we mentioned the Apollo 13 mission, as the birth of what we now call digital twinning. This example taken from a real event, has shown the possibilities and the evolution of simulation and virtualization models. And although simulation is still being widely used, along with virtualization, were the precursors of DT, both of which where the fundamentals of bringing digital twinning in life.

Their major difference with DT, is that they do not include a seamless connection and real-time data exchange allowing the continuous, or at least periodic, “twinning" of the digital to the physical. (Barricelli *et al.* 2019)

Digital twinning models have begun to entreat the interest of scientific communities, over simulation methods, precisely because they have greater capabilities, as they incorporate artificial intelligence models and can use all the possibilities of big data processing.

This lack of continuity for simulation, and the correlation of digital twins with artificial intelligence, and big data has made it the number one tool and future trend for the business world as well.

Table II describes in a glossy manner how simulation evolved into the concept of digital twin. *(Wichert et.al. 2015)*

From Simulation to Digital Twin

1960+ Individual application: Simulation is limited to very specific topics by experts, e.g., mechanics.	**1985+ Simulation tools:** Simulation is a standard tool to answer specific design and engineering questions, e.g., fluid dynamics.	**2000+ Simulation-based System Design:** Simulation allows a systemic approach to multi-level and multi-disciplinary systems with enhanced range of applications, e.g., model based systems engineering.	**2015+ Digital Twin Concept:** Simulation is a core functionality of systems by means of seamless assistance along entire life cycle, e.g. supporting operation and service with direct linkage to operation data.

Table II: Evolution of simulation Source: R. Wichert et.al. 2015

4.5 Implementation of DT.

To understand any concept under scientific research, it is essential to present the practical part of what we need to analyze. Therefore, the best way to comprehend both the meaning and the essential answers for our case studies in the chapters ahead, we need to see under which fields the digital twinning technique has been implemented.

4.5.1 Manufacture

The first that comes to our mind is how a significant amount of the work happening in the field of manufacture should be the first to implement such technologies. It's not only because simulation as the primary form of DT was already in use of behalf of manufacture, but because it was a natural consequence of the evolution of industry and automation to easily adopt it.

In order to optimize the processes that cover the product's entire life cycle, many companies make extensive use of the digital twin technology nowadays. As a matter of fact, implementation of this technology can provide with a significant assistance in the supervision of every single step during the manufacture process.

In a "smart" digital twin, the autonomous units perform high level tasks without human intervention, and decide between a set of alternative actions, while simultaneously they'd respond and react in failures or abrupt incidents. All this without interfering in other parallel tasks or units withing the production line.

The information must be as realistic as possible and describe the current state of the process and products.

This can be achieved by using a precise duplicate of a physical entity, meaning a digital twin. The key point of success is the continuous communication and data input between the physical element and its digital duplicate.

Digital twin's self-adaptation is very important in changes within the manufacture designing process, because of the speed required for such changes (and the DT as already mentioned, responds fast), and the smaller number of units required to do so.

4.5.2 Aviation

In manufacture the implementation of DT mainly served as a tool for solution of process issues (optimization and acceleration of production)

but also, in the design of the production stages of the product. In the field of aviation, it is mainly used for situation forecasting and scenario design that helps detect abrupt changes and then activating self-healing mechanisms

decision support, and diagnostics.

4.5.3 Healthcare

Digital twinning in healthcare is quite new mainly used for the maintenance of medical devices and performance optimization (i.e., accurate resulting and energy consumption levels.)

Two major companies have developed platforms that use this type of technology for assisting and optimize hospital's life cycle. Johns Hopkins Baltimore hospital in association with General Electric company, developed the «Capacity Command

Center» that aims to improve patient's outcome through centralized control and coordination of data. More specific, this platform uses AI technology, along with transformation of big data analysis, from a variety of patience's archives, that allow an optimum management for both the patient's treatments and the hospital's expenditures. Its main goal is to set the foundation of a continuous data base that will ultimately benefit hospital's long-term management and work for governmental associations in the management and coordination of patient care.

This application includes, besides a proper financial management for the hospital and insurance companies, the social dimension of the issue. By using a digital twin, the hospital can make more effective patient regimen decisions. Think of a digital copy of a patient that will be able to follow and foretell his activity by predicting important medical events in his life. After all, in medicine, effective treatments are directly related to the speed and avoidance of wasting time, something that the digital twin seems to overcome.

So, from the one size fits all treatment we knew so far, the DT technologies implemented in healthcare could provide an enormous breakthrough of the ultimate customed made individualized therapy scheme, becoming one of the sectors that could potentially benefit the most.

4.5.4 Smart Cities

When we began the literature review for this topic, the phrase "smart cities" was always relevant to the digital twinning technology. Thus, we can say that the application of this technology has been extensively applied in the digital design of

urban complexes as well as in the solution of connectivity and application issues of the IoT.

According to Tao et al. (Feiet al., 2020), when it comes to explaining the implementation of DT in smart cities there are many dimensions that are involved in such concepts. From the model dimension, data dimension, connection dimension, service/function dimension and physical dimension.

Due to the use of IoT there has been tremendous changes and connectivity is widely spread allowing digital twin cities to have four major characteristics.

Accurate Mapping, Virtual-real Interaction, Software Definition, and Intelligent

Feedback. Accurate mapping means exactly that, we make a precise digital model of the city by mapping everything. From roads, bridges, wells, lamps, to digital modelling of urban roads. Through the installation of special sensors on the ground and underground, it is possible to make digital copies and as a matter of fact a city's digital twin. This way, it is allowed to monitor exactly how our city works dynamically and continuously.

Virtual-real interaction means that all kinds of "traces", such as traces of people, logistics and vehicles that can be observed in the physical city, can be

searched in the virtual city once they are generated. Software definition means that the twin cities establish a corresponding virtual model based on the physical city,

and simulate the behavior of urban people, events, and objects in the virtual space by means of software platforms. (Deren et.al. 2021)

Intelligent feedback refers to the intelligent early warning of possible conflicts and potential dangers of the city through planning and design, simulation, and providing reasonable and feasible countermeasures. (Deren et.al. 2021)

CHAPTER FIVE

DIGITAL TWINNING IN BUSINESS

Digital Evolution Part III.

5.1 DT In Business.

According to *Technology Vision 2021*, a survey was conducted to monitor the extend of the DT technologies used in organizations. The results are quite promising for the future, as 8 per cent of businesses are extensively using this type of technology in full speed and as a main tool for forecasting and decision making within their organizations. Another 28% of organizations are considered to be advanced users and they use DT for prediction purposes and extracting insights, whilst a very interesting 56% uses it moderately explaining that the use of it is limited, and only for simulation purposes and testing. The rest 8 per cent does use this type of technology but without exploiting much of its potentials. However, most of the organizations'' executives do believe that digital twin offers tremendous opportunities even a mission control, or a central intelligence hub, that would help them gain more knowledge about their companies, their people, and their assets.

Petri Asikainen, Director of Core Technology Development at Konecranes revealed that a good percentage of small and mid-sized companies are eager to use DT

technology and other innovation tools, as it enables them to get faster access to new technological trends and allows them to have the comparative advantage in growth.

Digital twinning offers an extremely particular way of manipulating information, data, and processes. For example, a DT can offer solutions in can offer solutions for effective sales, can create personalized customer service, and in general quality services that go beyond even the technology of artificial intelligence. Under this prism for the use of DT in business, we realize that it is something more than a technology platform, but it is a multi-platform, with many faces and infinite prospects.

5.2 DT in Product Lifecycle.

The summary of reported publications and according to Tao et.al.2018 revealed a very interesting distribution of DT in product lifecycle (Figure IV). It is fascinating that a 19% of product designing uses this type of technology, either for new products or for improving the existing ones, in a more responsive, efficient, and informed manner.

An important part of product cycle such as the production itself implements DT technologies that allow process to become more reliable, flexible, and predictable. Above all, DTs can visualize and update the real-time status, which is useful for monitoring a production process. (Tao et.al. 2018).

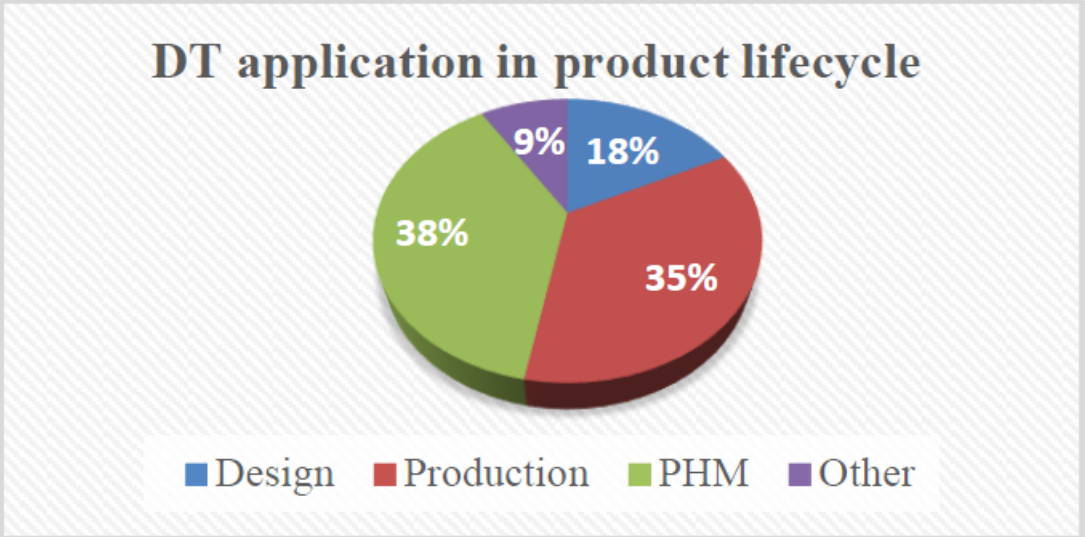


Figure IV. DT Application in Product Lifecycle

The rest 35% in prognostic and health management, is mainly used in the prognosis for the behavior of aircrafts. This application is mostly used way before any other of the abovementioned did. The main aspects of DT in this type of product and the most important key points about this part include improvements in uncertainty and minimization of failure.

5.3 Implementation in DT Entrepreneurship.

Although DT technology has been applied in many sectors such as industry, manufacture, aviation, healthcare as we analyzed in the previous chapter, it is essential to see what happens once DT has been implemented in the business world. From how well a product is designed, to how to sell it, and from what strategy fits best for one business to predicting potential risks, benefits, and outcomes.

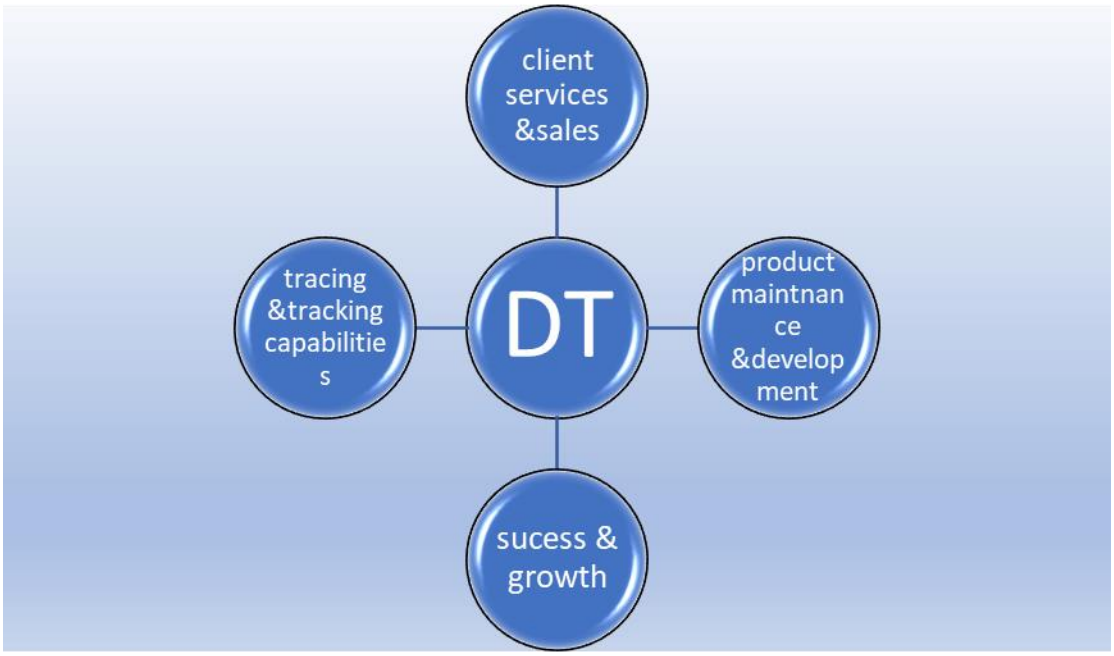


Figure V: DT in Businesses

5.3.1 Improving Client Services and Sales.

One of the most important areas of retail business is customer service and sales growth. Customer experience and genuine connection to a business's products is the cornerstone of successful sales that can ensure sustainability and gain market share. As for example we mentioned in the field of health the digital twining offers a completely individualized treatment depending on the individual through the data and the use of multiple elements of artificial intelligence technology.

By creating a digital body that is a precise copy of the physical, medical science can now deal with injuries, diseases with treatments fit to the patient's body after they have first been tested on their respective digital. Likewise, and through modeling we can construct digital twins that represent the demographic or psychogenic characteristics of our customers. In this way we not only achieve a better simulation

of the sales environment, thus allowing the best service in terms of personalization, but also, we manage to offer more suitable products per customer.

Amazon has been using the concept of digital twins in order to provide a tailored, custom experience to its users by using marketing. By visiting the website, users start to interact with what it has to offer. Every single product they have viewed, purchased, or added to their virtual basket, helps Amazon's Digital Twin algorithm create a digital version of the consumer. The more data their algorithm gets fed, the more accurate the digital replica of the users (https://www.challenge.org/insights/digital-twin-technology-companies/)

5.3.2. Improving Tracing and Tracking Capabilities.

What a digital twin technology offers is obvious, since by connecting many digital twins together businesses manage to essentially build a platform that constantly provides them with useful information regarding the entire process of manufacturing and detecting products. This way companies optimize their control over the entire process. In addition, resources are used optimally and elements that lead to inefficiency are avoided.

5.3.3. Optimized Product Maintenance and Development.

Nowadays most businesses offer digital products or services instead of a traditional product as we know it. By using this technology, it allows them to exploit information from users of products and services and through data analysis they can decide where a

company can find emerging opportunities for product development or what strategy to follow to obtain further development.

5.3.4. DT offers Success and Growth.

An overall look on how digital twining has been used so far, leads to the conclusion that it is more than just a useful tool, or a platform that collects and processes data. Digital twins are more of hubs with countless resources where organizations have the access to use and analyze their data, improve their strategies, prevent downfalls, upgrade their products, and get a better understanding of both their customers profiles, and their entire target market. All this can happen in a closed protected space that takes under consideration all of their components and attributes and by examining multiple variables, it results in different scenarios and outcomes. As a result, businesses, can significantly increase accuracy when planning for the future, while they can eliminate the time needed to plan for innovative products.

5.4 Future possibilities for digital twins

Logistics:

The future of the supply chain could not escape technological developments, let alone be indifferent towards applications such as that of the digital twins. Imagine a completely digitized supply chain, precise copy of the real and the potential for creating more efficient trade. If we for example take a digital twin of a warehouse, where all products correspond to their digital copies, which (digitally) simulate situations of real conditions in management, transportation, and delivery. This can potentially empower such companies in terms of better and faster warehouse management, choosing the best among many options, and avoiding many uneasy situations, or making critical decisions about the best managerial option of such large chains. If this technology were in hand, could the digital twin predict and thus prevent the event that happened in the Suez Canal? However, we are still a long way from its full implementation in this industry as this requires by definition a very large database and information, something that the big logistics companies are skeptical about, and do not seem ready to make available on open platforms.

Sustainability:

Perhaps one of the most interesting applications of digital twins is that of sustainability. Starting from which raw materials could be used for the production of one product, burdening the environment less, not by assessment, but with absolute accuracy (thanks to the existence of a whole digital representation of production and energy reserves that the process will require), to how a product should be made available to the final consumer, ensuring the conditions of sustainability.

Digital twins work by suggesting the most environmentally sustainable method or path.

Pharmaceuticals:

Likewise, digital twins could, in combination with other technologies, design pharmaceutical regimens and carry out efficacy tests in an environment that ensures not only accuracy in the results but also a significantly reduced time before a drug is available on the market.

CHAPTER SIX

INCUMBENTS AND START-UPS

(Do Incumbents watch and copy Startup practices to survive?)

6.1 General Findings.

In a recent study of Harvard Business School (https://hbr.org/2022/01/how-incumbents-survive-and-thrive) on the comparison between the two forces in the business world, those of established businesses and start-ups, the message was bleak and clear. A drop in the average tenure of the old economy companies and respectively the rapid growth of digital start-ups gives the dynamic message to the first it's a "do or die" deal.

Referring to the previous chapters on the technological discovery of the digital twinning and how important it is for companies and industry to have such a tool in the context of innovative strategies by large companies, it is understood that there are many challenges that these companies have to face if they want to remain competitive.

And while DT technology seems to be tailor made and suitable for these businesses (since they have easier access to capital, resources, and data), yet the ultimate application that will lead to great growth is still yet to come. Instead, according to recent studies, we often see large organizations slow back in digital development and strategies that would radically change their direction. We also see that due to the rapid growth of start-ups in almost all business sectors, a tendency to observe and imitate them was automatically created by the established companies of the kind.

6.2 A Comparative Eye.

But before we look at whether this is really the case, let's look at the main advantages of both cases. The following two tables emerge from the study of the Institute for Management Development and reveal a lot in relation to the turning points of the two major categories.

As Figure 6 reveals, the five main advantages of start-ups, as opposed to incumbents, are in areas of innovation and strategic flexibility, while the corresponding advantages of large companies are in terms of financial indicators.

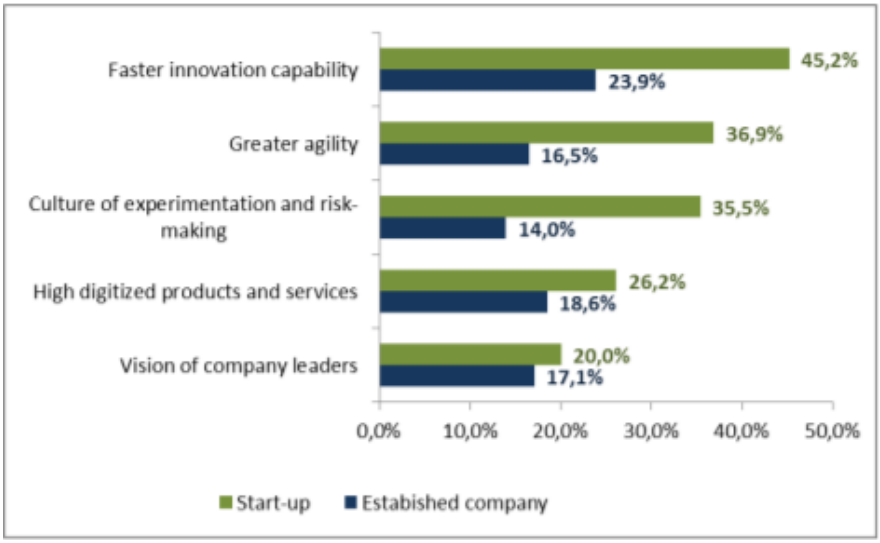


Fig. VI 5 Relative advantages of startups. Source DBT Centre

More specifically, the points where newcomers show a tremendous lead (and this is no surprise) are in the ability to quickly adopt innovative practices, in the agility they have and therefore apply the new data faster. Also, start-ups are the ones that have either developed or are embracing digital innovations with tremendous ease. As a result, they have the capacity to offer a higher level of digital products and services but also through the comfort of their digital knowledge, they show more familiarity in developing a general culture of experimentation in everything new and take risks relatively easier.

Of course, this in itself is clearly not an incentive for established companies to copy the new entrants, but it shows a relative audacity of the latter to open new paths of growth.

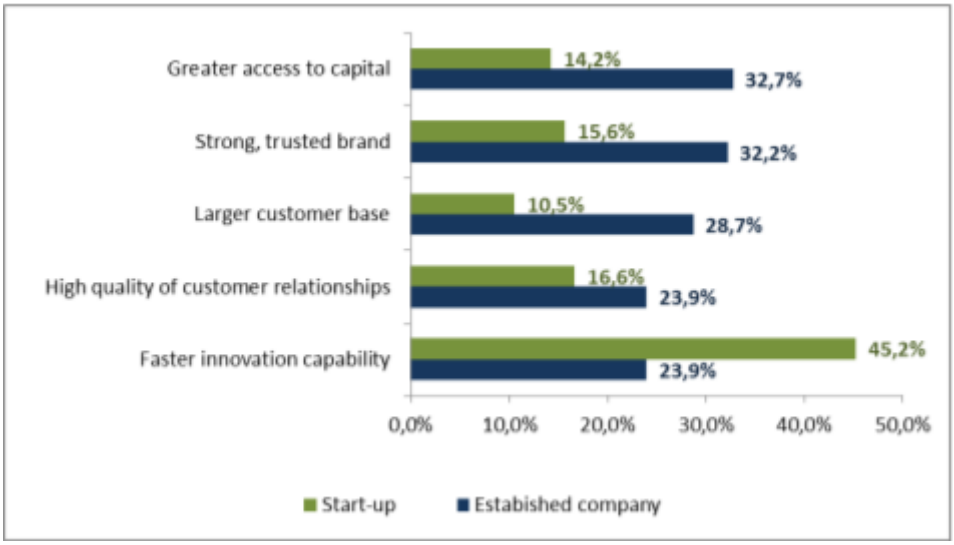


Fig. VII 5 relative advantages of incumbents. Source DBT Centre

On the opposite side, of course, the advantages of large organizations are more or less what is expected, and it includes capital adequacy and easy access to cash flows. Also, a large company does not need to build a new customer data base or gain market share. It already has these as well as a brand name that is difficult to dispel. Also based on the brand name, these companies have a huge and strong customer base and an absolute high quality customer service.

6.3 Startup Facts (that makes them so important)

The following table by Statista reveals some very basic facts about start-ups that will help us further in the study and will examine whether they are indeed the subject of copying by larger firms or maybe why not become the reason for cooperation (between incumbents and start-ups).

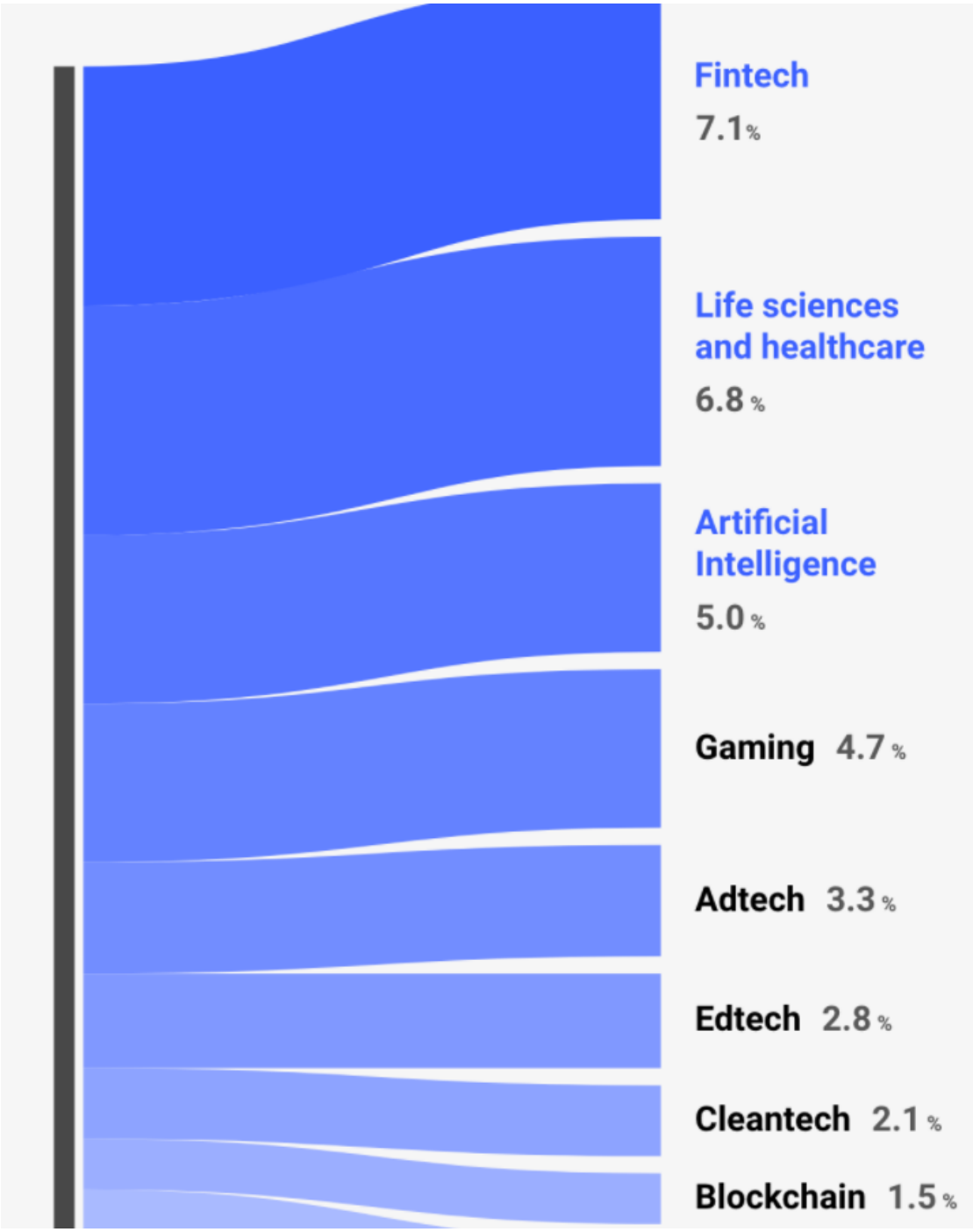
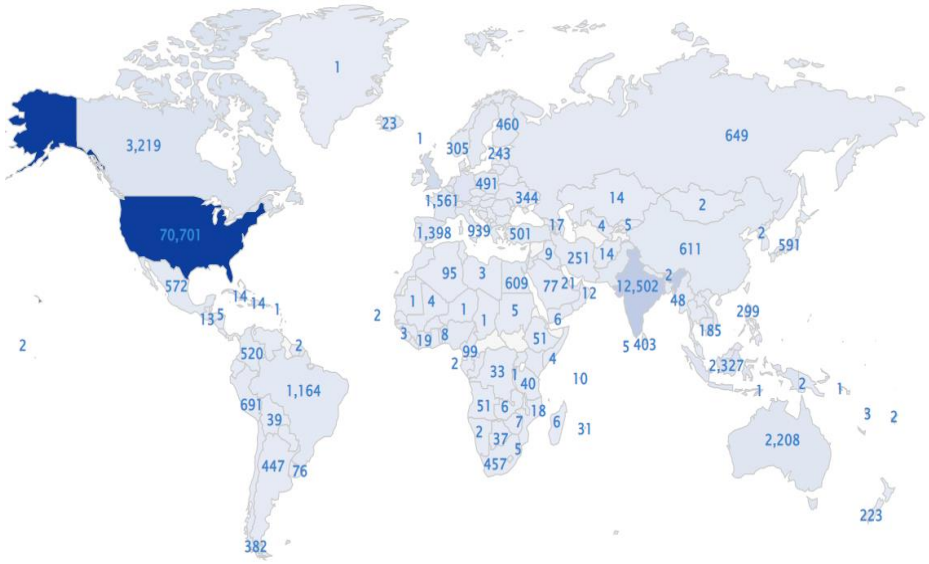


Fig. VIII Global Industry Distribution for Startups. Source: Statista

As it is very clear from the above picture (although the numbers are not absolutely accurate) the vast majority of start-ups are directed towards the fields of technology, followed by the field of health and artificial intelligence.

However, this ranking is expected if we take under consideration that the vast majority of new entrants are businesses based on a new application or a new platform. Due to the covid-19 pandemic the rise of companies orientated towards the health industry and everything in relevance to it is extremely high. It is clearer now and in accordance to the previous figures of the study, that the advantages of start-ups include their ability to implement technological innovations and rapidly develop at the same time

Also impressive are the numbers of countries with the most start-ups, and while we would expect it to be a privilege of Asian countries, United States holds the lead with a number of new entrants reaching 70,701. In the second place but away from number one, is India with 12,502 startups. It is also interesting that China only has a good 611 start-up companies (we refer to it as a global trading and business power) while in third place is Great Britain with 6,143. For the record, Greece is somewhere in the middle with 169 start-ups (Picture V).



Picture V: Startups per Country, global map. Source https://www.startupranking.com/countries

Another very interesting fact is that the majority of the approximately 600 unicorn companies in total are mainly based in the USA (over 50%), giving the suspicion that the American territory is suitable for a very successful development of start-ups around the world.

In terms of sectoral categorization of companies, there is a very big explosion, as we said before, of fintech companies, but also a very large and important part of the market is directed to e commerce start-ups with its value reaching 3.5 trillion dollars and launches to the top of the industry with the highest growth rates.

6.4 Startup facts for the future.

The data that predict the future developments and trends of the start-ups are the ones that can give us a hint as to whether the emerging companies can finally be a beacon for the already established ones in the field. The numbers are staggering in terms of the amount of investment projected to attract young start-ups, along with the fast-growing industries (like e-commerce and AI), that may be an object of desire to large organizations.

There is a strong trend of growth for start-ups in the field of health, especially after the last two years and the global events, as well as e-commerce which is still holding the lead. Nevertheless, the five major categories of start-ups that will occupy us in the near future concern the sectors (apart from health), of transport, financial services, artificial intelligence, and e-commerce.

Growth in numbers also translates into the value of these companies. More specifically, in just a few years, startups such as Airbnb and Uber have grown exponentially and established a global presence. At the moment, Airbnb is worth $24 billion, and Uber is valued at over $50 billion. In 2013, total market sales revenue was $ 15 billion, which means that in just seven years, projected market revenue is expected to increase more than 20 times (www.firstsiteguide.com).

Finally, 60% of entrepreneurs support that artificial intelligence and the technologies around it will monopolize the market of start-ups and innovation for the next 10 years, attracting huge investment funds. Those are sectors that have countless potential and in fact large established companies will not be able to stay indifferent towards them.

6.5 Two Poles.

Of course, the road to build a successful business is neither easy, nor is it always successful, considering that 42% of them fail. But no one can deny or underestimate the impact on the economy and entrepreneurship of start-ups that put things in economy under a new perspective.

Nor, of course, could their rapid growth leave the established companies indifferent. On the contrary, the incumbents with the startups, functioned and still function as two poles in the same planet. With the dynamics of each other contributing to the balance of the overall business market. What remains to be seen is whether these two poles sometimes function as communicating vessels. That is, if the established companies in the area can get startup data in order to remain equally competitive, or if even a collaboration benefits them.

6.6 What the history of the organizations has taught us.

After all, the advantages of big business are enough to keep them just as competitive against the tsunami we just described above and it's called startups; And finally, do organizations use the strategies of the new entrants in order to meet the challenges of their field.

This answer was given years ago in an interview by Steve Jobs, when he was asked about one of the keys to Apple's success. His response was shocking, as he said that Apple does not operate as a large multinational company with many offices around the world and by that he implied the classic way of operating a dominant multinational, but rather operates with the mentality, structure, and strategy of a start-up.

By this he meant that the management of his company followed the same standards as those of a novice. He also said that the core of the company (Apple) was working by creating new ideas, new products, new technologies which were constantly at the center of executives' discussions. In the first part of this chapter, referring to the advantages of start-ups, was the vision and culture and the possibility of constantly adopting new ideas, something that large organizations seem to be hindering.

So, this is a shocking indication that large organizations, in order to be up to date with developments, or even in order to meet up with the challenges of an always changing economic environment, very often follow in the footsteps of the new entrants, either at an organizational level, either at the level of mentality, or by adopting technologies and development strategies.

6.7 Cases.

Of course, it was easy for the Apple CEO to say this, considering that the first copy (not to say theft) of technological innovation was made by his company at the expense of the then innovative company Palo Alto Research Company. For the record, during Apple's visit for public relations purposes, executives observed a graphical user interface (GUI) that was light years ahead of anything Apple had produced and used it as an idea to integrate it into Macintosh, and of course this move of copying a specific technology, was more than successful for Apple (the rest is history).

In recent years, and in the world of social media where speed and innovation are a big asset, the leading Facebook company did not sit idly by, when it saw the smaller company (social networking platform) snapchat gaining more and more users at the expense of its own company Instagram, by adding new features to its application through 24-hour video stories.

Although due to its size, we would say that it was not an immediate threat, however this is a very classic example of watch and copy, since in order to face the competition that deprived the now meta company of potential profits, after failing to acquire it, it copied the exact same feature offered by snapchat to its users and even using the same name (Instagram stories). Some time ago, Meta added to the capabilities of Instagram, the reels that are an identical feature of tik tok, another new social networking platform, in order to face the competition once again.

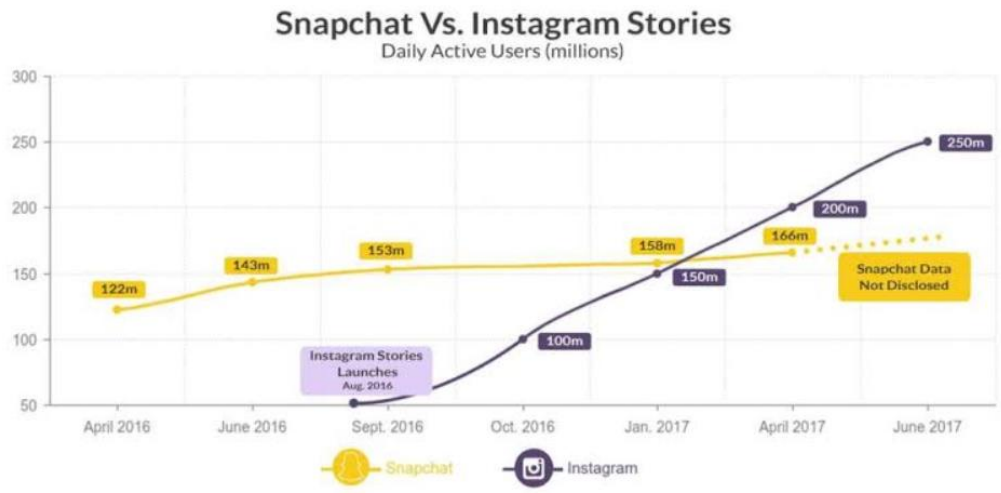


Figure IX: Users of Instagram vs Snapchat. Source: https://automonkey.co/blog/statistics-for-instagram-and-snapchat/

The above figure is very indicative of why in this case, it was so catalytic and important to copy an element. Instagram already had established loyal users and also made significant profits from ads. But this Instagram image remained stagnant and seemed to have nothing else to offer its users. When the new feature of snapchat was released, the current that followed and used it, shook the bays of Facebook and what they saw was a real threat. Copying exactly the same feature as snapchat had literally boosted Instagram users and doubled them in less than a year.

6.8 A deal breaker story.

All of these may not be straightforward cases that prove that there is a general tactic of watching and copying, however one cannot deny that a good idea that can get a large organization out of the difficult position when they simply just run out of ideas, will not be monitored, and copied.

A very interesting case was that of Nokia. A tech giant that collapsed literally overnight. In the literature reports on this subject but also in the sources on the internet, there were many common elements that agreed on one thing: That this big company, failed to react to the technological changes that were happening around it. Between 1998 and 2001 the company increased its turnover by over 500% making it the dominant company in mobile telecommunications worldwide.

After 2013, however, the market share fell below 3% with a corresponding drop in profits of 95%, forcing the company to shrink and close factories, but also to lay people off (Figure X). So, what did this big company do wrong?

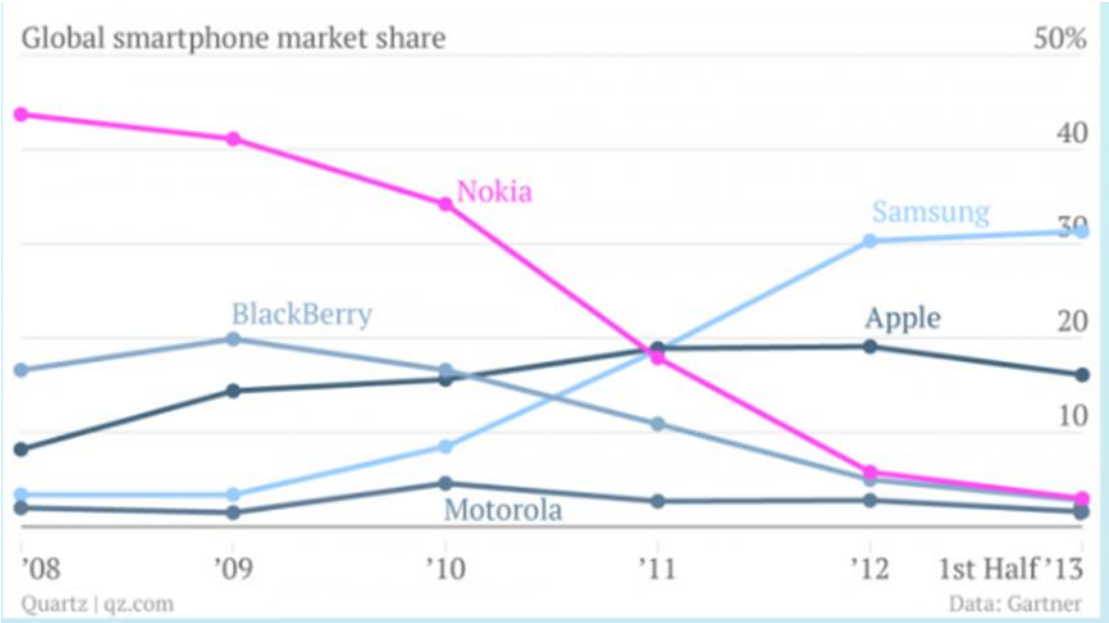


Fig. X Global smartphone Market Share Source: https://qz.com/430888/the-rise-and-fall-of-nokia-in-one-chart/

Nokia probably did not do what the others did. With the development of an emerging market for smartphones, and the two new software (IOS and ANDROID), Nokia, while witnessing the technological innovation, did not react in time. Instead, it

focused more on hardware than the then smaller Apple which invested in software, and Nokia never adapted to the new smartphone trend.

In addition, it completely relied on its admittedly strong brand name, which ultimately did not stand long enough to convince the market (and the final consumers), but also failed to comprehend the opportunities that would arise from the application possibilities offered by the new technology of smartphones.

As Figure VI states, incumbents show a significant lack of acceptance of innovation, as well as a culture that is more receptive to change and risk. And although these big companies, and in this case Nokia, have the best executives in the market, yet their vision is not in line with industry developments, something that seems to have happened in this case as well. Nokia just did not follow the market innovation, did not see what smaller competitors in the industry did, or saw them and simply relied on being dominant, and as a result, paid for it. Nokia failed to anticipate, understand, or organize itself to deal with the changing times.

6.9 Cooperate Instead of Copy.

Another interesting issue when it comes to studying how incumbents watch and copy startups, is to see what happens in a step further than this. It is no secret that after the crisis of 2008 many incumbents found themselves partnering with startups. Because of the economic crisis, disposable income was fewer, so the only channel of growth at that point were the startups.

A 2016 survey from Boston found that 67 percent of companies said they prefer working with earlier stage startups as they seek new technologies in business models.

A 2016 Open Axel report claimed more than half of the world's largest 500 companies work with startups. (https://www.wired.com/brandlab/2018/07/partnering-startups-helping-incumbents-grow/)

Back in the day, it would be impossible for a new company to enter the automobile industry, or the financial sector for that matter. However, after the vast development of smartphones and especially the applications on them, this was a game changer and the examples of Airbnb and Uber, verify that a new application could dominate over an existing business. So, the power of anything new is indisputable and the incumbents who fail to understand that are in danger of falling behind, while those embracing it now lead.

A counterexample is Unilever. The consumer-packaged goods giant launched Unilever Foundry in 2014 to accelerate business innovation and efficiency on a global scale. The Foundry uses a Shark Tank-like pitch-pilot-partner approach, meaning startups pitch ideas and, if accepted the company launches a pilot program and then partners with the startup if all goes well. One of the partnerships that came out of the Foundry is between mayonnaise brand Hellmann's and on-demand delivery startup Quiqup. The offering targets shoppers who are likely to make impulse purchases and allows such consumers to choose their favorite recipe and get it delivered to them directly within an hour. (https://www.wired.com/brandlab/2018/07/partnering-startups-helping-incumbents-grow/)

By embracing pioneering ideas, the companies establish more efficient and effective solutions for consumers, hence they keep up with what the market wants. Startups seem to be a major factor in achieving this.

CHAPTER SEVEN
IN-HOUSE DEVELOPMENT Vs. ACQUISITIONS

7.1 Challenges of the new era.

It makes sense in an ever-growing economy where businesses, whether it is incumbents or startups, are a living organization, they face different kind of challenges that they must adjust if they want to survive. That was the one part that the previous chapter tried to analyze. In the arena of entrepreneurship, large companies enjoy the benefits of their size on the one hand, while closely monitoring the creation of start-ups and sometimes copying them in terms of innovation, mode of operation or even seeking partnerships with them.

On the other hand, start-ups seize the opportunity offered by their flexibility, fresh ideas and the whole climate of recent years that favors this kind of development,

knowing of course that there is the so-called kill zone that can eliminate them from the map of entrepreneurship.

But another trend that has been prevailed over the recent years and is already applied by large giant companies, is the acquisition of these smaller companies by the larger ones. It even happens to such an extent that it has been reported in an earlier study of 2019, that when the heads of start-ups were asked about the long-term goals of their companies, about 50% mentioned the acquisition as a possible if not desirable scenario, with the picture not significantly changing both in 2020. (Figure XI a, Figure XI b).

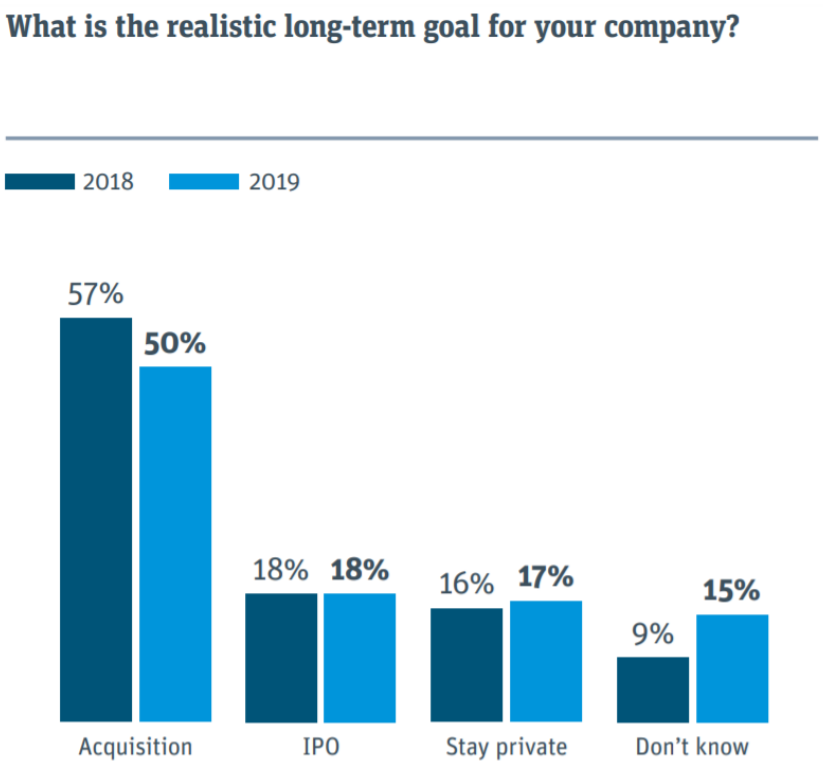


Fig. XI a. Long-Term Goals for Startup Companies 2019 Source: US Startup Outlook

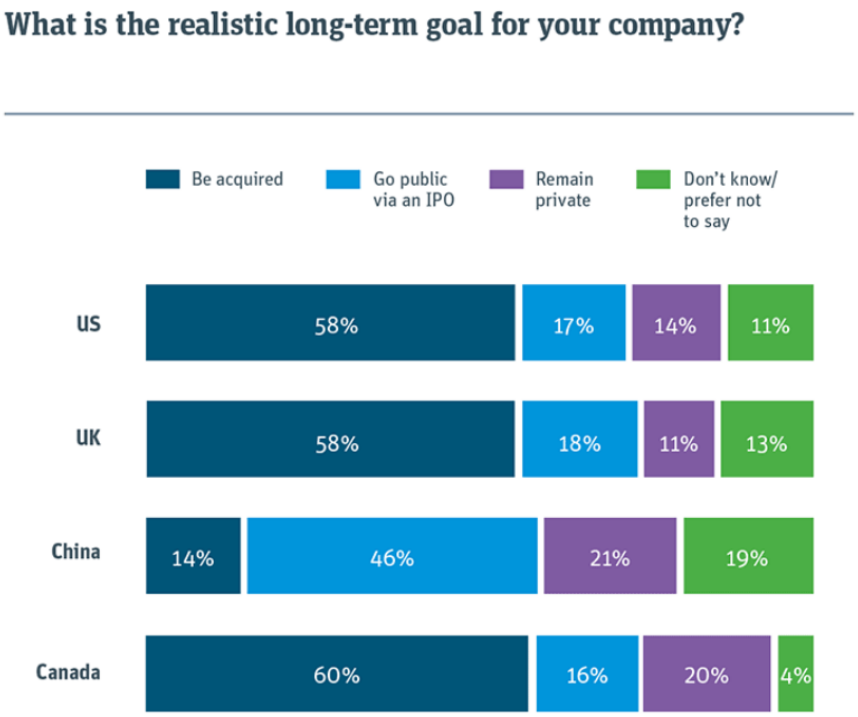


Fig. XI b. Long-Term Goals for Startup Companies 2020 Source: US Startup Outlook

Without that being the rule, but if we take under consideration how easy the big technology companies, acquire start-ups each year, as a means of growth strategy, then we can safely say that this could be a usual tactic.

A typical example is Facebook, which has so far made about 91 acquisitions of smaller companies, without lacking however the in-house development that got them so far in the first place.

As a matter of fact, and according to the US Startup Outlook, many startup entrepreneurs (ninety per cent of asked), believe that in the coming years there will be an increasing trend of M&As (mergers and acquisitions) arguing that with plentiful capital available, many corporations, private equity funds and scaling companies have the resources to make acquisitions (Figure XII).

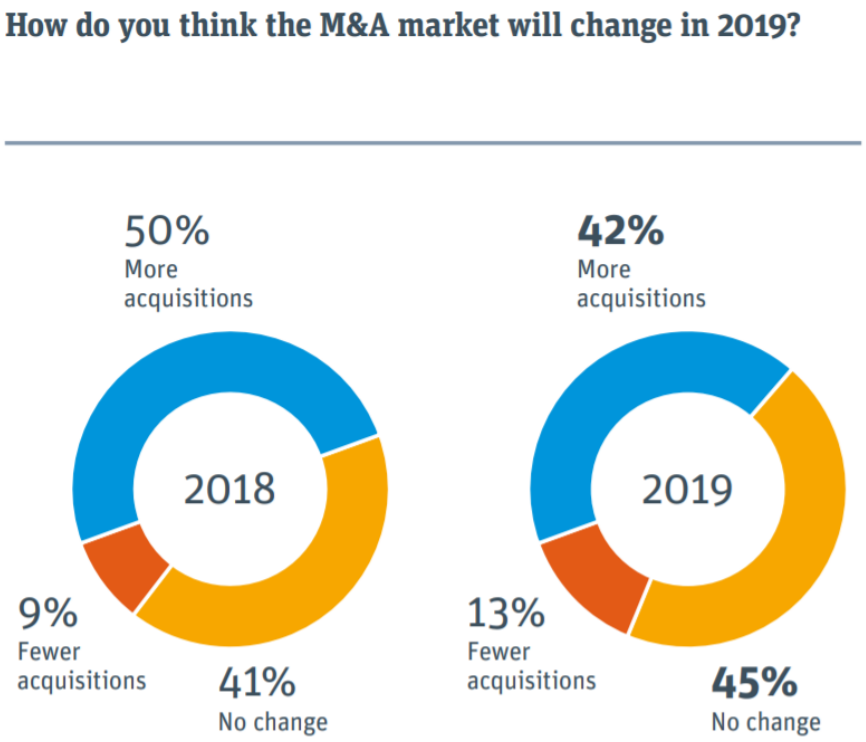


Fig. XII M&A market change for Startups in 2019 Source: US Startup Outlook

7.2 Comparison between the two tactics.

There has not been a clear picture of who does what, meaning that businesses and organizations don't just follow one strategy in favor of the other. Neither there is a worldwide rule which claims that startups are obliged to have an in-house development (although most of them are bound to do so) if they want to succeed, nor do the incumbents merge and acquire simply because their assets and flows allows them to.

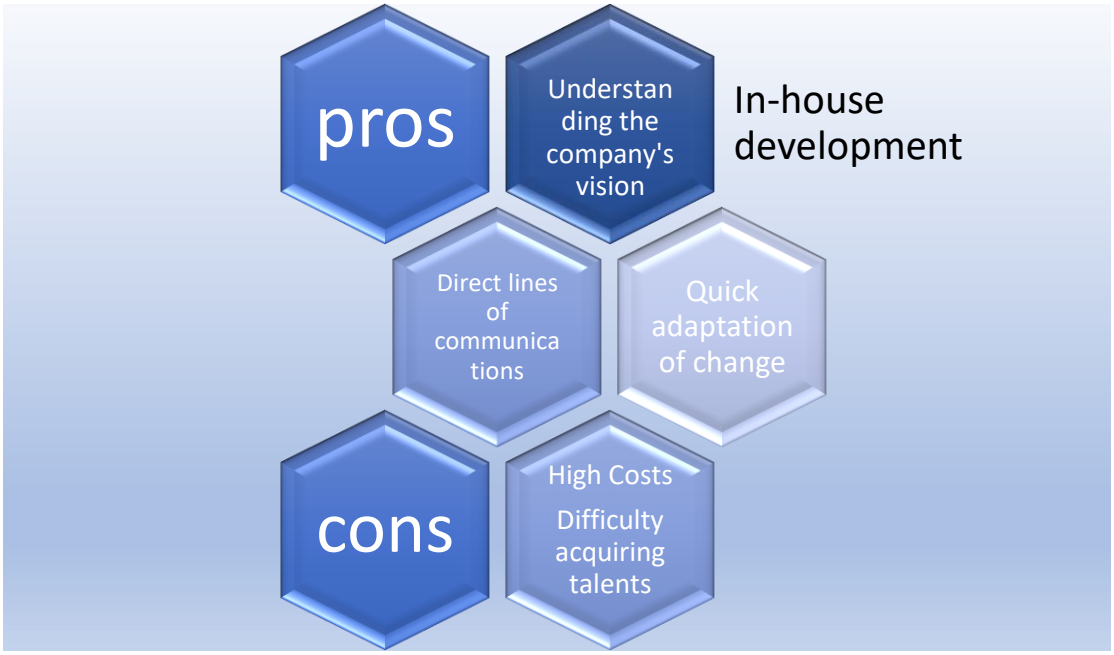


Figure XIII: In house Development

Figure XIV: Acquisition

As we can see in the figures above there are advantages and disadvantages in both strategies, hence whether one company will follow one strategy over the other, is a

choice made under many factors in consideration. It is no secret that most organizations as we will see, according to their short term or long-term targets, may follow one strategy at one time and then the other strategy at another time .

7.3 Organizations and their Strategies.

Big global organizations such as Apple, and especially after 1997's Jobs comeback, in house development was their main strategy without however excluding acquisitions that would help Apple strengthen its position in the global market.

An in-house development is preferable when one company wants to stay faithful to its vision and wants to have clear lines of communication among their people and that's what Steve Jobs wanted for his company. Moreover, any changes within the organizations, are easier to implement when people are already there, and they know their environment well.

Face-to-face communication is always going to be an advantage within companies because it ensures transparency and immediate feedback, since the team can be contacted any time.

However, another question that rises, is what happens when one department has finished their task, like for instance developers. The company will still have to pay employees, for a job that has already been completed and paid. Another issue that comes up, is that of massive changes in technology and software that could probably endanger the company to fall back on the current developments. If the company wants to have an up to dated in house team, or teams, then they must continually update and

perfect their knowledge and skills. These training opportunities represent a sound investment of time, money, and effort.

Acquisitions on the other hand have their own good and bad side, but the story tells us that the future will have plenty of them as a strategic tool, for many organizations.

Usually, an acquisition will take place when one organization wants to enter a new market and they need to reduce the obstacles of entry. By doing so, they manage to eliminate the entry barriers and the acquired resources become immediately usable.

Another advantage is that the company avoids the costs of proposing new services or products to the new market.

7.4 Cases II.

A good example is the acquisition of Chipita Global company by Mondelēz International (Source: Protagon.gr), where the former was the largest bakery producers in Central and Eastern Europe, with revenues reaching $ 580 million in 2020. Nearly 2 billion consumers in 56 countries around the world enjoy the company's packaged snacks. That strategic move by Mondelēz was made to enhance Mondelēz International's access to Europe and the Middle East, where Chipita has a strong presence.

Another global organization that uses both in house development and acquisitions strategies is Pay Pal. Although PayPal is well known for its in-house development (along with Amazon),

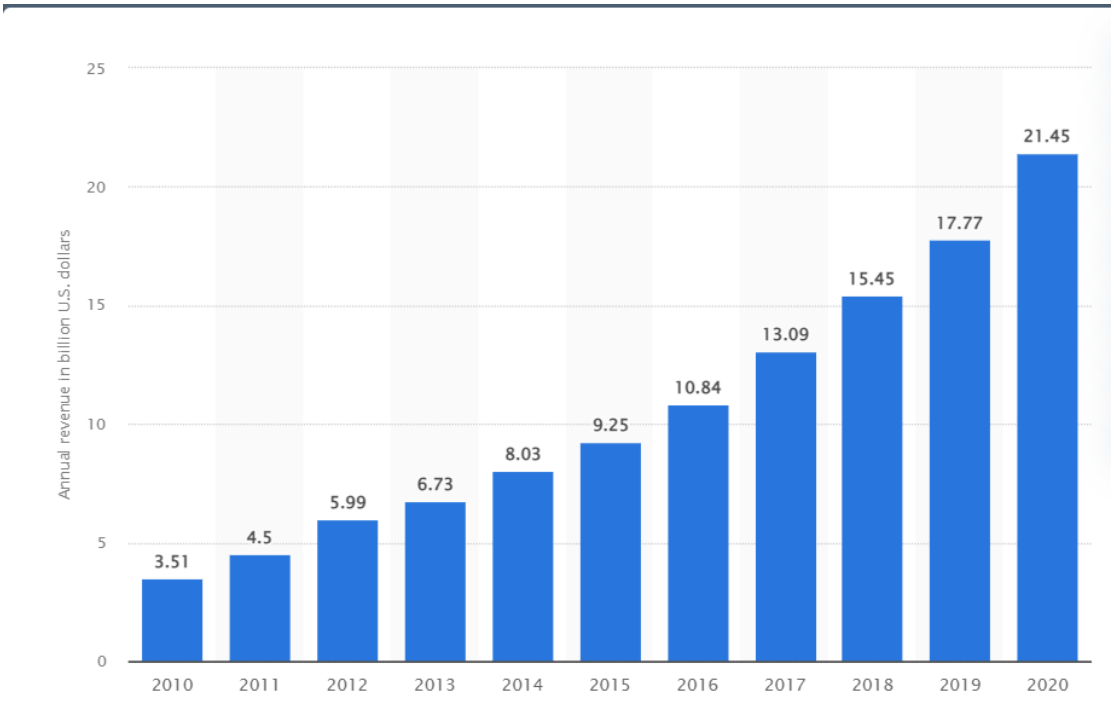


Fig. XV: PayPal's Annual Revenues from 2010-2020 (in billion U.S. dollars) Source: Statista

its acquisitions throughout the years, of smaller companies or startups were an important part of its strategy. At the beginning of the company's growth and before 2002, PayPal was a startup that couldn't go unnoticed with its unique at that time content of services and its promising future. This was the reason why its main opponent eBay a larger and well know company rushed and bought the smaller startup company for US$1.5 billion, as it realized PayPal was squeezing out its own in-house payment option (https://www.euromonitor.com/article/the-four-aspects-of-paypals-current-growth-strategy). By 2010 PayPal had reached more than 150million active users in more than 200 countries worldwide and four years later PayPal became independent of eBay as part of a strategic plan that would have given the company more flexibility and efficiency in its decisions.

In figure XV numbers speak out, as the percentage rate between 2010 and 2014 reveal an increase of growth at 128.7%, whereas after the company's change of administration and ownership status, growth rates were launched at a rate of 167.1%. Throughout the years, this company has showed the business world, that only when you adjust to the economic and market circumstances one can survive. PayPal did exactly that, by always having in house development as part of its strategy, while simultaneously have an open eye for anything new that could elevate and expand the organization.

Its mission statement is very clear, "Our fundamental commitment is to put our customers at the center of what we do. We must be bold and innovative and perfectly execute our immediate goals, with our eyes always on the future." Which implies an impeccable customer service on the one side and on the other side innovation, agility, and highly digitalized products.

According to emarketer.com (https://www.emarketer.com/content/look-back-paypal-2021-and-prediction-right) only in 2021 the company proceeded in four important and multimillion worth, acquisitions by purchasing smaller startups (Curv, Chargehound, Happy Returns and Paidy) and mainly focusing on the cryptocurrencies market (crypto transfer and storage startup Curv). But this was not the only year for PayPal of acquiring companies, since its long history of acquisitions go back since its first days of existence, where the company wanted to be a step ahead of everyone and have major comparative advantages in the market of cashless and secure payments. From 2002 to 2020 PayPal has made at least ten major acquisitions of smaller or start-up companies around the world, moves that have either allowed it to gain a significant comparative advantage in the market (2020 acquisition of Honey browser extension), or to strengthen the core of its services. For example, back in

2008, PayPal acquired the newly formed Israeli security company Fraud Sciences for $ 169 million. Fraud Sciences specialized in e-fraud detection as it developed technology designed to distinguish between real and fraudulent transactions. This technology integrated into PayPal technology systems, thus providing greater security to users who exchange money through online systems.

Other acquisitions would take place, to penetrate new markets (e.g., Europe through iZettle enhancing presence in physical stores through digital marketing), or obtain new customer data base, when in 2013, PayPal acquired Iron Pearl after looking for new sources of customers, in addition to the 123 million customers it already had. Iron Pearl was a software that helped businesses grow using growth forecasting models. This newly established company had the innovative tools, methodology and intellectual property needed for the analysis of social and cultural data resulting in the digital spread of products, combined with the analysis, and forecasting of data, and it was exactly what PayPal needed to establish its position furthermore, with less costs than trying to build similar software on its own.

7.5 The Verdict.

In conclusion, what PayPal and other major organizations like Facebook that obtained more than 90 smaller startups, tells us, is that there is no comparison of the two strategies per se. When an organization wants to stay strictly focused on the vision and the statement of mission, its easier to implement it through the existing executives. An inhouse development is more direct and companies get to train their teams from the ground up, making sure they know exactly how to use the tools at their disposal to develop in accordance with the company's philosophy. Its one thing

to hand pick the executives from the people within the organization, people they already know and worked with, and another to suddenly have executives from another company with different philosophy and state of mind.

However, when it comes to going further, and be more competitive, companies can't just ignore the changes and the overall business environment that grows around them. Most of the incumbents and the most successful organizations survived and remained competitive, by obtaining new weapons in their quiver, that came in the form of startups. The examples of such strategies are countless, and this is something that has been going on for ages now. Organizations that failed to accept the importance of acquisitions and the fact that it is a "necessary evil" for competitiveness in a business world that is changing day by day, stand a good chance of jeopardizing the overall viability of their business.

CHAPTER EIGHT
CONCLUSIONS

8.1 Conclusions.

The present diploma study analyzed three major axes concerning modern entrepreneurship.

Business and the way people must move within them, more or less simulate a human organism. There is a continuous evolution as well as a direct interaction with the environment.

Thus, companies, whether in the case of large organizations or in the case of new entrants, exist in the same environment and inevitably developments should concern both.

From classic economics to industry 4.0, there was a long way of ups and downs, for global economy, countries, people, industries, businesses, and technology. Each and every one of them contributing in what we now know as contemporary entrepreneurship and what the future of it holds.

One of the main ingredients of those changes, was the development of digitalization that was acknowledged as an indisputable force of entrepreneurship and the overall innovation. Digital technology brought along many new forms of businesses, platforms, applications, and strategies.

The future of modern entrepreneurship is in the hands of technology and its applications such as AI, Big Data, IoT, Clouds, and now DT. Technology now becomes an asset for the businesses, especially for the industry 4.0 which now implements the Digital Twinning technologies.

Although there are many ethical dilemmas that mainly surround the applications of digital twins, we must acknowledge that in every development there is always the good side along with the bad side. The point is to carefully draw the limits on its good side and to always take advantage of it for the benefit of societies since the whole of economics is a purely human-centered science. For the implementation of DT as we observed in the thesis, the sky seems to be the limit, especially when the future trends of this type of technology involves the AI element as a collaborative tool.

We defined the DT as precise as possible, as the virtual representation of a physical asset enabled through data and simulators for real-time prediction, optimization,

monitoring, controlling, and improved decision making (Rasheed et.al., 2020) and through that we described the advantages it offers within its implementations in industry, healthcare, and businesses in general. And although some might say that due to the costs it involves for a proper use, it is a privilege of big organizations, still as a technological breakthrough it could be used in most business models to help take entrepreneurship one step further.

On the other hand, the challenge of implementing such an innovative tool as the DT could be a risk even for established firms, that now struggle to keep up with the economic turmoil, and more, the continuous appearance of new smaller entrants that are technologically advanced, more flexible, and sometimes many steps ahead of them in terms of agility.

Big firms cannot remain indifferent towards the appearance of startups, or startups cannot stop from emerging in an economy that goes hand in hand with technology. So, that rises another issue going from the implementation of terrific tools such as DT, to observing and sometimes copying the newcomers which as their dominant element they have the use of new technologies, new applications and they are generally characterized by innovation.

So, what the organizations do? Do they watch and copy the newcomers by using their own executives, or they make the difference and acquire the new business directly, thus saving valuable time, gaining the comparative advantage either by entering a market directly or by acquiring ready-made technology? The history of many cases tells us that no one has used one over the other, and the most successful firms have used both depending on the time and what they wanted to achieve with a slight lead, due to technology, in the acquisition strategy.

The future is set to be quite interesting in entrepreneurship and business tactics, as long as it involves on one side the amazing applications like the digital twinning, or on the other side, where newcomers set the bar higher each time in accepting the tech challenges, and how they also accept the fact that by entering the kill zone of entrepreneurship they could be taken down either by being copied by an incumbent or by being acquired. Either case, none of the beforementioned could be characterized as a worst-case scenario, but indeed, it is how the business world really works and evolves through the decades, as it resembles the nature and its laws of survival.

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