Ca' Foscari
University
of Venice

Master's Degree Program

Languages, Economics and
Institutions of Asia and North Africa
(Ordinamento ex D.M 270/2004)

Final Thesis

The Fourth Industrial Revolution

Industry 4.0 & Made in China 2025

Supervisor
Ch. Prof. Andrea Pontiggia

Assistant supervisor
Ch. Prof. Adriano Boaretto

Graduand
Michele Lari
Matriculation Number 865818

Academic Year
2017 / 2018

ACKNOLEDGMENTS

Starting from the academic and working institutions, I would like to thank my thesis supervisor Prof. Andrea Pontiggia, who had followed me in this research and in the development of this study, helping and guiding me during this months. Also, I like to thank Gianni Casadei and Marco Rampichini, respectively SCM China Group Manager, and SCM Group APEC Manager, who introduced me in the study of Industry 4.0, and gave me the possibility to spend three months traveling China and living some very useful experiences.

I would like to thank all the professors that I met during these years, who carefully helped me in this crucial period of my life, and gave me some essential suggestions, that I will always keep in my mind.

Moreover, I must manifest my deep gratitude to my parents, brothers, aunts, uncles, grandparents and girlfriend for providing me with great assistance and encouragement during my years of study, offering me the necessary tranquillity and serenity, and helping me in the process of researching and drafting of this thesis.

Lastly, I would like to extend my gratitude to all the friends that are present in my life, to all those people who have always supported me, and who have never moved away from me, both in happy and hard days.

This result would not have been possible without them.

TABLE OF CONTENT

前言

我论文的题目是《第四次工业革命：工业4.0和中国制造2025》。之所以我选择分析这个题目：第一个原因是因为我为了SCM GROUP公司(一家意大利公司) 在深圳工作了三个月了。因为这家公司开始对于工业4.0进行一个深入的市场研究，他们派我到中国呆了一段时间，让我有机会参观一些中国工厂，了解更多关于这一论点的内容。这是第一次我研究这个问题。

我之所以选择分析这一论点的第二个原因是，创新一直在一个国家的经济发展中发挥着重要作用，在世界范围内更是如此。世界不断面临着许多变化。从它诞生至今，许多创新都有助于改变人们的生活和行为方式（在某些情况下是为了改善），在对生活的期望中产生进步，并创造新的商业前景。过去的两百年是人类最关键的时期，因为在那些年里，所有至今仍在使用的最有意义的成果都被发现了。

技术的发展和发现以及它们的加速实施，在竞争环境中有着核心的利益，因为当今世界所证明的技术创新的速度和范围，使得人类正处于一场新的工业革命的边缘，而这场革命将使人类面临一场新的工业革命。为了应对当前和未来市场的动态变化，研究人员和当局已经开始为正在兴起的工业模式制定新的定义。

这就是为什么工业4.0被认为是当前最重要的主题之一的原因。在过去的几年里，许多研究已经完成，以定义所涉及的技术，工业4.0对公司处理其价值链的方式所要求的变化。由于涉及到许多混乱和问题，并且与工业4.0的概念相结合，因此通常认为有必要进行更深入的分析，以便更好地了解工业4.0是什么，最重要的是，与这些技术方面直接相关的公司如何能够实施这些发展以及取得什么成果。
为了实现这一学术论文，最重要的方面是，世界各国政府正越来越多地处理这一问题，试图定义一些指导方针，或在某些情况下帮助企业实施工业4.0相关技术。机构、政府和私营部门在实施工业4.0过程中发挥了微妙和重要的作用。简言之，社会在成为工业4.0长期效益创造过程的一部分中起着至关重要的作用。

本研究将描述工业4.0对全球框架的影响，分析有关这一概念的主要参考文献和研究，并试图对工业4.0是什么以及它将如何影响世界环境提供更精确的定义。本文的核心将是在世界上两个最工业化和最重要的国家：德国（工业4.0的母国）和中国（几年前发布了其庞大的总体规划，中国制造2025）发表这一关键理论。

研究将分为三个部分，每一部分都对主题给予更深入的关注，从论证的定义开始，到实现德国工业4.0计划与中国制造2025的一项比较研究。

第一章将提供一些关于工业4.0发展和最有价值特点的基本知识和信息。这一概念将从一个历史概述开始定义，该概述将解释本导言开始时提出的世界经济的发展，然后从理论和管理的角度对这一理论进行定义。在此之后，我们将集中描述公司内部改进发展所需的采用路径，评估此类实施可能带来的最重要优势，以及公司开发这种新模式所面临的挑战。在评估了所有这些特性之后，本节将不仅描述工业4.0引入的各种技术因素和颠覆性技术，还将介绍企业必须遵循的创新路径，以发现更好的创造价值的方法。

本文的第二部分将重点研究中国“中国制造2025”政府项目。从对中国当前经济形势的简要介绍开始，重点将稳步转向中国未来几年计划面临的主要主题和转型。《中国制造2025》（MIC 2025）是中国雄心勃勃的计划的表达，即通过实施创新制造技术，创造全球最发达和最具竞争力的经济体之一。中国的工业总体规划希望在未来几年将中国转变为制造业超级大国。这一产业战略将挑战当前国际公司的经济体的领导地位。受德国工业4.0模式的启发，智能制造技术的推广是战略的基石。由于中国制造业最原始的工业流程升级，中国政府强烈希望提高其企业在国内的竞争力，并加强其全球扩张。

通过对原文的分析和部分相关作者的支持，我们将认真界定一个完整的框架，报告中国在未来应对的步骤、战略、重点领域和真正的变化。在可能的情况下，还将提供一系列示例，以提高整个总体规划的可靠性、实用性。

论文的第三部分将重点介绍德国工业4.0项目。我们将确定德国制造业的远景、战略、要求和计划，试着把重点放在项目最特殊的方面。该计划诞生于一个拥有世界上最先进制造业之一的国家，并被公认为制造设备行业的全球领导者。由于制造工程领域的竞争越来越激烈，并且由于一些国家开始采取措施通过先进制造业的发展来反对“工业化”，德国决定将自己选为这些概念理论化和应用的先行者。对于德国来说，工业4.0的发展将是一个渐进的过程。现代基础技术和经验需要根据制造工程的特殊需求进行调整，需要研究新地点和新市场的新的解决方案。这些目标的实现将使德国能够提高全球竞争力，保护本国制造业。

本研究将以中国制造2025和德国工业4.0计划的比较研究结束。
进行比较研究的目的是确定未来全球经济框架定义的主要差异（文化和战略）、相似性和下一步。要理解这两个项目的发展方向和实现最令人印象深刻的成果的计划，就必须确定这两个项目是如何采取不同的发展方式的，以及有哪些实质性的文化差异。
经过深入分析，我们划分了四大类，值得关注。这项工作的最后一部分，实际上将试图集中在以下方面的差异和相似之处；总体规划的目标和战略目标；战略实施；应用和结果。

最后，在结论中，我们总结了本文讨论的论点，提出了一些个人观点，并强调了最相关的方面。

INTRODUCTION

The world is continually facing a significant number of changes. Since its birth until now, many innovations have contributed to transforming (in some cases to improve) the way people use to live and to act, generating progress in the expectation of life and creating new business perspectives. The last two hundred years assume the role of the most critical period for humanity since all the most meaningful discoveries still used now were found out in those years.

Mainly, during the last decade the world's economy has been affected and altered by the increase in the population, the origin and the consequent extension of new markets, but most of all from the technological development and the acceleration in the implementation of discoveries and advancements. All these aspects have molded the structure of the manufacture. The last of these trends have a central interest in the competitive environment because the speed and range of the technological innovations that the world is nowadays testifying make indisputable that the humankind is on the brink of a new industrial revolution that will considerably modify the entire composition of the global economy. To deal with the dynamics that form the present and future market, researchers and authorities have begun producing new definitions for the rising industrial paradigm.

The most relevant and widespread of all is the so-called Industry 4.0. Industry 4.0 is considered one of the most important current topics. Nevertheless, no precise description of the term is presented by the traditional literature even if theories about its significance and value are still offered. Especially, shortening the most reliable of them, it is possible to define the new paradigm as a notion through whose implementation, businesses become able to produce, accumulate and provide new value through the exploitation of the technological progress delineating the present and future market. Industry 4.0 requires a series of severe changes in the way firms handle their value chain and drastic adjustments of the business operations and value propositions, because the fixed practices may no longer grant decent performances and returns in the long terms. An important aspect is that governments from all over

the world are increasingly dealing with this matter, trying to define some guidelines, or in some cases to help companies in the implementation of Industry 4.0 related technologies. Examining what affirmed above, it is possible to understand the object of this work.

This study will describe the effects of Industry 4.0 on the global framework, analyzing the main references and studies about this concept and trying to provide a more precise definition of what Industry 4.0 is and how it will influence the world environment. However, the core of this thesis will be the development of this critical theory in two of the most industrialized and important countries in the world: Germany (the home country of Industry 4.0) and China (which a few years ago just issued its vast masterplan, Made in China 2025). To do so, the research will be divided into three chapters, each of them providing a more in-depth focus on the theme, beginning from the definition of the argument and the points related to it to arrive at the realization of one comparative research between the German's Industry 4.0 program and Made in China 2025. It is necessary to remind that in order to make the reading more fluent, a series of data useful for the comprehension of the text will be presented, allowing the reader the opportunity to understand the whole research fully. To provide a better explanation of the thesis layout and to define better the reason behind this work and the problem that it tries to deal with, an analysis of the chapters structure will be provided hereafter.

The first chapter will provide some basic knowledge and information about the development and the most valuable characteristics of Industry 4.0. The concept will be illustrated starting from a historical overview that will explain the development of the world economy presented at the beginning of this introduction, and then a definition of the theory from a theoretical and managerial point of view. Follow the description of the path of adoption required for the development of the technical improvements inside the company, the evaluation of the most crucial advantages that could be derived from such implementation, and the challenges that companies have to face to exploit this new paradigm. After having assessed all these features, this

section will provide not only a description of the various technological factors and disruptive technologies introduced by Industry 4.0 but also the innovative path that firms have to follow to discover better ways to create value.

The second section of this thesis will focus on the Chinese "Made in China 2025" Governmental Program. Starting from a brief introduction on the Chinese current economic situation, the focus will steadily turn to the main themes and transformations that China has planned to face in the next years. Through the analysis of the original text and the support of some relevant authors, we will meticulously define a complete framework, reporting the steps, the strategies, the key areas, the real changes that China will deal with in the upcoming future. Where possible a series of examples will also be provided, for enhancing the reliability, the pragmatism and the solidity of the whole masterplan.

The first part of the third and the last chapter of the thesis will concentrate on the German's program. A study about the vision, the strategy, the requirements and the plans of German's manufacturing industry will be defined, trying to focus on the most particular aspects of the project. In the last part, the comparative research about Made in China 2025 and Germany's Industry 4.0 Program will be executed, attempting to highlight the main differences (cultural and strategical), the similarities and the next steps in the definition of the future global economic framework.

CHAPTER 1

DEFINITIONS, CHALLENGES AND CONTEXT OF INDUSTRY 4.0

"We are on the brink of the Fourth Industrial Revolution.
And this one will be unlike any other in human history"

Klaus Schwab

1. INDUSTRY 4.0

Over recent years a significant number of researchers and academics have been attracted by the expression Industry 4.0. Due to the novelty of the term and to the fact that a standard definition is not issued yet, the articles and the investigations over this topic are getting more and more.

Generally speaking, the Fourth Industrial Revolution (or Industry 4.0) is a definition used to explain the process that Innovative Companies or Governments have to apply and implement to enhance their industry evolution, and most of all for keeping their country, or their companies, abreast of the times. More specifically Industry 4.0 is characterized by the integration of disruptive technologies into production processes and plants, forcing the companies who want to implement these technologies to quickly move toward this direction, adjusting their structure, their mindset, and their departments to the new system and the new Industrial Era. The adaptation to the requirements and the demand of Industry 4.0 is surely not simple, because even if the topic is increasingly getting involved in researches and studies, a lot of confusion and a quite complete absence of a real and precise definition of the concept are making the process even more challenging.

Since a lot of chaos and problems assist and go together with the concept of Industry 4.0, it is commonly considered necessary to conduct more in-depth analysis to understand better what Industry 4.0 is and most of all how the companies directly concerned by these technological aspects can implement these developments and with what outcomes.

In the first section of this draft, a quick historical overview will pull the trigger for a deeper analysis of the New Industrial Revolution.

This first chapter will try to review and focus on the significant (and the most reliable) definitions of the concept, developing than some investigations on the requirements and the path of adoption that a company is suggested to apply to implement the new technologies involved in the fourth industrial revolution.

A review over the advantages, the reasons and the drivers of the new digital era will bring us to the following chapters of this work, in which we are going to focus on the development of Industry 4.0 all over the world, especially in Germany, where the concept was born and explored. We will explore than how the concept is evolving in China, where the government and the major firms are getting used to the idea of the implementation of Industry 4.0 for strengthening a "big but not strong" manufacture.

1.1.HISTORICAL OVERVIEW

To better understand the dynamics and the effect that the fourth industrial revolution has on the modern society, it's necessary to figure out what an industrial revolution is and examine which ones have influenced and changed most the world.

> *"The word revolution denotes abrupt and radical change. Revolutions have occurred throughout history when new technologies and novel way of perceiving the world trigger a profound change in economy systems and social structures".*

According to the definition given by Klaus Schwab (2017), nowadays we are living a period of profound changes and exciting challenges that can be considered as the beginning of a revolution that is transforming the way we live, work and relate each other. This is the reason why we can consider this era like a new industrial revolution, in which we are forced to understand how technologies are changing our lives and are reshaping the economic, social and human context in which we live.

For getting a broader comprehension of the Fourth Industrial Revolution is extremely important to have an overall picture, a general framework of the four industrial revolutions that the world has seen.

The first industrial revolution spanned from about 1760 to around 1840. Triggered by the construction of railroads and the invention of the steam engine, it ushered in mechanical production. Specifically, the implementation of the steam engine and the

corresponding new sources of power changed the functioning of plants, which made the production more manageable and cheaper (Schwab, 2017).

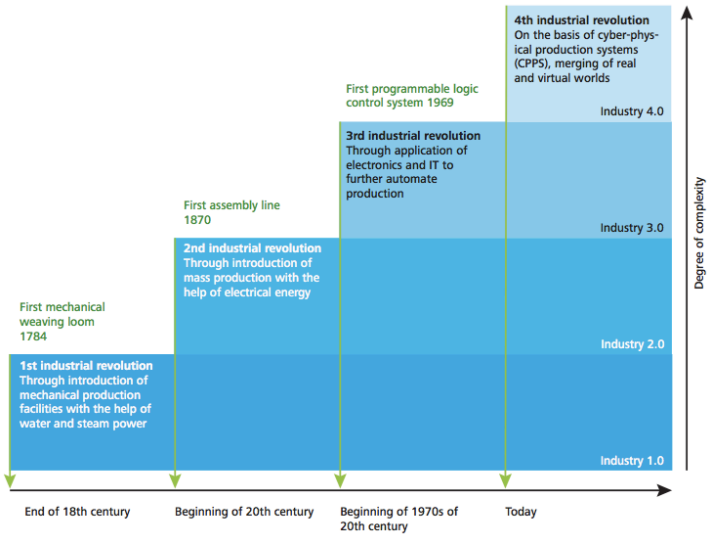


Figure 1.1 – the four stages of the industrial revolution (Deloitte, 2015)

The second industrial revolution, which started in the late 19th century and into the early 20th century, sees the introduction of electricity, handy power source used for the development of the assembly line. The development of these technologies also encouraged innovation in other sectors, like chemical products and extraction of petrol.

The third industrial revolution is the one considered responsible for the introduction of the computer, started in the 1960s, its called the computer or the digital revolution. The third industrial revolution played a critical role in the implementation of all the technologies that nowadays we are comfortable to use: semiconductors, mainframe computing, pc, and most of all internet, that brought to the development of industrial robots.

This revolution sees the use of electronics and IT for the automation of the production processes at levels never seen before (Schwab, 2017).

As we have already stated, digital technologies implemented with hardware, software, and networks are not new. The innovative aspect of the Fourth Industrial Revolution is

that nowadays these elements are getting more and more sophisticated and integrated. This is the reason why today we are facing the need to identify a Fourth Industrial Revolution: it began at the turn of the 21st century, thanks to the development of more powerful sensors, artificial intelligence, and machine learning process, which contributed to the birth of the Cyber-Physical Systems. It is fundamental to focus on the fact that these technologies are not new on the market, but that now constitute the core of the revolution.

A delicate and essential role in the implementation of Industry 4.0 is played by the institutions, the governments, and the private sectors. In a few words, society has a critical role in being part of this process to create the long-term benefits of Industry 4.0 (Kuruczleki et al., 2016; Schwab, 2017).

Besides, under the Fourth Industrial Revolution, even the way the companies are considered is different: before firms were seen as a transformation machine exploiting labor, but now they are a repository of competencies, knowledge, and creativity, acting as the site of innovation and learning (Kuruczleki et al., 2016).
To face all these transformations, a new picture which directs the diffusion of innovation is more than ever required. Also because the world lacks a narrative that outlines the opportunities and challenges of the Fourth Industrial Revolution, a definition of Industry 4.0 and it is characteristics will be analyzed in the next paragraphs, describing and studying how the new technologies will change the organization of global value chains, enabling smart factories and all their characteristics.

1.2.THE NEW INDUSTRIAL REVOLUTION

Industry 4.0, according to Hermann (2015) is one of the fastest growing research topics for both practitioners and academics (Hermann, Pentek, and Otto, 2015), but no definition has reached an overall consensus among them, generating comprehension issues of the topic itself (Åkeson, 2016, p. 9).

The term Industry 4.0 first appeared in Germany at Hannover Messe in 2011 when Professor Wolfgang Wahlster, Director and CEO of the German Research Center for Artificial Intelligence, addressed the opening ceremony audience. Industry 4.0 was introduced as the name of the strategic plan developed by the Federal Government for the high-tech manufacturing industry. From then on a lot of associations and institutions tried to give a clear definition of Industry 4.0 and to fix a reference model able to explain the concept of Industry 4.0, but the efforts were not able to produce a clear and unique description.

Nowadays, because this topic has increasingly arisen its importance and since even more and more researchers are focusing their analysis on this theme, every day several and different definitions related to Industry 4.0 are appearing, amplifying the level of ambiguity about it.

POOL OF DEFINITIONS

Choose which definition can be bright and proper to determine what we mean with Industry 4.0 is very hard because each of them is focused on some aspects, but no one completely defines it. This is why it is essential to refer to some of the most valuable definitions of Industry 4.0 for making the comprehension easier and more evident. The first definition ever made about Industry 4.0 is the one released by the German Government, in which Industry 4.0 was defined as follows:

> *"Industry 4.0 is best understood as a new level of organizational control over the entire value chain of the life cycle of products, it is geared towards increasingly individualised customer requirements. The basis of the fourth industrial revolution is the availability of all relevant information in real*

time by connecting all instances involved in the value chain." (Åkeson, 2016, p. 1).

Another reliable opinion is the one of the European Parlament (2016):

> *"Industry 4.0 describes the organisation of production processes based on technology and devices autonomously communicating with each other along the value chain: a model of the 'smart' factory of the future where computer-driven systems monitor physical processes, create a virtual copy of the physical world and make decentralised decisions based on self-organisation mechanisms." (Smit et al., 2016)*

Dr. Heiner Lasi and Dr. Hans-Georg Kemper give an interesting definition of Industry 4.0:

> *" The term "Industry 4.0" describes a future project that can be defined by two development directions. On the one hand there is a huge application-pull, which induces a remarkable need for changes due to changing operative framework conditions. Triggers for this are general social, economic, and political changes.*
> *On the other hand, there is an exceptional technology-push in industrial practice. This technology-push has already influenced daily routine in private areas. Buzzwords are Web 2.0, Apps, Smartphones, laptops, 3D-printers." (Lasi et al. 2014)*

In 2016, the Italian government tried to fix a more accessible definition of Industry 4.0, following the project and the plans the state was intended to follow for implementing it:

> *"Industry 4.0 identify the new business management paradigm aiming to cope with all the new opportunities and challenges provided by the lasts technologies, in particular, digitalisation and Internet of Things. "(SMACT competence center, 2016, p. 4)*

During the years several companies, in particular Advisory and Consulting groups, tried to give a more specific and managerial definition of Industry 4.0. As stated by IBM, whose explanation was reported by Deloitte (2017), industry 4.0 can be defined as:

> *"...the digitalization process of manufacturing industry concretized thanks to sensors inside the product, the tools used for the production, and the new supply chain organization based on the analysis of data generated by the above-stated sensors and the new activities that could be managed." (Deloitte, 2017, p. 4).*

While Deloitte itself gives two definitions of Industry 4.0 in two different years: the first in 2015, stated as follows:

> *"The term industry 4.0 refers to a further development stage in the organization and management of the entire value chain process required in manufacturing industry. Another term for this process is the "fourth industrial revolution"." (Deloitte, 2015, p. 5)*

The second one, in 2018 reported:

> *"Definitions for Industry 4.0 abound, but the change it portends at its core is the marriage of physical and digital technologies such as analytics, artificial intelligence, cognitive technologies and the internet of things (IoT). This marriage of the physical with the digital allows for the creation of a digital enterprise that is not only interconnected but also capable of more holistic, informed decision making. In a digital enterprise, data collected from physical systems are used to drive intelligent action back in the physical world. It is the possibilities arising from these feedback loops that generate abundant opportunities for new products and services, better ways to serve customers, new types of jobs and wholly new business models."(Deloitte, 2018, p 2)*

Maybe the most comprehensive definition is the one given by McKinsey in 2016, in which Industry 4.0 is defined as:

> *"Industry 4.0 is a confluence of disruptive digital technologies that are set to change the manufacturing sector beyond recognition: driven by the astonishing rise in data volumes, computational power, and connectivity; by the emergence of advanced analytics and business intelligence capabilities; by new forms of human-machine interaction, such as touch interfaces and augmented-reality systems; by improvements in the transfer of digital instructions to the physical world, such as in advanced robotics and 3-D printing." (McKinsey&Company, 2016, p. 2)*

Singularly these definitions cannot be considered as clear as the topic requires. However, taking advantage of them, it's possible to define Industry 4.0 as:

> *"The necessary process of digitalization of the manufacturing industry that will guide companies and societies to the evolution of a new and technologically advanced industrial model. This model would be obtained by the implementation of the nine technologies considered as the drivers of Industry 4.0, which will make the value chain attain a new and higher level of flexibility and collaboration."*

In a few words, Industry 4.0 will make use of the new disruptive technologies to create an alteration from the traditional manufacturing to a new pattern based on the digitalization of the production process.

INDUSTRY 4.0 PRECONDITIONS AND ENABLERS

The strength of the Fourth Industrial Revolution and the implementation of Industry 4.0 redefine the global situation, influencing the economic development and the lives of people, firms, and communities (Fabbrica Intelligente, 2015). The effects on them are relevant due to the fact that also if they do not constitute real drivers for the progress of Industry 4.0, they affect the economy, the consumption of goods and the correlations between economic agents, symbolizing the renewed environment that companies have to deal with. Following Fabbrica Intelligente (2015), they could be presented as follows:

- *Demographic changes*: represented by an increase in the global population, the average age, and the urbanization;
- *Globalization*: the increase of exportation and faster growth of the developing countries;
- *General resources shortage*: the shortage of petroleum and raw materials;
- *Climatic changes*: changes in every environment;
- *Technology*: increase of the technological advancement pace. (Fabbrica Intelligente, 2015)

The evaluation of these aspects is fundamental for a firm for having a transparent screen of how to implement the relative innovations and the rapidity that the company needs to allow such developments work. In a situation like the one stated, a change such the one illustrated by Industry 4.0 must require firms to shift from classical and traditional systems to completely renew their internal and external organization. In this process, one fundamental step is to evaluate and analyze the paramount requirements for doing so, considering the paramount requirements for developing into an Industry 4.0-ready company (KPMG, 2016). These preconditions are linked to the changes requested to alter from the current manufacturing situation to the implementation of a new reality. Doing this, several tools, also called enablers, are needed to make concrete the ecosystem digitalization permitted by Industry 4.0. These facilitators are mostly

associated with new and disruptive communication means that symbolize the roots upon which are build the innovations of tomorrow (MacDougall, 2013; Geissbauer, Vedso, and Schrauf, 2016). Information and Communication Technologies (ICT) are considered as the first driver of this digitalization process because they make possible to virtualize information and integrate systems along the overall production process, connecting all the stages and the outer environment with them (MacDougall, 2013). Thanks to ICT the concept of Networks become crucial; the new systems of interconnections will be ruled through network communications, allowing to link machine, products, systems, and people in a broad way that consider both the plants and the value chain (MacDougall, 2013). These communications systems make the manufacturing processes highly productive and integrated. Nevertheless, the two already cited technologies are just the most common enablers of the innovation process. In 2015 McKinsey did his best to define all the digitally disruptive technologies that could have a relevant influence in the next years, and that would function as a speed-up factor for Industry 4.0, identifying four clusters that can be observed in figure 1.2 below.clusters that can be observed in figure 1.2 below.

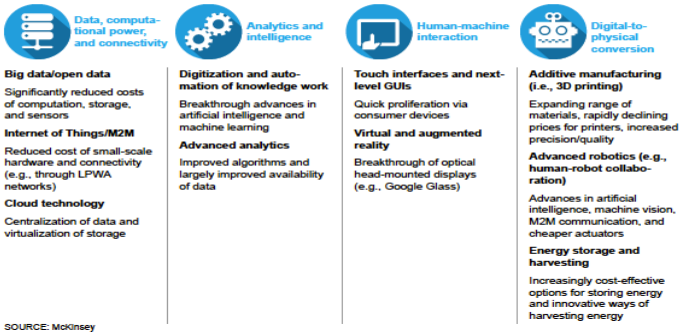


Figure 1.2 – Technology clusters (Wee et al., 2015, p. 11)

There are some technologies included in the clusters above that are not new on the market, but they are still present because they are at their tipping point to disrupt the manufacturing system (Wee et al., 2015). These clusters, classified regarding the impact they have on the market, can be described as follow:

1. *Data, computational power, and connectivity:* this group comprises Big Data, Internet of Things (IoT) and Cloud technology. In few words, this cluster includes all the technologies that permit efficient information storage,

transmission, and processing of data and information among all the actors of the supply chain. Their relevance is given by the cost reduction and the augmented capability of sensors and actuators to act as source and user of data.

2. *Analytics and intelligence*: the development of automation in the manufacturing procedures is considered in this cluster. The high degree of innovation achieved in the last years concerning artificial intelligence and learning capabilities of the machines give us the possibility to allow an extraordinary degree of digitalization and automation of the productive processes.

3. *Human-machine interaction*: year by year the obsessive use of personal devices has helped to achieve a great familiarity with customers about the interaction between human and machines. Due to this phenomena, technologies like touch interfaces, gesture recognition equipment and augmented reality devices that were already in use, are now combined to communicate with the machines making it more accessible for the industrial scenario.

4. *Digital-to-physical conversion:* the additive manufacturing combined with advanced robotics and new modes to handle energy are quickly developing. The implementation is becoming right thanks to the tools' cost precipitation, the expanding number and availability of technologically materials, and the extraordinary precision and quality of the technologies application.

For being more specific and following the study conducted by BCG in 2015, we can classify nine technological developments of Industry 4.0 displayed in figure 1.3 (BCG, 2015a).

From these enablers, the definition of the needs that firms have to deal with to create an authentic digitalized industrial sector can be determined. PWC (2016) indicated some elements that can be regarded as the bedrock of the implementation of industry 4.0 and its digitalization process:

Figure 1.3 - Industry 4.0's technological pillars (BCG, 2015)

1. V*ertical and horizontal value chain digitalization*: processes and data will be connected not just inside the company but also transversely all the levels forming the value-chain where the firm is placed and the related players. Due to that, data will evolve into a source of operational and decision-making management constantly accessible in real time.

2. P*roducts and service offering digitalization:* the digitalization of products and services will create growth of the actual portfolio and will generate new digital and integrated solutions. Besides, the high customizable degree of these new products and services will assure the chance to gratify clients needs more suitably.

3. *Digital business model and customer access:* firms have now the possibility to expand their offer with new digital solutions. To do so, they need to create processes of Business Model Innovation that can generate some benefits to disrupting digital business models that aspire to the creation, acquisition, and delivery of new digital value (Geissbauer, Vedso, and Schrauf, 2016).

In 2014 Capgemini Consulting developed one more exhaustive and detailed research related to this issue, finding other eight value drivers along four main pillars that define the essential features necessary to create value through Industry 4.0 (Consulting, 2014). These clusters constitute the aspects that are fundamental to exploit the potential of

Industry 4.0 fully. Here they will be just quickly listed because the outcomes of them and the integration with the other components presented before are more relevant than the clarification of any of them. Those groups are:

1. Smart Solution:
    - Smart Products
    - Smart Services
2. Smart Innovation:
    - Extended Innovation
    - Connected Lifecycle Innovation
3. Smart Supply-Chain:
    - Agile Collaborative Networks
    - Connected and Integrated Supply Chain
4. Smart Factory:
    - Decentralised Production Control
    - Data-driven Operational Excellence

The enablers, the nine pillars and the framework described in this section will guide us to the definition and implementation of new industrial and productive concepts acting as the final and proper base for the development of Industry 4.0.

The first of them is Cyber-Physical Systems (CPS). Wang in 2015 described CPS as deeply embedded computers and networks systems that can monitor and control the physical processes through feedback loops in which physical processes affect computation and vice versa (Davies, 2015; Åkeson, 2016). In these systems IT dominates, generating levels of autonomy from human intervention higher than in other systems. In this new virtual environment, the industrial analytics become essential, elaborating significant amount of data to obtain a better functioning of the processes and

better products development. In the realization of this process, remote access to operations and services would be required, generating a smooth and efficient system through the potential of the cloud (Università degli studi di Padova, 2016).

The second framework generated is Smart Factories. Also known as Intelligent Factory, the term refers to factories that can operate in every kind of industry and that distinguish themselves by extreme levels of technological advancement. These plants will be able to ensure customized production combining the possibilities offered by advanced solutions with design and higher functional performances (Fabbrica Intelligente, 2015b; Università degli studi di Padova, 2016). Those firms are also able to generate higher operational efficiency, optimizing processes and digitalizing the resources used, while, at the same time, maximize their presence in the market thanks to new products and predictive analysis of the market itself. All these advantages are fundamental to gain higher outcomes in an integrated value chain. To adopt this model and for obtaining all these benefits, an appropriate plan must be followed.

PATH OF IMPLEMENTATION

Companies that want to become the promoter of adoption of Industry 4.0 have to start a difficult road characterized by little changes over time that leads to the redesign of the whole firm and its core business (Geissbauer, Vedso, and Schrauf, 2016). For this reason, a proper path has to be designed to fix what steps have to done and how to deal with the problems and challenges that may come out.

Combining different sources and authors, in particular, PWC (2015) and Campgemini Consulting (2014), is possible to define a common roadmap, made of 6 steps, that can be used by those companies who wish to implement Industry 4.0.

Taking into account that this is a long, delicate and slow process, that has to create transformations that have to be incremental over time, derives that the fundamental feature for the implementation has no rush. Following this premise is possible to distinguish the essential stages:

1. *Digital maturity assessment:* fundamental starting point during which every firm has to evaluate the own level of digitalization, strength, and weakness.
2. *Environmental opportunities and threats:* refers to the evaluation of opportunities and risks related to the adoption of Industry 4.0, and the drafting and assumption that the competitive impact of this plan could have.
3. *Map the strategy and derive the roadmap:* trace a clear plan to follow considering how to conduct business in the future. Defining it and analyze the impact on the value-chain must be made to obtain proper insights. Done that is relevant define a complete path for the implementation of Industry 4.0.
4. *Delineate the needed capabilities:* create an understanding of the skills required to achieve the benefits ensured by Industry 4.0 completely. In this stage understand how to create these skills is fundamental.
5. *Evolve into a data saver:* implement all the devices, structures and systems to collect and analyze Data from the market. Thanks to this data new kind of decision-making processes and a comprehensive digital ecosystem where to connect value and stakeholders demands can be developed.
6. *Implement innovations:* implement changes and adjust the strategies over time to the new challenges and problems that may emerge. (Consulting, 2014; Geissbauer, Vedso and Schrauf, 2016)

BENEFITS

The roadmap designed in the last paragraph allows companies to achieve a series of advantages not just connected to manufacturing efficiency but also related to their market position and presence. Starting from the definition of the general benefits that could be achieved by a firm, Industry 4.0 tries to increase the level of production flexibility (BCG, 2016b; Ministero dello Sviluppo Economico, 2016). Due to the capacity to quickly reconfigure machines and devices and adapt them to different orders and conditions, producing small, but extremely customized, production batches,

promoting even higher innovation in the production lines, could become possible(Davies, 2015).

Adoption of Industry 4.0 will also improve Productivity. Thanks to the use of advanced analytics and predictive maintenance programs avoid downtime and breakdown, optimize the set-up times, and decrease the mistakes made by machines, increasing the production level of the production phases and also of the overall plant will become possible. (Davies, 2015; Ministero dello Sviluppo Economico, 2016).

Another relevant benefit derived by Industry 4.0 implementation is connected to quality. The digital and physical productions, because of sensors and other technologies enable companies to get real-time control over the processes, that will lead to significant improvements in terms of quality (Davies, 2015), decreasing the level of wastes, errors, and problems (Ministero dello Sviluppo Economico, 2016). It will also be possible to increase the quality of the goods exploiting the data acquired from the products to anticipate or solve production mistakes before the completion of the production process itself, enhancing the quality perceived and reducing the disappointment caused by faulty products.

Consequently, revenue increase is another critical advantage. This is true because companies that have decided to invest in new types of machinery able to deal with the new complexity of the market will be able to create products that can better fit the market, generating a rapid growth (Smit et al., 2016).

Fewer wastes and real-time availability of information about processes will make the costs level decrease. The expenses reduction will be achieved in all the sectors related to Industry 4.0, from the labor cost, decreased by the increased automation, to the logistic expenses, associated with a reduction of stocks and an optimization of the overall value-chain (BCG, 2016b; Geissbauer, Vedso, and Schrauf, 2016)

The competitive environment will be modified, increasing the competitiveness of the products thanks to new functionalities and services derived by the higher level of

technologies incorporated into them (Ministero dello Sviluppo Economico, 2016; SMACT competence center, 2016).

Last but not least, due to the new innovative solutions, the complete production process will be speeded up, so the speed is another relevant benefit given from the implementation of Industry 4.0. These new devices, processes, and machines will reduce the time to market of products and increase customers' reliance on the company. (BCG, 2016a).

From a practical point of view, Industry 4.0 will allow the development of various concrete and operative benefits. To have the possibility to exploit them at their best, companies must act immediately on the market to become the so-called "first mover", meaning that the first mover firms have higher possibilities to gain advanced digital capabilities, generating a competitive advantage not imitable that arise strong entry barriers (Geissbauer, Vedso and Schrauf, 2016). These advantages, are analyzed by Deloitte (2017) and can be listed as follows.

The first advantage is connected to the creation of an Integrated Production System that allows the firm to track all the assets and materials that are needed for the production of the goods. This tracking process is allowed by interconnected systems that enable devices and systems to intelligently communicate with each other, ensuring flexible decision-making processes that will lead to "zero-fault" systems (Deloitte, 2017). Due to the implementation of new technologies, the smart factory will be able to conform themselves to the markets alterations in a flexible way, replacing or expanding the modules that form the plant (Davies, 2015) to gain an improvement of the general performances from a technical and managerial point of view (Deloitte, 2017).

The integration of production systems can create even more advantages if supported by the interconnection of Information Technologies (IT) and Operation Technologies (OT). This interconnection will improve the development of a system that can track assets and materials such the previous, allowing the firm to keep sign also of products and their connection with the firm itself (Deloitte, 2017). This will be relevant for the development of data-integrated solutions able to provide all the possibilities offered by

Data and IoT, offering CPS that can make decisions on their own and produce through decentralization technologies. Because the opportunities granted by sensors and actuators, it will be possible to generate virtualization of the plant, connecting the production to virtual plants models and simulation models (Davies, 2015).

The implementation of Industry 4.0's technologies into products will give birth to an interconnection among all the products, and between the products and the factory which has produced them. These new products will have all the tools for the development, collection, sharing, and use of data, data that will be used to analyse quality, generating improvements not just on the product or services but also on the real-time adaptation achieved from the software and the control of the product's lifecycle (Deloitte, 2017).

Consequently, the exploiting of sensors and other tools will make it possible to get data that will be useful for real-time control of the systems. These products will be continuously monitored and diagnosed, giving the firms the possibility to develop remote control and assistance activities that will support the automation of services related to the product introducing proactive manufacturing processes (Deloitte, 2017).

Another operative advantage is originated from the integration of marketing and sales: through this connection derives customer's insights useful to preview in a more realistic way the future market possibilities and outcomes, having so the possibility to use them to develop new and improved sales opportunities, and to create new flexible pricing models (Deloitte, 2017).

The last benefit is related to the customers' connection, a link through which it will become possible to attain direct insights about the customers' products use and performances from the customer itself. Customers will also be able to self-solve problems related to the products because of the possibility to obtain remote help. The customization of products is another aspect that has to be taken into account analyzing this interconnection because customers will have the chance to customize the product according to their particular needs (Davies, 2015; Deloitte, 2017).

CHALLENGES

Even if advantages are a relevant topic when implementing a new production paradigm, more attention must be given to the challenges and risks concerned to its adoption. Industry 4.0 raises a series of complicated questions that need to be assessed and handled to complete its "perfect" implementation. Companies which would like to start a digitalization process, have to keep in mind that a transformation like this will require new know-how, skills, and organizational models that are not easily generable in a traditional manufacturing system (Deloitte, 2017). As stated above, a series of issues and challenges that companies have to deal with will appear; challenges that need to be managed to examine both the operations and the new general environment. These aspects will be promptly analyzed to get a broader focus on them.

The first and most crucial challenge connected to the implementation of Industry 4.0 is the one concerning Investments. Due to the fact that by this time the first movers are already developing this market, the companies that want to adopt Industry 4.0 have to think to ambitious investments plans, so, to reach the first-movers' level, firms have to make significant investments to generate above-average digital revenue (Geissbauer, Vedso and Schrauf, 2016). However, businesses have not to be demotivated from their amounts because this will be the only solution to keep the competitive advantage already achieved on the market (BCG, 2016b).

Data ownership and security is another critical test for companies. Due to the fact that the amount of data accumulated and shared is growing, firms must develop an appropriate system for the protection of data from cyber-attacks. For the realization of this system, companies have to grant the preservation of data not only from the ordinary risks but they also have to assure the confidentiality of data originated in a method that no one else, without specific authorization, could have access to them (Davies, 2015). Thanks to this, many rules are necessary to grant that privacy, data storage, and copyright of data are respected, equalizing trust of the network with the needs of protection. This condition will also originate some legal issue on the possibility to track customers because, with the use of data tracker products, the users will always be under

control, requiring another set of rules to state the extent of security and how the data could be used (Davies, 2015; Geissbauer, Vedso, and Schrauf, 2016).

The new nature of manufacturing itself will change the production to activities demanding elevated levels of capabilities; this is the reason why employment will become another critical challenge. Employees with low skills can be considered replaceable, while, on the other hand, specialized workers could find more suggestive levels of autonomy and more exciting works (Davies, 2015; Gilchrist, 2016). As correctly explained by Berger (2016), in this modern context, the improvement of new capabilities for the realization of new qualified tasks in a more flexible way is absolutely required (Berger, 2016); in this process the training and formation of the future Human Capital have to be modified from today, leading to the development of the cross-functional skills that will be requested in the future (BCG, 2015b; Kuruczleki et al., 2016). One important thing to remember is that the current human capital must be maintained, upskilling labor forces and providing specialized training (Kuruczleki et al., 2016).

To ensure the possibility to interconnect machines and exchange data between systems and software, standards are fundamental. These standards have to sustain the development of new communication infrastructure, otherwise, if the network would be entirely proprietary, the data and information sharing will be prevented, leading to higher levels of competition and costs for the companies involved (Davies, 2015; Berger, 2016b). That is the reason why a series of protocols, formats, and interfaces that can ensure inter-operability, inciting the implementation of Industry 4.0 technologies and ensuring the openness of the markets is requested (Davies, 2015).

Consequently to all these aspects, the implementation of Industry 4.0's concepts will arise some questions about the existing legal scenario. A proper legal framework adapted to this new context and helpful for firms in the development of the digitalization process must be determined by both European and National Institutions. This is a critical challenge for companies because without proper legal protection and activities aiming to stimulate interest on this topic, the plan itself will be useless and not

achievable taking into consideration the level of investment required (Smit et al., 2016). Furthermore, the invention of a protocol adapt to preserve the know-how and the data generated by the new industrial paradigm will be relevant because companies and government will invest to protect themselves from abuse and unlicensed access to data (Berger, 2016b; Smit et al., 2016).

Even the production focus will be altered creating not a few challenges. The change will be from a mass production system to a mass customization model identified by a flexible production with short time. This will modify the production, transforming large factories specialized per products, in smart plants with a high degree of technological equipment that would enable the production of goods at competitive costs in localized and flexible units (Berger, 2016b).

SUMMARIZING

The implementation of Industry 4.0 is a convoluted path that will invest all the aspects of companies that are trying to promote a more elevated level of competitiveness. This process ensures sustenance in the digitalization process, in the valorization of productive capability, in the achievement on a higher level of know-how, in the improvement of plants and procedures, and, generally, in all the investments necessary to fulfill the expected advantages.

It is important to keep in mind that this process will require time and a great effort from the top management to develop proper investments able to generate and retain a strong first movers' competitive advantage (Geissbauer, Vedso, and Schrauf, 2016). Besides, to shape the transformation, producers have to take decisive action to embrace the nine pillars of technological advancement (BCG, 2015a), recognizing the right way for the development of the strategy, but also an appropriate solution that fits with the strategy the company will try to develop.

1.3.THE DRIVERS

The next paragraph will provide a definition of the various technological innovations involved in the implementation of Industry 4.0 and will try to fix a path that companies could follow to disclose new value creation model. An analysis of the factors will be prosecuted to understand the relevant features of each technology better and to determine how a firm could introduce them into a real working environment. This study will allow the companies to reach information about the impact that each disruptive innovation has on the company, acquiring data that can be considered as a guide for the comprehension of the technological feasibility of Industry 4.0.

The transformation of the modern environment is supported by the discoveries and the birth of nine fundamental technologies. In this process of alteration, plants would become more advanced, introducing some technologies that can ensure production systems that twenty years ago weren't even imaginable.

> *"Industry 4.0 will make it possible to gather and analyse data across machines, enabling faster, more flexible, and more efficient processes to produce higher-quality goods and reduce costs. […] This in turn will increase in manufacturing productivity, shift economics, foster industrial growth and modify the profile of the workforce – ultimately changing the competitiveness of companies [..]" (BCG, 2015a, p. 4)*

This report drawn up by BCG is crucial because it embodies the results of the application of Industry 4.0, helping us to understand that the target can be achieved only with the implementation of these disruptive technologies. The relevance of this statement is increased by the knowledge of the company's environment and the topics associated with the adoption of such not easily usable technologies.

Following this brief introduction, a more intense focus on technological trends and their features must be done. The technologies will be deeply examined in the next paragraph, examining the general features, the effect on the firm's business model, finishing determining some practical examples for each of them.

An introduction describing what these technologies are and what they represent is fundamental. Mentioning the work of Klaus Schwab (The Fourth Industrial Revolution, 2016) and BCG (2015) it is now possible to introduce, giving a short description, the nine pillars as follow.

- Additive Manufacturing: also called 3D Printing, consists of creating a physical object by printing layer upon layer from a digital 3D drawing or model. 3D printing starts with loose material and then builds an object into a three-dimensional shape using a digital template.
- Advanced Robotics: also known as Advanced Manufacturing, is a system of cooperative robots, interconnected and easily programmable. Advances in sensors are enabling robots to understand and respond better to their environment and to engage in a broader variety of tasks.
- Augmented Reality: systems that, due to mobile tools or sensors, can add multimedia data to the reality perceived by humans. These systems will be more and more used by companies to provide workers with real-time information, improving decision making and work procedures.
- Cloud Computing: technology able to ensure informatic resources for the collection, storage, elaboration, and broadcast of data through online servers. Companies are already using cloud-based software, but with Industry 4.0, more production-related undertakings will require increased data sharing across sites and company boundaries. Meanwhile, the performance of cloud technologies will improve.
- Simulation: refers to several simulative systems used to simulate production processes, plants, and products through the analysis and elaboration of data obtained from sensors placed inside the same simulated object. In the engineering phase, 3-D simulations of products, materials, and production processes are already used, but in the future, simulations will be used more extensively in plant operations as well. These simulations will leverage real-time data to mirror the

physical world in a virtual model, which can include machines, products, and humans. This allows operators to test and optimize the machine settings for the next product in line in the virtual world before the physical changeover, thereby driving down machine setup times and increasing quality.

- Internet of Things: in its purest form it can be defined as a relationship between things (products, services, places) and people, that is made possible bu connected technologies and various platforms.
- Big Data & Analytics: defined as systems of technologies that ensure the proper processes of collection, organization, and analysis of a considerable amount of heterogeneous data. In an Industry 4.0 context, the collection and comprehensive evaluation of data from many different sources—production equipment and systems as well as an enterprise- and customer-management systems—will become standard to support real-time decision making.
- Cyber Security: technology used to permit the protection and the privacy, of assets, data and information from the network threats. With the increased connectivity and use of standard communications protocols that come with Industry 4.0, the need to protect critical industrial systems and manufacturing lines from cybersecurity threats increases dramatically. As a result, secure, reliable communications, as well as sophisticated identity and access management of machines and users, are essential.
- Vertical and Horizontal Integration: they are defined as those innovations used for the connection and integration of data along the value chain. These are the technologies that allow actors of the value chain to be connected. With Industry 4.0, companies, departments, functions, and capabilities will become much more cohesive, as cross-company, universal data-integration networks evolve and enable truly automated value chains.

- **Additive Manufacturing**

According to BCG's classification of technologies (BCG, 2015a), the first of the "disruptive" technologies proposed by Industry 4.0 is the Additive Manufacturing. Commonly known as 3D printing, it can be regarded as the creation of a three-dimensional item starting from its virtualised example (Consulting, 2014), using an approach that utilize the so-called "layer by layer" technique (Fabbrica Intelligente, 2015a) in which numerous stratum of materials, such as metal, powder, plastic or liquid, is added one over the other to achieve the final product (Deloitte, 2015). Additive manufacturing leads to the digitalization of productions, from the prototyping of the product to the realization of the real product (BCG, 2015a; Piller, Weller and Kleer, 2015; PwC, 2015a). This process can grant in one hand, the possibility to produce little batches of products strongly customized or even unique items (BCG, 2015a), while on the other, can give the companies the opportunity to get complex products through the assemblage of different components previously printed (PwC, 2015a).

The introduction of Additive Manufacturing is also relevant because it will affect many strategic choices. First of all it will lead to an essential change in the geographical production scheme, giving the chance to relocate manufacturing facilities from low wages countries such as India and China back to European Union, increasing the economic energy of the zone and decreasing the entry barrier costs for SME that try to enter this new reality (PwC, 2015a; Smit et al., 2016). 3D printers could be even used to bring the production close to the customer (Berger, 2014), reducing the size of the factories required and delivery facilities (Smit et al., 2016). The importance of Additive Manufacturing is, but there are very few companies that are already introducing this technology in their plants but, if they do not implement this technology in the next future, they will probably lose growth possibilities (Smit et al., 2016).

Examples: Two examples that can make better understanding the impact of Additive Manufacturing technologies inside the company follow:

- *Mykita*[1]: an illustration of how 3D printing could be used to customize the products, developing new ways of creation and management of the resources is the one adopted in 2015 by Mikita. The company during those years started manufacturing eyeglasses with 3D printers: the collection "My Very Own" through which due to the scan of the customers' faces everyone could obtain the actual data about the face conformation, and then the customer could choose the design of his new eyeglasses, was launched and had great results.
- *Luxottica*[2]: the leader in the market Luxottica in 2005 introduced 3D printers to optimize prototyping and production. Some years later it extended this solution over the entire production process to speed-up the production using the possibility to make prototype easily and quickly and simplifying it sending CAD files at the production department. It also granted more in-depth customization and consequently an increase in the customer's satisfaction.

• Advanced Robotics

Advanced Robotic concerns a series of different technologies, between which the most known and relevant are autonomous robots. In his book "*introduction to Ai robotics*" Murphy (2000) describes robots as:

"Mechanic creatures that can work in an autonomous way"
(Murphy,2000, p. 3);

He used three relevant terms in this definition: first of all the world creatures, intended to define Robots as systems able to take independent decisions; describing these creatures he used the term mechanic, this because he wanted to focus on the fact that these creatures are made by humans' work; finally he defined these mechanic creatures as autonomous, due to their intelligence. Always following Murphy's work we can qualify these technologies considering five aspects: senses, they can perceive the

[1] https://mykita.com/

[2] http://www.luxottica.com/

surrounding environment; mobility, because they have limbs and joints; they absolutely need a digitalized brain; they have to work through power sources, and they have to be able to intercommunicate not only between them but above all with humans (Murphy, 2000). Furthermore, Industry 4.0 has brought in the international context new robots that are becoming incredibly more autonomous, flexible and collaboratives (BCG, 2015a) using modern sensors and innovative software. , Even better, due to their capacity to interact with people (BCG, 2015), they are amazingly learning to study and to repeat action made by humans colleagues.

Due to the fact that nowadays robots are more and more involved in all the production process, all the aspects mentioned above necessarily have an influence on the productive structure possessed by the firms, particularly in the riskiest, intricated, and complicated activities, where they can act accurately, without feeling stress or fatigue as for the human counterpart (Bloem et al., 2014). Especially, computers and electronic systems, electrical items, means of transports and types of machinery are at the moment the industries where robots are most used, with an impact of automation of about 85% of the overall processes internally conducted (BCG, 2015).

An aspect that emphasizes the relevance of robots in modern manufacture, is the statistic about the number of robots actually used inside firms: according to BGC (2015), every year the exploitation of robots inside companies is continuously increasing of about 10%, and by the end of 2025 the number of robots used is expected to reach about 4 or 6 billion of units (BCG, 2015). In this context, the complication is about the trade-off between robots and humans; a trade-off that is not connected to the barriers arisen by the cost, but most of all to the legal system, to the policies at protection of the employee, and the cultural backroad of the country. Because of this, it is clear why nations with different protection systems and mindset, are experiencing different rates of adoption (BCG, 2015).

Examples: To better comprehend the impact of Advanced Robotics inside the firms, we can make two examples:

- *Amazon*: for the organization of its warehouses, the America electronic commerce, and cloud computing leader, in 2012 adopted Kiya Systems. This brought a reduction of time needed for the delivery of 70% compared with traditional systems. This because, while robots do these activities, humans can proceed to increase the performances of the system itself (Forum, 2015).
- *Alibaba*[3]: in 2018, a Chinese logistic firm majority-owned by Alibaba has opened a warehouse with over 700 robots working in it. The aim was to deal with the demand from Singles Day, the annual shopping festival run by the Chinese e-commerce giant. The robots that Cainiao (the company owned for 51% of shares by Alibaba) put in the warehouse can automatically pick up a parcel and deliver them to another part of the warehouse where it is then picked up by a delivery firm. This incredibly led to significant time savings.

• Augmented Reality

The third technology proposed by Industry 4.0 is the Augmented Reality. It can be defined as a system using mobile tools (like smartphones or virtual glasses) that allows adding multimedia information to the reality perceived by the human, ensuring the possibility to see, hear and manipulate the digital environment in which such data are contained (Peressotti, 2016). In the future, these technologies will be used to give access to real-time sharing of information, useful for improving manufacturing processes and decision making. This allows the users to reach digital information that could be added to the real situation in which the user is working, exploiting them for different purposes. For example, today Simulation is generally used for the 3D image of the virtual context through special eyeglasses, but other services are also available to provide a sound or tactile incentive. Even more, it can also be used to increase the efficiency of workers,

[3] https://www.cnbc.com/

augmenting the information sharing and making use of them to assist workers when a specific job is needed or training and giving remote assistance when an intervention is required.

Owing to touch interfaces it will become possible to promote also a new human-machine interaction that can be used to sustain systems based on Augmented Reality. These platforms can be used to help users, giving them pieces of information and directions (BCG, 2015), but also letting them supervise the production process concerning production, quality and logistic (McKinsey&Company, 2015).

Example: A specific example can be done to better comprehend the cited influence of Augmented Reality inside the companies.

- *Mitsubishi Electric*[4]: in sustainment of its maintenance processes, in 2016, it introduced a unique VR technology. The system introduced is based on a 3D model of plants, that ensure the technicians the possibility to check the production line through VR. This new technology assists them in decreasing the workload and reduce the number of mistakes that the user could do. The system could be used for a series of maintenance activities using a model derived by a scanning of the factory with cams that ensure exceptionally accurate virtualization of the plant itself.

• Cloud Computing

The fourth "disruptive" technology involved in Industry 4.0 is Cloud Computing . It embodies several informatics resources for the storage, elaboration, and transmission of data. It is one of the most crucial innovation, examining the vast quantity of data that moves on the web today. Due to the fact that this mass of data cannot be handled by traditional servers because the high computing capacity required to analyze and use this vast number of data (PwC, 2015b), a new technology that consists of an isolated server in which data can be stored, examined and handled to take advantage of the efficiency

[4] http://it.mitsubishielectric.com/it

of modern IT systems combined with the real-time accessibility of data is required. Cloud Computing needs to have two fundamental features: it needs to be a system provided with higher flexibility and responsiveness at market changes (Marston *et al.*, 2011). Cloud Computing is a technology more complicated than how it's imagined because exploiting all the new potentialities offered by its high capacities, and it will be possible to directly use, as a customer or for internal purposes, or as a provider to offer, three new groups of utilities through the web:

- IaaS (Infrastracture as a Service), through which furnish a virtualized computing hardware;
- PaaS (Platform as a Service), represented by a web platform for the development of software and applications;
- SaaS (Software-as-a-Service), to give new software in contrast to the payment of a subscription fee. (Marston *et al.*, 2011; Wang *et al.*, 2016).

Looking at the features of this new technology, it is possible to make a classification following the property of the system. We can define the Cloud as private, if it's handled by a private operator that needs to be able to ensure a great privacy and control for a single user, or use it internally (Marston et al., 2011; Gilchrist, 2016); on the other hand it can be defined as public, if the same infrastructure is provided and shared among various clients on a pay per use base or other payment systems (Marston et al., 2011; Gilchrist, 2016); finally we can define it hybrid, if it is a merge of the previous, where the non-relevant information are typically managed on a public base, while the most critical are fixed under a private controller (Marston et al., 2011; Gilchrist, 2016).

Example: Follows an example for better understanding the impact that Cloud Computing has on the companies:

- *Nova Chemicals*: to improve the planning and the processes, the Canadian chemical and plastic firm introduced Big Data and Cloud Computing. The implementation of these technologies also influenced the Human Resources department; therefore the access to informations become quickly, and allows the companies to have more and more specific information about what to do, how to

do and at what time This clearly brought to better coordination, to the decrease of downtime, a reduction of 47% of reaction time and an augment of 61% of predictive maintenance (Wee et al., 2015).

- **Simulation**

As BCG stated in 2015, simulation can be defined as the application of simulative systems to the production process, using data to create the physical world in a virtual reality environment (BCG, 2015). Briefly, using the data collected from the firm's environment simulation digitalize in a virtual domain the physical entities composing the company, such as machines, products, and people (BCG, 2015). The use of such technology assists businesses in the collection and elaboration of data in real time to examine and optimize processes performances and to control issues that could arise in the process before their actual manifestation (Peressotti, 2016).

It is possible to affirm that today simulation is mostly used in the first phases of the product manufacture, the development and configuration phases of a product, that can generally be considered as strategic steps commonly executed off-line in the traditional manufacturing approach. However, the importance that such systems are acquiring generates the potentiality that they could also be enlarged to activities more operational, increasing the level operations performed through online platforms (Kagermann, Helbig and Helbig, 2013; Fabbrica Intelligente, 2015a;). The virtualization of the plant is extremely relevant because it will make possible to simulate in Virtual Reality the operations, making the production process smoother and more efficient in terms of costs, time, and tasks required (Kagermann, Helbig and Helbig, 2013; BCG, 2016b;).

Example: The most relevant examples about Simulation could be made in the automotive industry:

- *Maserati*[5]*:* the introduction in his plants in Grugliasco of a new platform (Siemens' PLM Teamcenter), allowed Maserati to gain a complete digitalization

[5] http://www.maserati.it

of processes and a diminution of time to market without influencing the quality of the products.

- *Mercedes-Benz*: in this case the implementation of simulation technologies has allowed the company to generate virtual production lines founded on digital models, through which it can simulate the overall production process, controlling and handling the complication of brand new cars in a better way. This allows the firm to evaluate the technical feasibility of the production before the design of the real line. Furthermore, workers can use avatars for the analysis of processes and assembly activities (BCG, 2016b).

• Internet of Things

In 1999, the English entrepreneur Kevin Ashton fantasized a system where the physical environment could communicate and connect with computers through sensors. From this idea the development of IoT as known today began, creating an increment of adoption that brought to the actual situation where the number of sensors into the products is more significant than the people living in this world (Witkowski, 2017). Nowadays, Internet of Things is fundamental for the development of Industry 4.0, and it can be described as a network of physical systems composed of other technologies, such as sensors, actuators, communication module, and cooperative devices, that can operate collaboratively to gain results unachievable without their intelligence, software, and interconnectivity (Obitko and Jirkovský, 2015; Saurin, 2017). The interconnection, the most relevant feature of IoT systems, could be considered as multidirectional along the complete production line because it integrates processes with plants, machinery, and products to obtain a proper machine-to-machine communication that could work without human intervention (Bloem et al., 2014; Obitko and Jirkovský, 2015;). This communication system, thanks to wireless technologies and microelectronic tools, will lead to the development of Cyber-Physical Systems operating as the new frontier of plant automation and effectiveness (Bloem et al., 2014). Another important aspect is the digitalization of the Value Chain for all the companies involved (PwC, 2014), leading to

the development of structures where real-time data will be considered crucial for the development of updated products. This increased technological growth ensured by the IoT will increase in importance in the long run, making IoT itself a fundamental technology for every company. Following Cisco's thesis, by 2025 IoT will interconnect more than 45 billion devices (Bloem et al., 2014), generating an even more significant level of connection among the users and the surrounding environment that will bring to the creation of a new method of making business.

Example: An example can be made to better understand how IoT influences companies' strategy:

- *Cimbali*[6]: a leading firm in the coffee machine industry, had started a project for the development of "connected coffee machine" that, due to the use of sensors, will be able to provide improved post-sale services, to track the performances and ensure predictive maintenance services that can provide a constant level of quality over time. Owing to the sensors will also be possible to localize the machine, to accumulate information into the firm's platform, and to offer new significantly customized services. Last but not least, from the data analysis will become possible to set-up products that fit customers' demands better.

• Big Data & Analytics

The expression Big Data & Analytics refers to many tools, technologies, used to sustain the process of organization and collection of heterogeneous data that is not possible to be supported by traditional tools. This definition implies that this notion is not just connected to the quantity of data collected but also with the processing capabilities owned by the systems to provide real-time analysis of the same. Examining the last part of the concept, Big Data & Analytics tools can be considered in the field of technologies that are derived by unions of other innovative developments. Indeed, they are related to the alterations made in the way algorithm, and forecasting models act,

[6] http://www.cimbali.it

aiming to provide the increased potential required to manage the Big Data itself efficiently (Schmidt et al., 2015; Åkeson, 2016).

Considering the way Data are growing, and the evolved necessity to handle the tremendous and complex amount of data collected over time, nowadays the adoption of Big Data & Analytics solution could be considered as critical for companies operating in such context (Obitko and Jirkovský, 2015; Witkowski, 2017). Moreover, there are three different dimensions along which Data are changing and growing:

- Volumes, because of the ability of the products to continually develop useful data for the market;
- The speed of the data sharing on the market;
- Variety, due to the fact that data that derive from various sources and different users are heterogeneous for their nature.

All these aspects bring to a reinterpretation of the approaches taken by the companies till now about data collection, storage, and usage, requiring not only new means for the acquisition of data but also new and more intricate systems for their examination. (Obitko and Jirkovský, 2015; Witkowski, 2017).

Example: An example can be made to better understand the above-cited impact of Big Data & Analytics inside the firms.

- *DHL*: logistics and delivery giant, has introduced "Resilience360", a system intended to control the risk management along the value-chain (Witkowski, 2017). Because of data in addition to design a proper value chain for every customer will become possible also to increase its efficiency avoiding downtime and improving the customers' satisfaction. Thanks to the introduction of data, DHL has optimized the resources use, being able to constantly forecast process based on data extracted by warehouses and sensors, for the planning of the next 48h delivery (Jeske, Grüner and WeiB, 2013). This has even allowed the classification of the best clients and the explanation of strategies to best fit their

particular needs, creating an improvement of DHL's offering about product range and innovation (Jeske, Grüner and WeiB, 2013).

- **Cyber Security**

The enormous sharing of pieces of information via the web has consequently intensified the need for protection of production systems, networks, and data from possible threats (Peressotti, 2016). This is the reason why Cyber Security in a critical topic in Industry 4.0. To ensure the safety and the protection of the firms from dangers deriving from misuse of the informatics systems and the new technological context, the so-called Cyber-Physical Systems were developed. This causes the establishment of protection methods derived from the implementation of this new technology that could be referred to the privacy of data and the limitation of access at the same.

All these systems aim to grant the incorruptibility and obtainability of data in a safe environment (Kagermann, Helbig and Helbig, 2013), helping to avoid the possibility that damages coming from unauthorized users may take place (Smit et al., 2016).

The criticality of this topic derives from a broader examination of the cyber environment. In 2016, the level of digital attack was almost one million a day, creating huge costs for the firms (Smit et al., 2016). These complications are also related and change in accordance to the level of gravity depending on the company's size:

- Small firms are mostly exposed to internal risks derived by attacks created by employees inattention;
- Medium and large enterprises are generally affected by external attacks, as IP steal, phishing and pharming (Deloitte, 2016a).

Example: A clear example that can help to better understand the impact of Cyber Security inside the firms is the one concerning a modern firm:

- *Securonix*[7]: is a recently upgraded company with a focus on the resolution of security problems. It is involved in the application of innovative technologies aimed to detect, monitor, investigate and manage threats and risks connected to cybersecurity issues.

• Vertical and Horizontal Integration

With the expression Vertical and Horizontal Systemic Integration, a series of systems that ensure the integration of data and the coordination of processes along the overall value-chain are intended. Thanks to this interpretation, departments, and functions are meant as part an integrated system that connects all the firm operating into the same chain, and not more as a party of the firm(Ministero dello Sviluppo Economico, 2016; Peressotti, 2016). This unification becomes fundamental because Industry 4.0 depends on a higher level of combination to adequately manifest the potential obtained by the implementation of new technologies into the plants. In particular, three are the directions that the alliance can take after the introduction of new technologies and systems inside the same value-chain: horizontal, vertical and end to end (Mrugalska and Wyrwicka, 2017).

Horizontal one alludes to the formation of a network of players where all the actors are integrated with the aim to create higher value, and where all the different players act as commercial partners creating a new business model based on cooperation (Mrugalska and Wyrwicka, 2017).

Vertical integration, on the other hand, refers to the combination of distinct functions related to the same production cycle; tasks that are gathered together to develop an intelligent and efficient production process where the players could be different firms,

[7] https://www.securonix.com/

each one specialized in a particular stage of the process (Mrugalska and Wyrwicka, 2017).

End-to-end integration is connected with the concept of total integration. It refers to the development of collaborative networks where firms, departments, functions, and capacities become much more correlated, as a cross-company in which the universal data-integration interface is able to assure the truly automated value-chain (BCG, 2015; Mrugalska and Wyrwicka, 2017).

Briefly, the end-to-end integration is a concept that can be described even as a merging of the other two. It has to be regarded the final aim of Industry 4.0 because, as stated by Wang, the vertical integration brings to the development of the intelligent firm; a firm that can directly support the development of horizontal integration among different value networks and, consequently, a real end to end system (Wang et al., 2016).

Example: Follow a proper example of how Vertical and Horizontal Integration can modify and improve a firm's strategy:

- *Continental Tire*: has introduced a technological system for the integration of all the production processes because of the problems arose inside the production plant and into the whole supply chain. This ensures a better comprehension of the overall supply-chain and more significant control over all the real-time connected players (BCG, 2016b). In this way, Continental can increase customers' satisfaction, regarding the orders and their timing.

CHAPTER 2

MADE IN CHINA 2025

"打造具有国际竞争力的制造业，是我国提升综合国力、
保障国家安全、建设世界强国的必由之路"

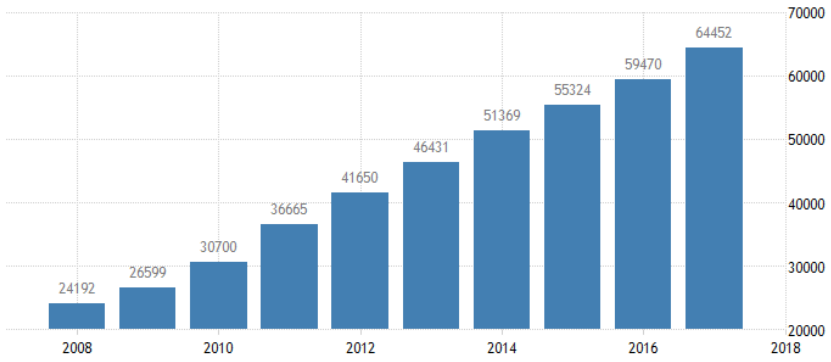
[Building an internationally competitive manufacturing industry is the only way to enhance China's comprehensive national strength, safeguard national security and build a world power.]

MIC, Made in China 2025

2. CURRENT SITUATION IN CHINA

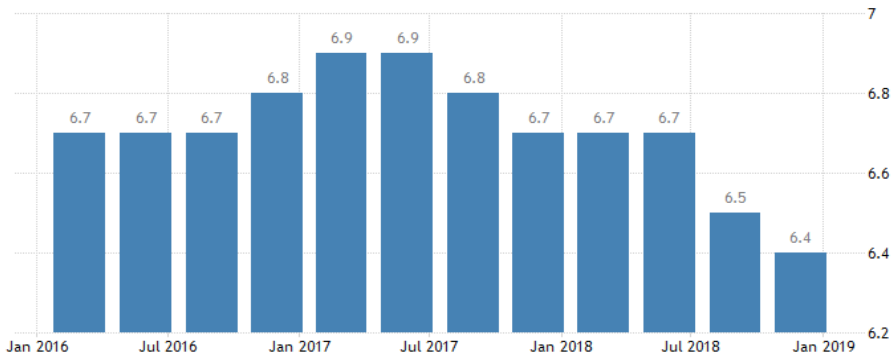
In the last years, China has shown annual growth rates usually double or triple that of developed market peers. This country has developed the most impressive economic growth of any other global economy for the past ten years. Their low wages, high investment rates, and an export-driven market has been a big part of this phenomenal growth.

However in recent years, China's economic growth has been slowing down, and countries such as Vietnam, Cambodia, and Indonesia are starting to offer a cheaper cost of labor. Since manufacturers start moving their production elsewhere, China is getting ready for hard days ahead.



2.1 China Average Yearly Wages in Manufacturing (TradingEconomics)

Although these considerations, as of now, China is still considered "the factory of the



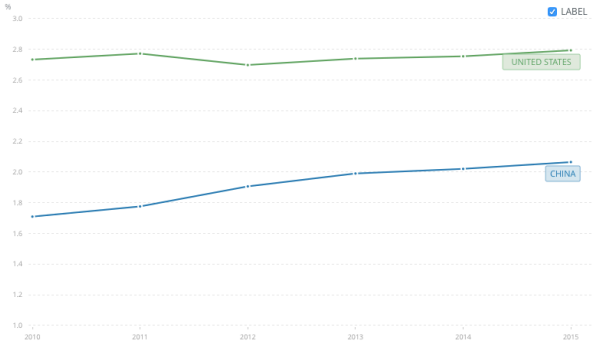
2.2 China GDP Annual Growth Rate (TradingEconomics)

world" accounting for about a third of the global total of the output value for equipment manufacturing (Lee, 2015).

It is fundamental to focus on two critical factors about China that are fundamental in the development of this country as a global power.

First of all, China is steadily increasing it is GDP spending on Research and Development percentage, which means that in the last years Chinese government, companies, and consumers are demanding for more advanced and innovative products.

According to the World Bank, R&D expenditures have been made on creative work to increase knowledge, including knowledge of the humanities, culture, and society, and the use of knowledge for new applications. R&D covers basic research, applied research, and innovative development. During the period 2010–2015, China increased its R&D expenditures far more than that of the United States. The proportion of R&D in China's GDP has been increasing steadily.



2.3 R&D Expenses 2010-2015 (World Bank Data)

	2002	2003	2004	2005	2006	2007	2008	Increase 2002–2008 (%)
China	630	667	712	856	931	1077	1199	90
US	4654	4911	4708	4633	4721	4673		0.4
Japan	4943	5170	5176	5385	5416	5409	5189	5
Germany	3225	3261	3274	3297	3390	3525	3667	14

2.4 Researchers in R&D (per million of people) (World Bank Data)

Patent applications can be defined as "applications filed through the Patent Cooperation Treaty procedure or with a national patent office for exclusive rights for an invention a product or process that provides a new way of doing something or offers a new

technical solution to a problem" (The World Bank Data).

In 2010, China showed the most significant number of patent applications in the world. Chinese residents filed 293,066 patent applications, an increase of 636% compared with 2002. In 2008, there were 1199 researchers per million people engaged in R&D in China, an increase of 90% in the period 2002 to 2008, representing the most massive change in this category.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	Increase 2002–2010 (%)
China	39,806	56,769	65,786	93,485	122,318	153,060	194,579	229,096	293,066	636
US	184,245	188,941	189,536	207,867	221,784	241,347	231,588	224,912	241,977	31
Japan	365,204	358,184	368,416	367,960	347,060	333,498	330,110	295,315	290,081	−21
Germany	47,598	47,818	48,448	48,367	48,012	47,853	49,240	47,859	47,047	−1

2.5 Patent Application 2002-2010 (resident) (World Bank Data)

In the Dynamic Years, the Chinese government made painstaking efforts to create an educated workforce hoping to contrast emerging and dynamic development problems in the world. This is another critical indicator: the fact that during 2002–2011, the number of four-year college graduates increased by 355%, and postgraduate graduates increased by 432%. In 2011, China produced 6080,000 four-year college graduates, which is the same number of the total labor force of Denmark and Norway combined (the World Bank Data).

Year	Graduate students	Returned study-abroad students
1985	17,004	1,424
1986	16,950	1,388
1987	27,603	1,605
1988	40,838	3,000
1989	37,232	1,753
1990	35,440	1,593
1991	32,537	2,069
1992	25,692	3,611
1993	28,214	5,128
1994	28,047	4,230
1995	31,877	5,750
1996	39,652	6,570
1997	46,539	7,130
1998	47,077	7,379
1999	54,670	7,748
2000	58,767	9,121
2001	67,809	12,243
2002	80,841	17,945
2003	111,091	20,152
2004	150,777	24,726
2005	189,728	34,987
2006	255,902	42,000
2007	311,839	44,000
2008	344,825	69,300
2009	371,273	108,300
2010	383,600	134,800
2011	429,994	186,200

2.6 Graduated Students and Returned Study-Abroad Students (National Bureau of Statistics of China 2011)

An important element for reading this statistic is that since the program of economic reform in 1978, many Chinese students and scholars have studied abroad. This group of

well-educated talent forms a unique category of human resource, which has been called "the returned study-abroad students". This group increased by 938% in the period 2002–2011 and equals the size of the total labor force of Iceland as of 2011.

These highly educated people who have enhanced economic and social reforms will continue to benefit China and the rest of the world. Investments in education in China are continuously increasing, and in addition to a formal college education, the Chinese government required business enterprises to direct a specific part of their revenues for education. CEOs, managers, shop floor supervisors, engineers, and technicians are rotated continuously to take part in short business courses in local universities and overseas business education programs to learn Western management systems, and the rules and strategies China need to compete in a global market. This growth reflects the result of a 2005 study done by Li (2005), in which she demonstrated that investments in advanced technology and human resource development are two new-found spheres of the Chinese manufacturing industry. The rate of R&D investment and the growth of an educated workforce support her hypothesis. When Paul Krugman, a Nobel Prize winner, was solicited to define America's economic success with one word, he chose the word "education" (Krugman, 2009). Education and the impact of education can be considered as a chief soft power virtue that will influence a nation's economic success and its manufacturing capability. Soft power development, which involves education, R&D investment, innovation, and human resources, has enabled China to grow in the past decade. Moreover, a low-cost and educated workforce paired with first-class innovation and engineering capacity helped China reinforcing her core competitiveness in the last years.

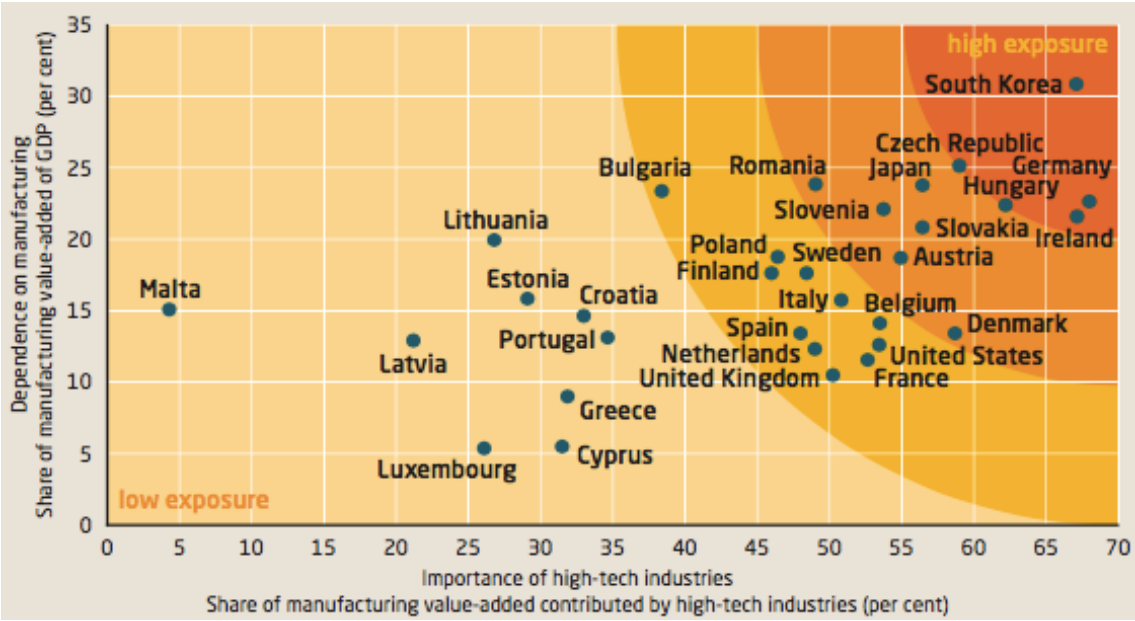
In a period in which competition from international competitor's increases, demand decreases, and economic growth slows down, the Made in China 2025 masterplan finally came out. With the significant changes defined in the strategy, involving the industry, the society, and the economic policies, experts expect China's GDP to grow by an average of 5.7% between the years 2017 to 2020, helping China to become the world's fastest growing economy.

2.1. INTRODUCTION TO MADE IN CHINA 2025

Made in China 2025 (MIC 2025) is the expression of China's ambitious plan to create, through the implementation of innovative manufacturing technologies, one of the globe's most developed and competitive economies.

China's industrial masterplan aspires to transform the country into a manufacturing superpower over the coming years. This industrial strategy will challenge the economic leadership of the current driving economies and international firms.

This massive masterplan virtually identifies and involves all high-tech industries that sincerely support the economic growth in evolved economies as aviation, machinery, automotive, robotics, high-tech maritime and railway equipment, energy-saving vehicles, medical devices, and information technology. As we can see from the following graphic countries in which these high-tech industries contribute a large share of economic growth are most affected to China's plans.



2.7 Effects of China's MIC 2025 on High Tech Industrial Countries (MERICS)

Inspired by the German paradigm of Industry 4.0, the promotion and the spreading of smart manufacturing technology is the cornerstone of the strategy.

Due to the upgrade of the most primitive industrial processes of China's manufacturing sector, the Chinese government strongly wishes to improve the competitive power of its

companies on domestic markets and to enhance their worldwide expansion.

The political pressure for industrial upgrading in China creates a considerable need for smart manufacturing goods alike automated robots, smart sensors, wireless sensor networks, and identification chips. Theoretically, the global economy has excellent reasons to embrace China's search for increased innovation capability, granted that China abides by the principles and regulations of open markets and fair competition. Therefore, if from a certain point of view it would seem that for many foreign enterprises, this can initially provide desirable business opportunities, because the transformation of China's manufacturing base requires advanced technologies that Chinese suppliers are not able to provide at their current technological level, and since China's industrial upgrading, in the short-term, can mean tremendous profits for international companies, like for example for China's economic partners in Europe and the United States, for which it could even open opportunities for a mutually beneficial deepening of economic, technological as well as political cooperation, on the other hand, Made in China 2025 in its form expresses precisely the opposite: China's leadership regularly intervenes in national markets so as to benefit and help the economic dominance of Chinese enterprises and so as to disadvantage foreign competitors. This is clear in smart manufacturing such as in many other high-tech industries implemented in the strategy. Essentially, Made in China 2025 aims for substitution: China seeks to replace foreign with Chinese technology at home gradually, and to prepare the ground for Chinese technology companies entering international markets.

Indications of this aim are everywhere in MIC 2025. For example, China intends to raise the internal market percentage of Chinese suppliers for "basic core components and important basic materials" will correspond to 70 percent by the year 2025.

Even more, some strategies set very concrete benchmarks for a specific category: 40 percent of mobiles chips on the Chinese market are assumed to be manufactured in China by 2025, as well as 70 percent of industrial robots and 80 percent of renewable energy equipment.

For the sake of achieving these goals, government entities at all levels redirect vast sums of money into China‘s industrial tomorrow.

The recently established Advanced Manufacturing Fund alone amounts to 20 billion CNY (2.7 billion EUR). The National Integrated Circuit Fund even received 139 billion CNY (19 billion EUR). These national capitals are complemented by a plethora of secondary provincial level investment means. The financial resources are immense contrasted to, for instance, the 200 million EUR of national funding that the German government has implemented for research on Industry 4.0 technologies so far (Wübbeke, Meissner, Conrad et al., 2016).

While Chinese high-tech enterprises experience massive state subsidy, their foreign opponents in China face a complete set of obstacles to market entrance and obstacles to their business activities: the closing of the market for information technology, the isolation from local subsidy plots, the low level of data security and the intense accumulation of digital data by the Chinese state. As China's smart manufacturing capabilities mature, it is clear that the Chinese state will further step up its discriminatory practices and restrictions of market access in the eld of smart manufacturing (Wübbeke, Meissner, Conrad, et al., 2016).

For the moment, however, these barriers are not already as fixed in smart manufacturing as in other segments such as the service sector and the aviation industry. MIC 2025 is in its early days, and there are still opportunities to adjust its path and goals.

An essential consideration for Europe is that if the administration in the United States implements the protectionist plan proclaimed in the whole election campaign, Europe's negotiation position will possibly change. Holding global trade and investment flows open will then become a fundamental common interest between Europe and China. Europe's economic significance for China will rise and vice-versa. Despite all current attritions, this mid-term change in the global economy will possibly open new roads for negotiating the conditions of Sino-European economic relationships, including in smart-manufacturing.

Made in China 2025 also presents an outward-looking dimension: the increasingly faster purchases of international high-tech companies by Chinese investors. To

accelerate China's technological catch-up and to skip steps of technological advancement, Chinese firms are gaining core technologies through investment overseas. In itself, this is not shocking nor unacceptable. However, China's technology acquisitions are partially sustained and managed by the state. China pursues an outbound industrial policy with government funds and highly enigmatic investor networks to simplify high-tech acquisitions abroad. This threatens the principles of fair competition: China's state-led economic system is abusing the openness of market economies in Europe and the United States.

Chinese high-tech investments demand to be deciphered as building blocks of an overarching political plan. It intends to purchase cutting-edge technology and produce large-scale technology transfer systematically. In the long term, China desires to get control over the most valuable segments of global supply chains and production networks. If successful, Made in China 2025 could quicken the corrosion of industrial countries' current technological guidance across industrial areas. Governments in Europe and the U.S. increasingly recognize this dimension of China's demand for technological upgrading as a critical and urgent challenge (Wübbeke, Meissner, Conrad, et al., 2016).

Made in China 2025 is the manifestation of China's complex and strategic industrial policy. The masterplan will shortly help China to increase the global competitiveness of prominent Chinese companies, by the targeting of the most significant industries of the future. Made in China 2025 is a powerful and smart challenge to the advanced economies of today. European and the U.S. have to provide immediate and equally smart replies to this trial.

2.2. MADE IN CHINA 2025

Global industry is at the brink of the next technological revolution. Integration of intelligent machines, modern communication, big data, and cloud computing is building a turbulent transformation in industrial production. Countries and industries all over the world realize that these innovative technologies are reshaping the trends and the standards of international competition. The race for advanced industrial production can determine the destiny of large firms and the total development of overall economies. China considers this worldwide race an outstanding opportunity to technologically and economically discuss with the leading industrialized and innovative countries. The aim is to become a global leader in manufacturing high quality and high-tech products by the first half of the 21st century and to replace Chinese technology for foreign on domestic and global markets. The realization of this goal is based on three factors: the capacity to develop innovative products, to make up internationally well-known brands and to create modern industrial production facilities. China understands that the country's future economic progress and prosperity cannot be based on rusting factories and manual labor. However, China actually places itself in a weak starting position in the global race for smart manufacturing. The current level of automation and digitalization in China's industry is lower than in industrial countries. China's government aim is to make every effort to get ahead in the actual transition towards smart manufacturing. For the realization of this purpose, the leadership's instrument is a vigorous, comprehensive and ambitious industrial policy, embodied in the long-term strategy called Made in China 2025. Thanks to this political plan, China is directing substantial financial resources to promote the technological upgrading of Chinese enterprises. This policy is already starting to create a rise in demand for technologies such as industrial software, sensor networks and robots (Wübbeke, Meissner, Conrad, et al., 2016). In the next paragraphs, this major masterplan will be analyzed, and the most important key points will be studied.

LAYOUT AND AIM OF MADE IN CHINA 2025

Manufacturing industry is the main body of the national economy, the foundation of founding the country, the instrument of rejuvenating the country and the foundation of strengthening the country ("制造业是国民经济的主体，是立国之本、兴国之器、强国之基"). From the beginning of industrial civilization in the mid-eighteenth century, the history of the rise and fall of the world's powerful countries and the struggle history of the Chinese nation have repeatedly proved that without a strong manufacturing industry, no country or nation will be strong ("十八世纪中叶开启工业文明以来，世界强国的兴衰史和中华民族的奋斗史一再证明，没有强大的制造业，就没有国家和民族的强盛"). Building an internationally competitive manufacturing industry is the only way for China to enhance its comprehensive national strength, ensure national security and build a world power ("打造具有国际竞争力的制造业，是我国提升综合国力、保障国家安全、建设世界强国的必由之路"). Since the origin of the People's Republic of China, especially since the reform and opening up, China's manufacturing industry has been developing rapidly and continuously. It has established a complete and independent industrial system, vigorously promoted the process of industrialization and modernization, significantly enhanced its comprehensive national strength and supported our position as a world power ("新中国成立尤其是改革开放以来，我国制造业持续快速发展，建成了门类齐全、独立完整的产业体系，有力推动工业化和现代化进程，显著增强综合国力，支撑我世界大国地位"). However, compared with the advanced level in the world, China's manufacturing industry is still large but not strong. There are obvious gaps in independent innovation ability, resource utilization efficiency, industrial structure level, information level, quality, and efficiency. The task of transformation, upgrading and leapfrogging development is urgent and arduous ("然而，与世界先进水平相比，我国制造业仍然大而不强，在自主创新能

力、资源利用效率、产业结构水平、信息化程度、质量效益等方面差距明显，转型升级和跨越发展的任务紧迫而艰巨").

At present, a new round of scientific and technological revolution and industrial transformation has formed a historic convergence with China's accelerated change of the mode of economic development, and the pattern of international industrial division of labor is being reshaped. China must seize this critical historical opportunity, implementing the strategy of building a strong manufacturing country, strengthening overall planning and forward-looking deployment following the requirements of the "four comprehensive" strategic layout. It also has to strive to build China into a manufacturing power, leading the development of the world's manufacturing industry by the time of the founding of the People's Republic of China, through three decades of efforts, to lay a solid foundation for the realization of the Chinese dream of great rejuvenation of the Chinese nation. Made-in-China 2025 is the first ten-year action plan for China to implement the strategy of building a strong manufacturing country. The strength of this country is the starting point from which every next consideration is based and founded. The primary goal of China is to improve its manufacturing system, is to turn its manufacturing system from "large to strong", exploiting and taking advantage of the "new round of technological revolution and industrial transformation". MIC2025 aim is to provide all the directions and the information for China and for each company for reaching this aim.

Our analysis will focus on four main parts of this masterplan:

- Development Situation and Environment
- Strategic Guidelines and Objectives
- Strategic Tasks and Key Points
- Strategic Support and Guarantee.

Through the main parts of this governmental plan and the aid of some respectful examples, all the principal aspects, the primary goals, and the guidelines will be analyzed and studied.

• Development and Environment (“发展形势和环境”)

In this section 3 themes concerning the context and the actual global situation are argued:

1. The global manufacturing industry is facing significant adjustments;
2. Significant changes have taken place in China's economic development environment;
3. The task of building a powerful manufacturing country is arduous and urgent.

The first section gives the basis for the next guidelines, founding the whole masterplan on the precondition that the deep integration of the new generation of information technology and manufacturing industry is triggering far-reaching industrial changes, forming new production modes, industrial forms, business models and economic growth points. All countries are intensifying scientific and technological innovation to promote breakthroughs in the fields of three-dimensional (3D) printing, mobile internet, cloud computing, big data, bioengineering, new energy, and new materials. Moreover, intelligent manufacturing, such as smart equipment and intelligent factory based on the physical information system, is leading the change of manufacturing mode. Network crowdsourcing, collaborative design, mass customization, precise supply chain management, life cycle management, e-commerce and so on are reshaping the industrial value chain system; intelligent terminal products such as wearable, smart products, smart household appliances, intelligent automobiles continue to expand manufacturing.

China takes all these factors as "我国制造业转型升级、创新发展迎来重大机遇", which means significant opportunities for the transformation, the upgrading and the innovation of China's manufacturing industry.

The next move for China is to "必须放眼全球，加紧战略部署，着眼建设制造强国，固本培元，化挑战为机遇，抢占制造业新一轮竞争制高点", focus on the whole world, intensify its strategic deployment, build a strong manufacturing country, consolidate capital and cultivate yuan, turn challenges into opportunities, and seize the commanding heights of a new round of competition in manufacturing industry.

The second section focuses on the main changes that have taken place in China's economic development environment, which describe a country in which the synchronous advancement of new industrialization, informatization, urbanization and agricultural modernization, the potential of super-large-scale domestic demand is continuously released, providing a broad space for the development of China's manufacturing industry.

New equipment demand of various industries, new consumption demand of the people, new livelihood demand of social management and public services, and new security demand of national defense construction, require manufacturing industry to rapidly upgrade its level and capability in major technological equipment innovation, quality and safety of consumer goods, equipment supply of public service facilities and national defense equipment support. Fully deepening reform and further opening up will constantly stimulate the vitality and creativity of manufacturing industry and promote the transformation and upgrading of this industry.

China's economic development has entered a new normality, and the development of manufacturing industry is facing new challenges. The constraints of resources and environment have been continuously strengthened, the cost of production factors such as labor force has been rising, and the growth rate of investment and export has slowed down. The excellent development mode, which mainly relies on the input of resources and expansion of scale, is unsustainable.

Due to these causes, for China "调整结构、转型升级、提质增效刻不容缓", is urgent to adjust the structure, transform and upgrade, and improve quality and efficiency. It's fundamental to form a new driving force for economic growth and shape further

international competitive advantages, focusing on manufacturing, the difficulties in production, and to the fact that the way out is also in manufacturing.

The third and the last part of this section recognizes China's manufacturing weak factors and try to define the goals and the next steps in the realization of China's dream.

After decades of rapid development, China's manufacturing industry ranks first in the world and has established a complete and independent manufacturing system, which has become an important cornerstone to support China's economic and social development and a significant force to promote world economic development.

"我国已具备了建设工业强国的基础和条件", China already have the basis and the conditions for building a strong industrial country. These foundations are given by the constant technological innovation that has dramatically improved the comprehensive competitiveness of China's manufacturing industry. For example, a number of great technological equipment, such as manned space flight, manned deep submergence, large aircraft, Beidou satellite navigation, supercomputer, high-speed railway equipment, millions of kilowatt-level power generation equipment, millions of meters deep-sea oil drilling equipment, have made breakthroughs, and formed a number of internationally competitive industries and backbone enterprises.

However, China is still in the process of industrialization, and there is still a big gap compared with advanced countries. The manufacturing industry is large but not strong (制造业大而不强); independent innovation ability is weak (自主创新能力弱); key core technology and high-end equipment are highly dependent on the outside world (关键核心技术与高端装备对外依存度高), and the manufacturing innovation system with enterprises as the main body is not perfect (以企业为主体的制造业创新体系不完善). The product grade is not high (产品档次不高), and there is a lack of world-renowned brands (缺乏世界知名品牌); the utilization efficiency of resources and energy is low (资源能源利用效率低), environmental pollution is more prominent (环境污染问题较为突出) and the industrial structure is unreasonable (产业结构不合理).

The development of high-end equipment manufacturing industry and productive service industry lags (高端装备制造业和生产性服务业发展滞后); the level of informatization is not high (信息化水平不高), and the depth of integration with industrialization is not enough (工业化融合深度不够); the degree of industrial internationalization is not high (产业国际化程度不高), and the ability of enterprises to operate globally is insufficient (企业全球化经营能力不足). To promote the construction of a powerful manufacturing country, we must focus on solving the above problems.

Derives that, to build a strong manufacturing country, China must seize the rare strategic opportunities, actively respond to the challenges, strengthen overall planning, highlight innovation drive, formulate particular policies, give full play to institutional advantages, mobilize all social forces to strive hard, rely more on Chinese equipment and brand to realize the transformation from Made in China to Create in China(更多依靠中国装备、依托中国品牌，实现中国制造向中国创造的转变). China must fulfill the conversion from Chinese speed to Chinese quality (中国速度向中国质量的转变), and the change from Chinese production to Chinese brand (中国产品向中国品牌的转变), completing the strategic task of Made-in-China from big to strong.

• Strategic Guidelines and Objectives (“战略方针和目标 战略方针和目标”)

The second part of MIC 2025 is the one which discusses three relevant issues:

1. Guiding Ideology (指导思想);
2. Basic Principles (基本原则);
3. Strategic Targets (战略目标).

For what concerns the Guiding Ideology, to follow the promotion of the innovation and development of manufacturing industry with Chinese features, to improve quality and efficiency, to accelerate the deep integration of the new generation of information technology and manufacturing industry, to promote intelligent manufacturing as the main direction, to meet the needs of economic and social development and national defense construction for major technical equipment as the goal, to strengthen industrial basic capacity, improve the level of comprehensive integration, and improve multi-level and multi-type personnel training, China needs to follow five basic principles, which are illustrated in the first section and which can be considered five pillars of the whole ideology behind MIC 2025:

1) Innovation Driven ("创新驱动"): China should persist in putting innovation at the core of the overall development of manufacturing industry, improve the institutional environment conducive to innovation, promote cross-sectoral and cross-sectoral collaborative innovation, break through a number of critical common technologies in crucial areas, promote the digitalization and networking of manufacturing industry, and take the path of innovation-driven development.

2) Quality First ("质量为先"): Adhere to quality as the lifeline of building a strong manufacturing country, strengthen the main responsibility of enterprise quality, strengthen quality technology and cultivate independent brands ("自主品牌培育"). Constructing the system of laws and regulations ("建设法规标准体系"), quality supervision and management ("质量监管体系"), advanced quality culture ("先进质量文化"), creating a market environment for honest management ("营造诚信经营的市场环境"), and taking the development road of winning by quality ("走以质取胜的发展道路").

3) Green Development ("绿色发展"): Sustainable development should is regarded as an important focus of building a powerful manufacturing country, energy-saving, and environmental protection technologies, processes and equipment should be promoted and applied, and cleaner production should be carried out in an all-around way. Develop

circular economy ("发展循环经济"), improve the efficiency of resource recovery and re-utilization ("提高资源回收利用效率"), construct green manufacturing system ("构建绿色制造体系"), and take the development path of ecological civilization ("走生态文明的发展道路").

4) Structural Optimization ("结构优化"): Structural adjustment should be taken as a key link in building a strong manufacturing country. Advanced manufacturing industry should be vigorously developed ("大力发展先进制造业"), traditional industries should be upgraded ("改造提升传统产业"), and the transformation from production-oriented manufacturing to service-oriented manufacturing should be promoted ("推动生产型制造向服务型制造转变"). China will optimize the modern industrial layout ("优化产业空间布局"), cultivate many industrial clusters and enterprise groups with core competitiveness ("培育一批具有核心竞争力的产业集群和企业群体"), and take the development path of improving quality and efficiency ("走提质增效的发展道路").

5) Talent-Oriented Development ("人才为本"): We should persist in taking talents as the basis of building a strong manufacturing country ("坚持把人才作为建设制造强国的根本"), establish and improve a scientific and rational mechanism for selecting, employing and educating talents ("建立健全科学合理的选人、用人、育人机制"), and accelerate the training of professional and technical personnel, managerial personnel and skilled personnel urgently needed for the development of manufacturing industry ("加快培养制造业发展急需的专业技术人才、经营管理人才、技能人才").

China will create an atmosphere of mass entrepreneurship and innovation, build a team of manufacturing talents with excellent quality and reasonable structure, and take the development path led by talents.

For what concerns the second section, four Basic Principles are defined:

1) Market Leadership and Governance Leadership ("市场主导，政府引导"): China will entirely deepen reform ("全面深化改革"), give markets the crucial role in allocating resources ("充分发挥市场在资源配置中的决定性作用"), reinforce the dominant position of enterprises ("强化企业主体地位"), and encourage the vitality and creativity of the firms ("激发企业活力和创造力"). China will also actively transform government functions ("积极转变政府职能"), strengthen strategic research ("加强战略研究和规划引导"), improve relevant policies ("完善相关支持政策"), and create a stable environment for enterprises ("为企业发展创造良好环境").

2) Focus on the Present with the Long-term perspective ("立足当前，着眼长远"): China will speed up structural transformation, improve quality and performance, and develop sustainable manufacturing capabilities to avoid and limit bottlenecks and weak links that restrain manufacturing ("针对制约制造业发展的瓶颈和薄弱环节，加快转型升级和提质增效，切实提高制造业的核心竞争力和可持续发展能力"). China will also understand the new round of technology and industrial revolution and make up strategic plans and far-sighted policies to consolidate current advantages and capture the high ground to manage future competition ("准确把握新一轮科技革命和产业变革趋势，加强战略谋划和前瞻部署，扎扎实实打基础，在未来竞争中占据制高点").

3) Holistic Advancement and Breakthroughs in Key Areas ("整体推进，重点突破"): China should keep on developing manufacturing industry coordinating all the national activities like in a chess game ("坚持制造业发展全国一盘棋和分类指导相结合"), China will do overall planning ("统筹规划"), rationalize layout ("合理布局"), clarify the direction of innovative development (明确创新发展方向), promote the in-depth development of civil-military integration ("促进军民融合深度发展"), and accelerate the promotion of the overall level of manufacturing industry ("加快推动制造业整体水平提升"). It will also focus on the major needs of economic and social development and

national security ("围绕经济社会发展和国家安全重大需求"), it should integrate resources ("整合资源"), highlight key points ("突出重点"), implement some major projects to achieve first breakthroughs ("实施若干重大工程，实现率先突破").

4) Independent Development and Open Cooperation ("自主发展，开放合作"): Master core technologies, improve the industrial supply chain and cultivate domestic capabilities in strategic areas correlated to national welfare, the people's livelihood, and industry security ("在关系国计民生和产业安全的基础性、战略性、全局性领域，着力掌握关键核心技术，完善产业链条，形成自主发展能力"). Continue to expand the 'Opening Up' strategy further to decisively engage with global resources and markets, strengthen global distribution, stimulate international collaboration and communication, and improve new comparative advantages to increase the overall level of manufacturing ("继续扩大开放，积极利用全球资源和市场，加强产业全球布局和国际交流合作，形成新的比较优势，提升制造业开放发展水平").

This section ends with an in-depth analysis of the strategic targets and goals that China has to reach in the next years. In light of domestic conditions and international realities, China will struggle to achieve strategic manufacturing goals by following the "Three Steps".

Step 1: Strive to enter the ranks of manufacturing powers in 10 years ("第一步：力争用十年时间，迈入制造强国行列"): By 2020, industrialization will be realized, the position of manufacturing power will be further consolidated, and the level of manufacturing digitalization will be greatly improved ("到 2020 年，基本实现工业化，制造业大国地位进一步巩固，制造业信息化水平大幅提升"). China will master a number of key core technologies in key areas, further enhance the competitiveness of the dominant areas, and greatly improve product quality ("掌握一批重点领域关键核心技术，优势领域竞争力进一步增强，产品质量有较大提高"). The manufacturing industry will then made remarkable progress in digitalization, networking, and intellectualization. Energy consumption, material consumption and pollutant emissions

of industrial added value in key industries will be significantly decreased. ("制造业数字化, 网络化、智能化取得明显进展。重点行业单位工业增加值能耗, 物耗及污染物排放明显下降").

By 2025, the overall quality of manufacturing industry will be significantly improved, the innovation ability will be enhanced considerably, the labor productivity of the whole staff will be substantially improved, and the integration of industrialization and informatization will take a new step ("到 2025 年，制造业整体素质大幅提升，创新能力显著增强，全员劳动生产率明显提高，两化（工业化和信息化）融合迈

Indicators	2013	2015	2020	2025
Innovation				
Share of R&D spending of operating revenue (in %)	0.88	0.95	1.26	1.68
Invention patents per 100 million CNY total revenue	0.36	0.44	0.7	1.1
Quality				
Quality competitiveness index*	83.1	83.5	84.5	85.5
Growth of industrial value-added (in %)	9.7	5.9	7.9	9.9
Productivity growth (in %, annual average)	7.3	6.6	7.5	6.5
Digitisation of Industry				
Broadband internet (penetration in %)	37	50	70	82
Use of digital design tools in R&D (penetration in %)	52	58	72	84
Use of numerical control machines in key production processes (penetration in %)	27	33	50	64
Environmental Protection				
Decrease in industrial energy intensity (in % compared to 2015)	-	-	-18	-34
Decrease in CO_2 emission intensity (in % compared to 2015)	-	-	-22	-40
Decrease in water usage intensity (in % compared to 2015)	-	-	-23	-41
Reuse of solid industrial waste (in % of total waste)	62	65	73	79

Key technologies targeted by Made in China 2025
- New generation information technology
- High-end computerised machines and robots
- Space and aviation
- Maritime equipment and high-tech ships
- Advanced railway transportation equipment
- New energy and energy-saving vehicles
- Energy equipment
- Agricultural machines
- New materials
- Biopharma and high-tech medical devices

2.8 Major Manufacturing Indicators, 2013-2015 (中国制造2025)

上新台阶”). The energy consumption, material consumption and pollutant discharge of industrial added value in key industries have reached the advanced level in the world. ("重点行业单位工业增加值能耗、物耗及污染物排放达到世界先进水平"). China will have then formed a group of multinational corporations and industrial clusters with strong international competitiveness, and will have enhanced their position in the global industrial division of labor and value chain. ("形成一批具有较强国际竞争力的跨国公司和产业集群，在全球产业分工和价值链中的地位明显提升").

Step 2: By 2035, China's manufacturing industry as a whole will reach the middle level of the world's manufacturing power camp ("到 2035 年，我国制造业整体达到世界制造强国阵营中等水平"). Innovation capability has been greatly improved, breakthroughs have been made in key areas, overall competitiveness has been significantly enhanced, a leading capacity of global innovation has been formed in profitable industries, and industrialization has been realized in an all-around way. ("创新能力大幅提升，重点领域发展取得重大突破，整体竞争力明显增强，优势行业形成全球创新引领能力，全面实现工业化").

Step 3: One hundred years after the founding of the People's Republic of China (1949), the position of a manufacturing power will be more consolidated, and its general strength will enter the forefront of the world's manufacturing power ("新中国成立一百年时，制造业大国地位更加巩固，综合实力进入世界制造强国前列"). Major areas of manufacturing industry will have innovative leadership and obvious competitive advantages and will build a leading technology and industry system in the world (“制造业主要领域具有创新引领能力和明显竞争优势，建成全球领先的技术体系和产业体系").

• Strategic Tasks and Key Points (“战略任务和重点 战略任务和重点”)

This part can be considered the central body of the whole masterplan. In this section all the main aspects, the main steps and the future developments are illustrated. It’s divided into nine points:

1) National Manufacturing Innovation Capability;
2) Full Integration of Informatization and Industrialization;
3) Fundamental Industry Capabilities;
4) Strengthening Quality and Branding;

5) Implementing Green Production;

6) Promote Breakthroughs in Key Areas;

7) Deeply Promoting Structural Adjustments in Manufacturing;

8) Develop Service-Oriented Manufacturing and The Product Service Industry;

9) Internationalization of Manufacturing.

To realize the strategic task of transforming China's manufacturing sector, China must implement the problem-oriented method, create an overall plan, and concentrate on critical areas. The program must embody the consensus of the entire society and lead to comprehensively increasing the development quality and core manufacturing competitiveness.

In the following paragraphs, we will focus on the major themes and aspects, and we will deepen and analyze the most important points of the nine sections mentioned above.

1. Improve National Manufacturing Innovation Capability (提高国家制造业创新能力)

China will improve the manufacturing innovation system, founded on companies and guided by the market, and which combines government, production, education, investigation, and operations. China will innovate watching the industrial supply chain and will demand to research core technologies, apply experimental and technological attainments in practice, and improve innovation capacities in required fields.

China defined six main guidelines to follow to fulfill the above goals:

1) Improve the development and the research of Core Technologies: China will:

Strengthen the dominant position of enterprises in technological innovation, support enterprises to enhance their innovation capabilities, promote the construction of national technological innovation demonstration enterprises and enterprise technology centers, and fully include enterprises in the decision-making process and implementation of internal science and technology programs ("强化企业技术创新主体地位，支持企业

提升创新能力，推进国家技术创新示范企业和企业技术中心建设，充分吸纳企业参与国家科技计划的决策和实施"). Ordinarily, formulate and publish technology innovation roadmaps in principal areas of manufacturing based on national strategy ("瞄准国家重大战略需求和未来产业发展制高点，定期研究制定发布制造业重点领域技术创新路线图"). China will continue to implement major national science and technology projects and support research and development of key core technologies through national science and technology plans (projects, funds, etc.) ("继续抓紧实施国家科技重大专项，通过国家科技计划（专项、基金等）支持关键核心技术研发"). China will also allow key enterprises to play a leading role and universities and research institutions to play a supporting role to create many innovation coalitions and promote collaborative innovation involving government, production, education, research, and operations. Finally, they will make breakthroughs in many key technologies which have a significant impact on improving industrial competitiveness.

2) Innovation Design Capability: China will:

Carry out innovative design demonstrations in key areas such as traditional manufacturing, strategic emerging industries, and modern service industries, and comprehensively promote and apply advanced design technologies featuring green, intelligent and collaborative features ("提高创新设计能力。在传统制造业、战略性新兴产业、现代服务业等重点领域开展创新设计示范，全面推广应用以绿色、智能、协同为特征的先进设计技术"). Strengthen the research and development of common key technologies in the field of design, and overcome common technologies such as information design, process integration design, complex process, and systematic design ("加强设计领域共性关键技术研发，攻克信息化设计、过程集成设计、复杂过程和系统设计等共性技术"). China will also develop some key design tools and software with independent intellectual property rights, and build and improve the innovative design ecosystem ("开发一批具有自主知识产权的关键设计工具软件，建设完善创新设计生态系统").

Moreover it will create a number of innovation design clusters with international collaboration, cultivate industrial design enterprises, stimulate original equipment producers (OEMs) to build R&D centers to transfer to knowledge to domestic brands and will develop innovation design education and create the National Industrial Design Excellence Award to push enthusiasm across society for innovation design ("建设若干具有世界影响力的创新设计集群，培育一批专业化、开放型的工业设计企业，鼓励代工企业建立研究设计中心，向代设计和出口自主品牌产品转变。发展各类创新设计教育，设立国家工业设计奖，激发全社会创新设计的积极性和主动性").

3) Industrialization of Scientific and Technological Achievements: China will:

Improve the operational mechanism for the transformation of scientific and technological achievements, study and formulate guidelines for promoting the transformation and industrialization of scientific and technological achievements, establish and improve the information dissemination and sharing platform for scientific and technological achievements, and improve the technology transfer and industrialization service system with the technology trading market as the core ("完善科技成果转化运行机制，研究制定促进科技成果转化和产 业化的指导意见，建立完善科技成果信息发布和共享平台，健全以技术交易市场为核心的 技术转移和产业化服务体系"). Upgrade incentive mechanism for commercializing research by transforming the method, application, and revenue management of scientific and technological attainments in public institutions, and by enhancing evaluation and pricing processes ("完善科技成果转化激励机制，推动事业单位科技成果使用、 处置和收益管理改革，健全科技成果科学评估和市场定价机制").

Improve shared mechanisms through collaboration between government, production, education, research, and operations in accordance with market laws and innovation application, and address financial and social funds to develop many pilot centers of excellence for technology integration and engineering ("完善科技成果转化协同推 进机制，引导政产学研用按照市场规律和创新规律加强合作，鼓励企业和社会资本

建立一 批从事技术集成、熟化和工程化的中试基地").

Besides, China will also speed up the transformation and industrialization of national defense and promote two-way transfer between military and civilian technologies ("加快国防科技成果转化和产业化进程，推进 军民技术双向转移转化").

4) Perfect National Manufacturing Innovation System: China will:

Reinforce comprehensive planning, organize a network of manufacturing innovation centers approved by engineering data centers, and encourage market-oriented innovation selecting and risk-reward sharing mechanisms that foster innovation ("加强顶层设计，加快建立以创新中心为核心载体、以公共 服务平台和工程数据中心为重要支撑的制造业创新网络，建立市场化的创新方向选择机制 和鼓励创新的风险分担、利益共享机制"). Make advantages of present technology resources and adopt new mechanisms and models of cooperation between government and society to build some Industrial Technology Research Bases and to conduct industrialization analysis and pilot projects ("充分利用现有科技资源，围绕制造业重大共性需 求，采取政府与社会合作、政产学研用产业创新战略联盟等新机制新模式，形成一批制造 业创新中心（工业技术研究基地），开展关键共性重大技术研究和产业化应用示范"). Set up several public service platforms to support collaborative innovation in manufacturing industry, normalize service standards, carry out specific services such as technology research and development, inspection and testing, technology evaluation, technology trading, quality certification and personal formation, and improve the transformation and application of scientific and technological achievements ("建设 一批促进制造业协同创新的公共服务平台，规范服务标准，开展技术研发、检验检测、技 术评价、技术交易、质量认证、人才培训等专业化服务，促进科技成果转化和推广应用"). Construction of manufacturing engineering data center in key areas to provide enterprises with innovative knowledge and open sharing services of Engineering data ("建设重点领域制造业工程数据中心，为企业提供创新知识和工程数据的开放共享服务").

5) Building Manufacturing Innovation Centers: China will:

By 2020, 15 manufacturing innovation centers (industrial technology research bases) will be formed, and 40 manufacturing innovation centers (industrial technology research bases) will be formed by 2025 [“到 2020 年，重点形成 15 家左右制造业创新中心（工业技术研究基地），力争到2025 年形成 40 家左右制造业创新中心（工业技术研究基地)”].

6) Reinforce Intellectual Property Rights (IPR): China will:

Reinforce IPR resources in major areas of manufacturing and develop industrialization-oriented patent pools strategically ("加强制造业重点领域关键核心技术知识产权储备，构建产业化导 向的专利组合和战略布局"). Assist and support enterprises to apply intellectual property rights to compete in the market competition, cultivate a number of excellent enterprises with broad strength of intellectual property rights, encourage the formation of intellectual property agreements, and promote the coordinated use of intellectual property rights by market participants ("鼓励和支持企业运用知识产权参与市场竞争，培育一批具备知 识产权综合实力的优势企业，支持组建知识产权联盟，推动市场主体开展知识产权协同运 用"). Steady promote the decryption and market application of defense intellectual property rights ("稳妥推进国防知识产权解密和市场化应用"). Establish and improve the intellectual property appraisal mechanism, encourage and support key enterprises and professional institutions to cooperate in patent evaluation, acquisition, operation, risk early warning and response in key areas ("建立健全知识产权评议机制，鼓励和支持 行业骨干企业与专业机构在重点领域合作开展专利评估、收购、运营、风险预警与应对").

Build a public service platform for the comprehensive use of intellectual property rights ("构建知识产权综合运用公共服务平台"). Encourage transnational intellectual property licensing and study and formulate policies and measures to reduce the cost of intellectual property application, protection and rights protection of small and medium-

sized enterprises ("鼓励开展跨国知识产权许可。研究制定降低中小企 业知识产权申请、保护及维权成本的政策措施").

2. Promote The Full Integration of Informatization and Industrialization (推进信息化与工业化深度融合)

China will promote the complete integration of next-generation IT and industrialization and will consider intelligent manufacturing as the main priority of integration. Will also focus on developing smart devices and products, making the manufacturing process smart, and cultivating new methods of production to ultimately improve the intelligence level of R&D, production, management, and services.
The steps to reach these goals are defined in this chapter: The steps to reach these goals are defined in this chapter:

1) Intelligent Manufacturing Development Strategy: China will:

Formulate smart manufacturing development planning and define development goals, essential tasks, and structure ("编制智能制造发展规划，明确发展目标、重点任务和重大布局"). Make up an intelligent manufacturing coalition to collaboratively develop intelligent equipment, R&D, systematic, integrated innovation, and industrialization ("强化应用牵引，建立智能制造产业联盟，协同推动智能装备和产品研发、系统集成创新与产业化"). Promote the integrated application of the industrial Internet, cloud computing, and big data across the whole industrial chain from R&D and design to manufacturing, operations, management, sales and service ("促进工业互联网、云计算、大数据在企业研发设计、生产制造、经营管理、销售服务等全流程和全产业链的综合集成应用").

2) Accelerate Intelligent Manufacturing Equipment and Products Development: China will:

Organize the research and development of intelligent manufacturing equipment and intelligent production lines with deep perception, smart decision-making and automatic execution functions, such as high-end, digitally controlled machine tools, industrial

robots, additive manufacturing equipment ("组织研发具有深度感知、智慧决策、自动执行功能的高档数控机床、工业机器人、增材制造装备等智能制造装备以及智能化生产线"). Accelerate and support precision manufacturing and agile manufacturing in key industries, like machinery, aerospace, shipping, automobile, light industry, textile, food, and electrical equipment. ("加快机械、航空、船舶、汽车、轻工、纺织、食品、电子等行业生产设备的智能化改造，提高精准制造、敏捷制造能力"). Overall layout and promotion of research and development and industrialization of intelligent transportation, intelligent construction machinery, service robots, intelligent household appliances, intelligent lighting appliances, wearable equipment, and other products ("统筹布局和推动智能交通工具、智能工程机械、服务机器人、智能家电、智能照明电器、可穿戴设备等产品研发和产业化").

3) Promoting Intelligent Manufacturing Processes: China will:

Build intelligent trial factories and digital workplaces to implement technologies that allow man-machine interaction, industrial robots, intelligent logistics management, and additive manufacturing, and support the simulation, optimization, numerical control, real-time monitoring, and self-adaptive control of manufacturing technology ("在重点领域试点建设智能工厂/数字化车间，加快人机智能交 互、工业机器人、智能物流管理、增材制造等技术和装备在生产过程中的应用，促进制造 工艺的仿真优化、数字化控制、状态信息实时监测和自适应控制"). Accelerate the application of product life cycle management, customer relationship management, and supply chain management system, and promote the connection between group management and control, design and manufacturing, production and marketing, business and financial convergence, and realize intelligent management and control ("加快产品全生命周期管理、客户关系管理、供应链管理系统的推广应用，促进集团管控、设计与制造、产供销一 体、业务和财务衔接等关键环节集成，实现智能管控"). Speed up the construction of intelligent inspection and supervision system for key industries such as explosives, dangerous chemicals, food, printing and dyeing, rare earth, pesticides and so

on, and improve the level of intelligence ("加快民用爆炸物品、危险化学品、 食品、印染、稀土、农药等重点行业智能检测监管体系建设，提高智能化水平").

4) Deepening the Application of Internet in Manufacturing: China will:

Develop a roadmap for the integration of Internet into the manufacturing industry, and clarify the direction, objectives and path of development ("制定互联网与制造业融合发展的路线图，明确发展方向、目标和路径"). Build new manufacturing methods based on personalized customization, crowd-sourced design, and cloud manufacturing, and promote ways of research, manufacturing, industrial organization that are founded on dynamically sensing consumer needs ("发展基于互联网的个性化定制、众包设计、云制造等新型制造模式，推动形成基于消费需求动态感知的研发、制造和产业组织方式"). Speed up the development and application demonstration of the Internet of Things technology, cultivating new industrial Internet applications such as intelligent monitoring, remote diagnosis management, whole industry chain traceability, etc. ("加快开展物联网技术研发和应用示范，培育智能监测、远程诊断管理、全产业链追溯等工业互联网新应用"). Implement pilot projects of innovative application of industrial cloud and big industrial data, build many high-quality industrial cloud services and industrial big data platforms, and promote open sharing of software and services, design and manufacturing resources, key technologies and standards ("实施工业云及工业大数据创新应用试点，建设一批高质量的工业云服务和工业大数据平台，推动软件与服务、设计与制造资源、关键技术与标准的开放共享").

5) Reinforce Internet Structure: China will:

Strengthen the planning and layout of industry Internet infrastructure and build modern industrial Internet features with low latency, high reliability and wide coverage ("加强工业互联网基础设施建设规划与布局，建设低时延、 高可靠、广覆盖的工业互联网"). Accelerating the deployment and construction of optical fiber network, mobile communication network and wireless local area network in manufacturing

agglomeration area, realizing broadband upgrading of information network and improving broadband access capability of enterprises ("加快制造业集聚区光纤网、移动通信网和无线局域网的部 署和建设，实现信息网络宽带升级，提高企业宽带接入能力").

Develop smart control software, industrial application systems, fault diagnose software, and related tools, as well as sensing and notification system protocols to achieve the real-time connection, accurate identification, effective interactions and intelligent control of people, equipment, and products (针对信息物理系统网络研发 及应用需求，组织开发智能控制系统、工业应用软件、故障诊断软件和相关工具、传感和通信系统协议，实现人、设备与产品的实时联通、精确识别、有效交互与智能控制").

6) Intelligent Manufacturing Projects: China will:

Focus on the key links in key manufacturing areas to carry out the integration innovation and engineering application of new generation information technology and manufacturing equipment integration ("紧密围绕重点制造领域关键环节，开展新一代信息技术与制造装备融合的集成创新和工程应用"). Enhance collaborative analysis and industrialization of smart products and equipment. We will rely on influential enterprises to concentrate on main technologies, such as substituting people with robots in key positions, intelligent process control in production, supply chain optimization, and intelligent plants ("支持政产学研用联合攻关，开发智能产品和自主可控的智能装置并实现产业化。依托优势企业，紧扣关键工序智能化、关键岗位机器人替代、生产过程智能优化控制、供应链优化，建设重点领域智能工厂/数字化车间").

No later than 2020, intelligent level in major manufacturing areas will significantly grow. The effective cost of pilot demonstration projects will decrease by 30%. Production cycles will reduce by 30%, and faulty product rates will fall by 30%. By 2025, principal manufacturing areas will become wholly digitalized. Operation costs of

pilot demonstration projects will drop by 50%. Production cycle will fall by 50%, and faulty product rates will decrease by 50% ("到 2020 年，制造业重点领域智能化水平显著提升，试点示范项目运营成本降低30%，产品生产周期缩短 30%，不良品率降低 30%。到 2025 年，制造业重点领域全面实现智能化，试点示范项目运营成本降低 50%，产品生产周期缩短 50%，不良品率降低50%”).

3. Fundamental Industry Capabilities (强化工业基础能力)

A weak industry foundation in fundamental spare parts and components, advanced techniques, key materials and industrial technology (now on referred to as the "Four Foundations") limits Chinese manufacturing innovation and quality development. China must adhere to the principles of focusing on key problems, aligning production with demand, innovating collaboratively, and making technical breakthroughs in key sectors to eliminate the bottleneck that restricts industrial competition. Broadly promoting the "Four Foundations" as central to Chinese manufacturing progress.

The path for the reinforcement of the "Four Foundations" is made of four steps:

1) Planning to Define Primary Directions, Goals, and Approaches: China will:

Formulate the catalog of guidance for industrial "four-foundations" development, publish the report on industrial strong-base development, and organize and implement industrial foundation improvement project ("制定工业"四基"发展指导目录，发布工业强基发展报告，组织实施工业强基工程").

2) Strengthen the “Four Foundations” Innovation Capability: China will:

Build a developed technology innovation system and make full advantage of accessible sources to organize fundamental technology research institutions to coordinate joint works in key manufacturing technologies, such as advanced modeling and processing, support enterprises to carry out innovations and train talents and professionals ("建立基础工艺创新体系，利用现有资源建立关键共性基础工艺研究机构，开展先进成

型、加工等关键制造工艺联合攻关；支持企业开展工艺创新，培养工艺专业人才").

Strengthen the research of necessary proprietary materials to improve China's self-sufficiency in the exclusive materials supply chain and manufacturing technology ("加大基础专用材料研发力度，提高专用材料自给保障能力和制备技术水平").

Build the National Industrial Foundation Database to accumulate, handle, and apply enterprise test and measurement data ("建立国家工业基础数据库，加强企业试验检测数据和计量数据的采集、管理、应用和积累").

3) Coordinate Development of Complete Machine Manufacturing: China will:

Improve the National Science and Technology Plan (special projects and funds) and associated projects to facilitate the improvement of entire machine manufacturing by coordinating "Four Foundations" related enterprises, universities and research institutions in key areas, such as digital control machines, railway transportation equipment, aerospace and aeronautics, and power generation equipment ("依托 国家科技计划（专项、基金等）和相关工程等，在数控机床、轨道交通装备、航空航天、 发电设备等重点领域，引导整机企业和"四基"企业、高校、科研院所产需对接，建立产业 联盟"). Create industry coalitions, establish a new model for collaborative innovation and merge production and experience to enhance localization of main types of equipment ("形成协同创新、产用结合、以市场促基础产业发展的新模式，提升重大装备自主可 控水平").

4) Industrial Foundation Improvement Project: China will:

Develop demonstration projects establishing incentive and risk compensation mechanisms for supporting the first movers or illustrating cross-domain applications of essential core components (components), advanced basic processes and key basic materials.

By 2020, 40% of the core necessary components and essential basic materials will be internally guaranteed ("到 2020 年，40%的核心基础零部件、关键基础材料实现自主保障").

No later than 2025, 70% of the essential spare parts and key elements will have national origins. China will formulate a renovated industrial technology service system and continuously create a complete machine-led industrial innovation development process in which companies can cooperate ("到 2025 年，70%的核心基础零部件、关键基础材料实现自主保障，80 种标志性先进工艺得到推广应用，部分达到国际领先水平，建成较为完善的产业技术基础服务体系，逐步形成整机牵引和基础支撑协调互动的产业创新发展格局").

4. Strengthening Quality and Branding (加强质量品牌建设)

China will improve quality control technology, quality management mechanism, build a solid foundation for quality development, optimize the quality development environment, and strive to achieve a substantial improvement in manufacturing quality. Enterprises will be encouraged to pursue excellence in quality, form brand-name products with independent intellectual property rights, and continuously enhance their brand value and overall image of Chinese manufacturing.

China will assist the improvement of quality through five different steps:

1) Promoting advanced quality management techniques and methods: China will:

Use leading enterprises as model examples and demonstrations to help advanced production management methods, such as six sigma, lean production, quality diagnosis, and continuous quality improvement ("开展质量标杆和领先企业示范活动，普及卓越绩效、六西格玛、精益生产、质量诊断、质量持续改进等先进生产管理模式和方法"). Stimulate enterprises to enhance online monitoring, online control, and product life cycle quality traceability ("支持企业提高质量在线监测、在线控制和产品全生命周期质量追溯能力"), use and enhance quality management activities as quality

management groups ("开展质量管理小组、现场改进等群众性质量管理活动示范推广"). Strengthen quality management of small and medium-sized enterprises and carry out activities to improve talent level, safety training, evaluation and counseling and mentoring activities ("加强中小企业质量管理，开展质量安全培训、诊断和辅导活动").

2) Accelerate the improvement of product quality: China will:

Conduct plans to increase industrial production quality. Make breakthroughs in technologies that have limited product quality improvements, prioritizing main fields, like automotive, digitally controlled machine tools, railway equipment, engineering machinery, specialty equipment, principal raw materials, spare components, and electronic parts ("实施工业产品质量提升行动计划，针对汽车、高档数控机床、轨道交通装备、大型成套技术装备、工程机械、特种设备、关键原材料、基础零部件、电子元器件等重点行业"). Promote the application of advanced modeling and processing methods, on-line detection devices, intelligent production and logistics systems, and testing equipment, to make indicators like the performance consistency, quality reliability, environmental adaptability, service life, and others reach the advanced international level of comparable goods ("推广采用先进成型和加工方法、在线检测装置、智能化生产和物流系统及检测设备等，使重点实物产品的性能稳定性、质量可靠性、环境适应性、使用寿命等指标达到国际同类产品先进水平").

Achieve quality management, quality self-declaration, and quality traceability system embracing the whole life cycle of products in the fields of food, pharmaceuticals, infant and child products, and household appliances to guarantee the quality and safety of vital consumer products ("在食品、药品、婴童用品、家电等领域实施覆盖产品全生命周期的质量管理、质量自我声明和质量追溯制度，保障重点消费品质量安全").

Intensify the reliability of national defense material to increase the actual fight capacity of domestic defense armies ("大力提高国防装备质量可靠性，增强国防装备实战能力").

3) Improve Quality Supervision Systems: China will:

Perfect product quality standard system, policy planning system and quality management laws and regulations ("健全产品质量标准体系、政策规划体系和质量管理法律法规"). Establish a compulsory reporting system for product accidents in consumer goods production and operation enterprises, improve the system of collecting and publishing quality credit information to make enterprises the main responsible for quality ("建立消费品生产经营企业产品 事故强制报告制度，健全质量信用信息收集和发布制度，强化企业质量主体责任"). Institute a quality blacklist system through the high consideration of recording the violation of laws and regulations in quality as an important asset to rank enterprises' credit and increase the power to solve and punish illegal performances related to poor quality and counterfeit brands ("将质量 违法违规记录作为企业诚信评级的重要内容，建立质量黑名单制度，加大对质量违法和假冒品牌行为的打击和惩处力度"). China will also establish regional and industry quality and safety early warning system to prevent and resolve product quality and safety risks ("建立区域和行业质量安全预警制度，防范化解产品质量安 全风险").

4) Strengthen Quality Foundation: China will:

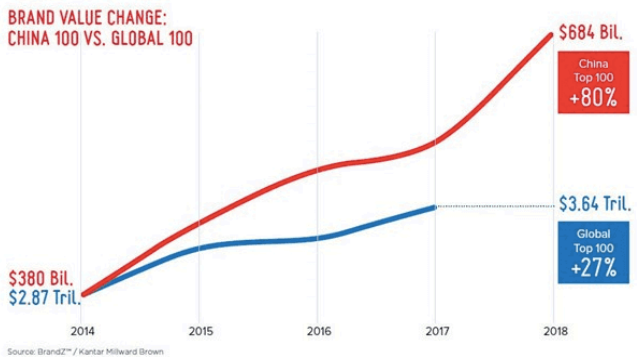
Formulate and implement standards for quality, safety, hygiene, environmental protection and energy conservation of manufacturing industry in line with advanced international standards ("制定和实施与国际先进水平接轨的制造业质量、安全、卫生、环保及节能标准"). Reinforce fundamental and frontier research of science and technology measurements to create some metrological standards with high accuracy and stability to develop the capabilities of national manufacturing quality monitoring ("加强计量科技基础及前沿技术研究，建立一批制造业发展急需的高准确度、高稳定性计量基标准"). China will improve the technical support system for inspection and testing, build much high-level industrial product quality control and technical evaluation laboratories and product quality supervision and inspection centers, and encourage the

establishment of professional testing technology alliances ("完善检验检测技术保障体系，建设一批高水平的工业产品质量控制和技术评价实验室、产品质量监督检验中心，鼓励建立专业检测技术联盟"). Improve the management mode of certification and accreditation, develop the effectiveness of compulsory product certification, promote the healthy development of voluntary product certification, improve the level of management system certification, and steadily promote international mutual recognition ("完善认证认可管理模式，提高强制性产品认证的有效性，推动自愿性产品认证健康发展，提升管理体系认证水平，稳步推进国际互认").

5) Promote Manufacturing Brand Building: China will:

Leading enterprises to create brand management system, focusing on the process of R&D, innovation, manufacturing, quality management, and marketing services, to improve the internal quality and consolidate the basis of brand development ("引导企业制定品牌管理体系，围绕研发创新、生产制造、质量管理和营销服务全过程，提升内在素质，夯实品牌发展基础"). Build several professional institutions for branding cultivation and operation, and to provide brand management consulting and marketing service ("扶持一批品牌培育和运营专业服务机构，开展品牌管理咨询、市场推广等服务"). Build a batch of regional brands of industrial clusters with unique features, strong competitiveness and strong market reputation ("打造一批特色鲜明、竞争力强、市场信誉好的产业集群区域品牌"). Build brand culture, by guiding enterprises to strengthen brand awareness based on quality and reputation as the core, establishing brand development concept, and enhancing the awareness about the brand added value and soft power ("建设品牌文化，引导企业增强以质量和信誉为核心的品牌意识，树立品牌消费理念，提升品牌附加值和软实力"). Speed up the internationalization of China's brands, intensify the power to promote Chinese brands and establish a good image of Chinese brands by making full use of media ("加速我国品牌价值评价国际化进程，充分发挥各类媒体作用，加大中国品牌宣传推广力度，树立中国制造品牌良好形象").

Example: In the last years several numbers of Chinese brands are affirming their power in the global market. Companies such as Huawei ("华为技术有限公司"), the most important and known Chinese multinational in the field of telecommunications equipment and consumer electronics, are continuously acquiring important global market shares. Founded in 1987, Huawei has 170.000 employees (around 76.000 engaged in R&D field) and 21 R&D centers all over the world. It's been nominated the 78's world's most valuable brand for Forbes, and it has become the third mobile manufacturer in the world (right after Samsung and Apple). Other well-known brands can be considered Haier (海尔, a Chinese multinational consumer electronics, and home appliances company), Alibaba (阿里巴巴集团控股有限公司), a Chinese multinational conglomerate specialized in e-commerce, internet, technology, and retail. Following "Statista" (an important data website) it can be considered the 10th most valuable brand in the world (in the ranking we can also see other critical Chinese brands, like Tencent, ICBC, China Construction Bank and China Unicom). Last but not least brands like Lenovo, WeChat, Xiaomi, Baidu, Moutai, confirm what has already been stated, the increasing importance and criticality of Chinese brands on the global market (as evident in the following image).



2.9 Brands Value Change, China 100 vs Global 100 (BrandZ/Kantar Millward Brown)

5. **Implementing Green Production (全面推行绿色制造)**

In order to perfect capabilities for researching advanced energy-saving and environmental technology and for speeding up the ecological updating of manufacturing, China will lively promote low-carbon, recycling, augment the efficiency of manufacturing resource consumption, reinforce life-cycle green product management, and build up a high-efficiency green manufacturing system.

For the realization of these purposes, China will follow the next four main steps:

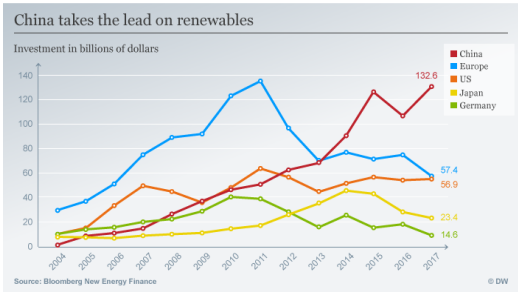
1) Accelerate Green Manufacturing: China will:

Strengthen the research and development and application of green products, promote lightweight, low power consumption, easy recovery and other technical processes ("加强绿色产品研发应用，推广轻量化、低功耗、易回收等技术工艺"). Upgrade the energy efficiency of energy-using goods like electrical machines, boilers, and combustion engines, and speed up the elimination of outdated mechanical and electrical products and technology ("持续提升电机、锅炉、内燃机及电器等终端用能产品能效水平，加快淘汰落后机电产品和技术"). Energetically develop green development in emerging industries ("积极引领新兴产业高起点绿色发展"), Significantly reduce energy consumption in production and use of restricted substance content in electronic goods, create green data centers and green base stations to stimulate low-carbon development of new materials, new energy, high-end equipment, and bio-industry ("大幅降低电子信息产品生产、使用能耗及限用物质含量，建设绿色数据中心和绿色基站, 大力促进新材料、新能源、高端装备、生物产业绿色低碳发展").

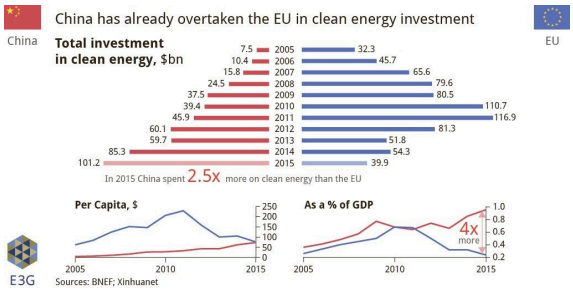
Example: as evident in the graphics that follow, recently China is investing a significant number of funds and making an impressive effort on increasing the use of clean energy in China and on reducing the severe problem of pollution among the country.

These statistics let us understand the importance of this theme in China, considered as a first-importance problem all over the country. Probably the enormous efforts that China

government is doing is still not enough, and the pollution is a huge problem yet, but this data and the path China is implementing should let us sure enough that this is one of the core issues of this country, and shows that the problem of pollution is taken seriously by the leadership (as we'll see in the next paragraphs, the use of electric car and coaches is becoming more and more a critical and compulsory aspect in this society).



2.10 Investments on renewables (Bloomberg)



2.11 Investments in Clean Energy (BNEF, Xinhuanet)

2) Promoting the efficient recycling of resources: China will:

Significantly reduce energy consumption, material consumption and water consumption level ("大幅降低能耗、物耗和水耗水平"). Promote recycling and stimulate materials and resource sharing among enterprises, industrial parks, and industries ("全面推行循环生产方式，促进企业、园区、行业间链接共生、原料互供、资源共享"). China will also promote standardized and large-scale development of the resource recycling industry, strengthen technical and equipment support, and improve the comprehensive utilization of large industrial solid wastes, waste metals, waste electrical and electronic products ("推进资源再生利用产业规范化、规模化发展，强化技术装备支撑，提高大宗工业固体废弃物、废旧金属、废弃电器电子产品等综合利用水平").

3) Actively building a Green Manufacturing System: China will:

Support enterprises to produce green products, advance ecological design to significantly improve the level of energy efficiency, environmental protection and low carbon production ("支持企业开发绿色产品，推行生态设计，显著提升产品节能环保低碳水平"). Institute green factories that achieve intensification, material protection, clean product, waste recycling, and low carbon energy sources, and set up green parks,

supporting mechanical coupling in industrial parks and performing near-zero emissions ("建设绿色工厂，实现厂房集约化、原料无害化、生产洁净化、废物资源化、能源低碳化。发展绿色园区，推进工业园区产业耦合，实现近零排放").

Create a green supply chain, speeding up the establishment of a resource-saving and environment-friendly oriented procurement, production, marketing, recycling, and logistics system, and implementing an extended producer responsibility system ("打造绿色供应链，加快建立以资源节约、环境友好为导向的采购、生产、营销、回收及物流体系，落实生产者责任延伸制度"). Strengthen green enterprises, and support enterprises which implement green strategies, green standards, green management and green production ("壮大绿色企业，支持企业实施绿色战略、绿色标准、绿色管理和绿色生产"). Reinforce green supervision by improving energy savings and environmental regulations and standard systems and upgrading energy saving and environmental protection supervision ("强化绿色监管，健全节能环保法规、标准体系，加强节能环保监察").

4) Green Manufacturing Projects: China will:

Organize and implement special technical reforms of energy efficiency improvement, cleaner production, water saving, pollution control and recycling in traditional manufacturing industry ("组织实施传统制造业能效提升、清洁生产、节水治污、循环利用等专项技术改造"). Implementing the plan of upgrading cleaner production level in key regions, river basins and industries, and firmly promote the prevention and control of sources of atmospheric, water and soil pollution ("实施重点区域、流域、行业清洁生产水平提升计划，扎实推进大气、水、土壤污染源头防治专项"). Generate standard and evaluation systems for green products, factories, industrial parks, and companies ("制定绿色产品、绿色工厂、绿色园区、绿色企业标准体系，开展绿色评价").

By 2020, several green demonstration factories and more or less a hundred green pilot industrial parks will be created. There will be a turn of energy and resources consumption in some heavy chemical industries. Most contaminant emission intensity in major industries will decrease by 20% ("到 2020 年，建成千家绿色示范工厂和百家绿色示范园区，部分重化工行业能源资源消耗出现拐点，重点行业主要污染物排放强度下降 20%"). No later than 2025, manufacturing green development and consumption of green products will then have attained advanced international measures, and a green manufacturing system will be set up ("到 2025 年，制造业绿色发展和主要产品单耗达到世界先进水平，绿色制造体系基本建立").

6. Promote Breakthroughs in Key Areas (大力推动重点领域突破发展)

China will focus on strategic points like next-generation IT, high-end equipment, new materials, and biopharmaceuticals and will devote the most significant part of its social resources to improve and implement strategic industries.

This part is the core part of the whole masterplan. Through an analysis of eleven products fields and the next steps in the improvement and development of the core technologies and the core products, this section exposes the practical steps that China will do in some innovation-driven fields.

1) New Generation Information Technology Industry (Next Generation IT) ("新一代信息技术产业").

- Integrated Circuits and Special Equipment: China will:

Efforts will be made to upgrade the level of integrated circuit design and continuously improve IP (intellectual property) design tools ("着力提升集成电路设计水平，不断丰富知识产权（IP）核和设 计工具"). China will make breakthroughs in general core chips related to national information and network security and will complete the development of electronic industry to enhance the application and the adaptability of domestic chips ("突破关系国家信息与网络安全及电子整机产业发展的核心通用芯片，提升国产芯 片的应用适配能力"). Master high-density packaging and three-

dimensional (3D) micro-assembly technology to enhance the packaging industry and test self-development ability ("掌握高密度封装及三维（3D）微组装技术，提升封装产业和测试的自 主发展能力").

- Communication Equipment: China will:

Master core technologies like new computing, high-speed interconnection, advanced storage, systematic security ("掌握新型计算、高速互联、先进存储、体系化安全保障等核心技术"). Make breakthroughs in the fifth generation mobile communication (5G) technology, core routing and switching technology, ultra-high speed and large capacity intelligent optical transmission technology, and core technology and architecture of the future network ("全面突破第五代移动通信（5G）技术、核心路由交换技术、超高速大容量智能光传输技术、"未来网络"核心技术和体系架构"). Research and development of high-end servers, large-capacity storage, new routing switching, new intelligent terminals, a new generation of base stations, network security and other equipment to promote the systematic development of core information and communication equipment and large-scale applications ("研发高端服务器、大容量存储、新型路由交换、新型智能终端、新一代基站、网络安全等设备，推动核心信息通信设备体系化发展与规模化应用").

Example: Chinese best telecommunications companies (China Unicom, China Mobile, ZTE and China Telecom) are investing their time and their funds to win the race on the development of the 5G network. In contrast with the development of 2G, 3G, and 4G, in which China couldn't realize pilot projects or couldn't contribute on time, for what concerns 5G it seems that China should win the race with the US and other countries. The 18th of January (2019), ZTE, in partnership with China Unicom, announced that the first end-to-end call from Shenzhen to Guangdong was completed. They also tested a WeChat-Group call, online navigation, and video reproducing showing the whole world the advancements done in this field[8].

[8] www.techblog.com

- Operating Systems and Industrial Software: China will:

Improve key industrial software like operating systems and security ("开发安全领域操作系统等工业基础软件"). Make breakthroughs in the core technology of high-end industrial software, such as intelligent design, simulation tools, industrial Internet of Things, industrial big data processing, etc. ("突破智能设计与仿真及其工具、制造物联与服务、工业大数据处理等高端工业软件核心技术"), and develop self-controlled high-end industrial platform software and key domain application software ("开发自主可控的高端工业平台软件和重点领域应用软件"). China will finally build and perfect integrated standard and safety evaluation systems for industrial software ("建立完善工业软件集成标准与安全测评体系").

2) *High-end Digital Control Machine Tools and Robots (*高档数控机床和机器人*).*

- High End Digital Control Machine Tools: China will:

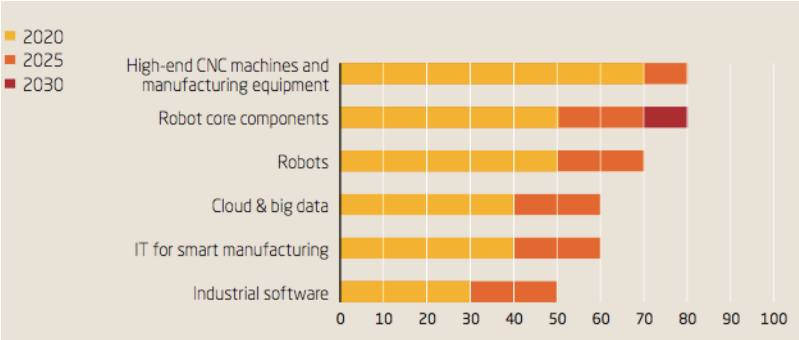
Develop some precision machine tools characterized by high speed, high efficiency, flexibility and develop basic manufacturing equipment and integrated manufacturing system ("开发一批精密、高速、高效、柔性数控机床与基础制造装备及集成制造系统"). Speed up the research of innovative technologies and equipment like high-end digital control machine tools and additive manufacturing ("加快高档数控机床、增材制造等前沿技术和装备的研发").

- Robots: China will:

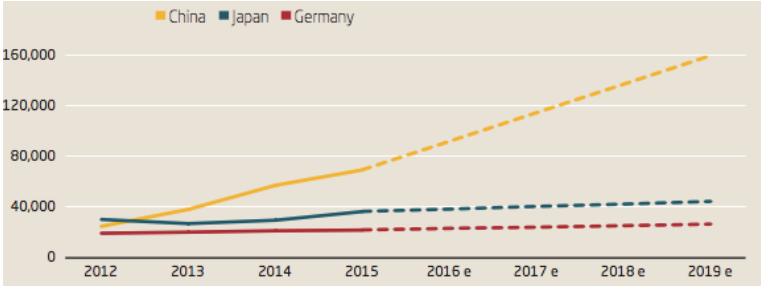
Dynamically research new products and stimulate robotic standardization and expand their market application modularization for the sake of meeting demand for industrial robots in automobile, machinery, electronics, national defense, chemicals and light industry, specialty robots and service robots in medical treatment, domestic services, education and entertainment ("围绕汽车、机械、电子、危险品制造、国防军工、化工、轻工等工业机器人、特种机器人，以及医疗健康、家庭服务、教育娱乐等服务机器人应用需求，积极研发新产品，促进机器人标准化、模块化发

展，扩大市场应用”). Reduce and remove the bottleneck of components parts like robot bodies, reducers, servomotors, controllers, sensors, drivers and integrated system design (“突破机器人本体、减速器、伺服电机、控制器、传感器与驱动器等关键零部件及系统集成设计制造等技术瓶颈”).

Example: In recent years China is increasing the substitution of human resources with robots. Newest trends and strategies predict that the next step in the development and implementation of robots and advanced technologies in China (as clear in the image below) will be the development of Chinese companies (or the acquisition of foreign ones) for replace foreign market shares inside the companies with domestic ones.



2.11 Goals for domestic market share of various Chinese smart manufacturing products, in per cent (Merics)



2.12 Shipments of multipurpose industrial robots in selected countries, per unit (IFR)

As we can see from the tab 2.12, China is tremendously increasing the shipment of multipurpose industrial robots, and its expected to raise more and more this data.

A famous case study in this field is the acquisition realized in 2016 between Midea (Chinese electrical appliance manufacturer) and Kuka (German flagship for industry 4.0 and robots). The acquisition of the 94.55% shows the ambition and the confidence of

Chinese companies, which entirely desire to develop innovation and wish to contribute in the realization of this masterplan[9].

3) *Aerospace and Aeronautic Equipment (*航空航天装备*):*

- Aerospace Equipment: China will:

Speed up extensive aircraft research to improve the development of wide-bodied airplanes and stimulate international collaboration on heavy helicopter research ("加快大型飞机研制，适时启动宽体客机研制，鼓励国际合作研制重型直升机"). Encourage the industrialization of regional line aircraft, helicopter, crewless aerial vehicles and general-purpose airplanes ("推进干支线飞机、直升机、无人机和通用飞机产业化"). Develop advanced airborne equipment and systems to form an independent and complete aviation industry chain ("开发先进机载设备及系统，形成自主完整的航空产业链").

Example: A several numbers of Chinese airlines companies are developing more sophisticated vehicles and are starting to offer more extensive and more global trips. For instance, China Southern Airlines, China Eastern Airlines, and Air China have recently entered the ranking of the world's largest airlines companies in the world, immediately following American companies and Ryanair[10].

- Aeronautic Equipment: China will:

Develop the next generation of carrier rockets and heavy-duty vehicles to enhance the ability to enter the space ("发展新一代运载火箭、重型运载器，提升进入空间能力"). Accelerate the construction of the national and civil space infrastructure, by developing new platforms such as satellites, payload, space broadband Internet system ("加快推进国家民用空间基础设施建设，发展新型卫星等空间平台与有效载荷、空天地宽带互联网系统"). Encourage crewed space flight and lunar exploration and

[9]www.merics.org; www.freshfields.com

[10] www.worldatlas.com

moderate development of deep space exploration ("推动载人航天、月球探测工程，适度发展深空探测").

Example: On 2 January 2019, a Chinese spacecraft realized the first-ever landing on the far side of the moon. Chang'e-4 aims to analyze the moon's ground. For the realization of this purpose, the lander will use ground-penetrating radar. It can get information from just below the lunar surface. The rover also will take panoramic images of a landscape that has never been seen from the ground before. Moreover, measurements by the craft could help establish the safety of human travel to the moon, will record charged particles and radiation and will test whether plants and insects can grow together on the moon (it seems that cotton seeds had sprouted, even if they died shortly afterward, however, during the frigid lunar night)[11].

4) *Oceanographic and High-technology Shipping Equipment (*海洋工程装备及高技术船舶*)*

China will make great efforts to improve equipment and critical systems for deep-sea exploration, resources exploitation, and offshore operations ("大力发展深海探测、资源开发利用、海上作业保障装备及其关键系统和专用设备"). China will promote the development and engineering of deep-sea space stations and large floating structures ("推动深海空间站、大型浮式结构物的开发和工程化"), and gain competencies for comprehensive testing, detection, and evaluation related to marine engineering equipment to improve utilization of oceans ("形成海洋工程装备综合试验、检测与鉴定能力，提高海洋开发利用水平"). Make progressions in luxury cruise design and building, comprehensively enhance the international competitiveness of high-technology ships like liquefied natural gas carriers ("突破豪华邮轮设计建造技术，全面提升液化天然气船等高技术船舶国际竞争力").

[11] www.sciencenewforstudents.com

Example: Two projects that must be mentioned are:

- Jiaolong (蛟龙号), also called underwater dragon, is a submarine considered to be the world's only deep-sea vessel that can reach the depth of 7000 meters.
- Rainbow Fish: due to the innovative technologies implemented and to the evolution of the initial project, China is trying to build the Rainbow Fish (expected in the 2019) a submarine that is expected to reach the impressive depth of 11.000 meters[12].

5) Advanced Rail Transportation Equipment (先进轨道交通装备)

China will foster a next-generation green, intelligent, high-speed and heavy-load rail transportation equipment system to offer customers a total solution focusing on the system life cycle. China will establish the world's leading modern rail transit industry system ("研发新一代绿色智能、高速重载轨道交通装备系统，围绕系统全寿命周期，向用户提供整体解决方案。建立世界领先的现代轨道交通产业体系").

Example: 高速: China Railway High-Speed (CRH) is considered one of the most critical and innovative aspects of modern China. In 2017, CRH provided service to 29 of the country's 33 provincial-level administrative divisions and operated over 25,000 km's passenger tracks in length, accounting for about two-thirds of the world's high-speed rail tracks in commercial service. It is the planet's most widely adopted railway service, with 1.713 billion journeys delivered in 2017 bringing the total aggregate number of trips to 7 billion. Some vehicles can even reach the speed of 415 km/h and spend a maximum of 5 hours to cover the distance from Beijing to Shanghai (1318 km)[13]

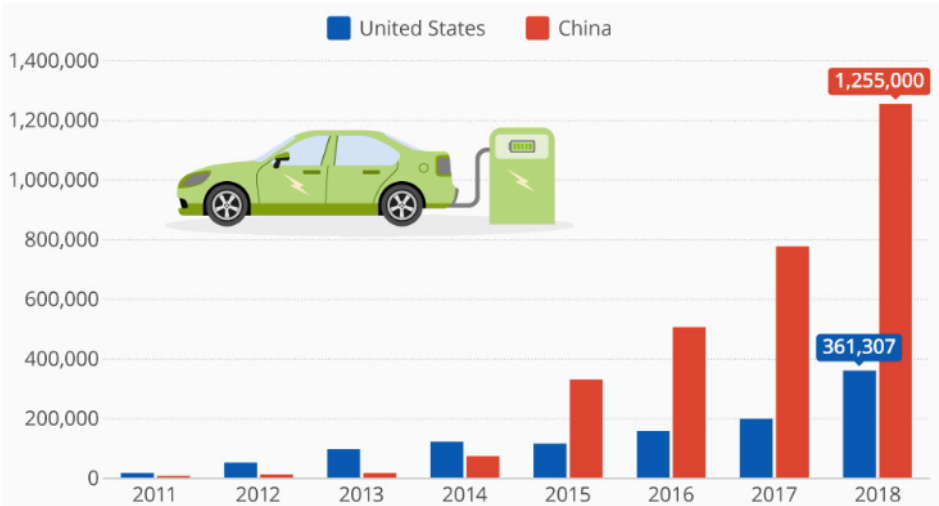
[12] www.oceanologyinternationa.com; www.scmp.com

[13] www.wikipedia.org

6) Energy Efficient and New Energy Automobiles (节能与新能源汽车)

China will continue to promote the development of electric transports and fuel cell vehicles ("继续支持电动汽车、燃料电池汽车发展"). Master the core technology of low-carbon, informatization, and intelligence of automobiles ("掌握汽车低碳化、信息化、智能化核心技术"). Create a complete industrial system and innovation system from key components to the whole finished vehicle ("形成从关键零部件到整车的完整工业体系和创新体系"), and stimulate energy-savings and new energy automobiles with independent and domestic brands to match advanced international levels ("推动自主品牌节能与新能源汽车同国际先进水平接轨").

Example: As we can extract from the graphic below, China is enormously investing funds and money in the development and expansion of electric vehicles. In



2.13 Plug-in electric vehicle sales in the US and China (Statista)

some cities, like Shenzhen, nowadays almost the totality of the taxis, cars, motorbikes, and scooters are electric.

Shenzhen will also become the first city in China in which in the next years the electric cars will be forbidden, and in which the implementation and introduction of Electric Bus (BYD company) in 2018 has been tested. At Shenzhen Eastern Bus Co., one of BYD's three bus-fleet partners, the monthly electricity bill of 17 million yuan is one-

third of what its diesel bill used to be. The company has 15,000 employees and 5,800 buses, which use seven charging stations. Most of the coaches are charged at night, when electricity is cheaper, though they sometimes have to top off in the afternoon. Each bus, indeed, takes about three hours for a full charge and has a range of 250 kilometers (155 miles).

Another indicator of the high-level degree of innovation in this field in China is given by the recent choice of Elon Musk (Tesla CEO) to open Tesla "Gigafactory3" in China, at Shanghai[14].

7) *Electric Power Equipment (*电力装备*)*

China will promote the industrialization and demonstrate the application of large-scale high-efficiency and ultra-clean coal power units, and further improve the manufacturing level of super-large capacity hydropower units, nuclear power units and heavy-duty gas turbines ("推动大型高效超净排放煤电机组产业化和示范应用，进一步提高超大容量水电机组、核电机组、重型燃气轮机制造水平"). Promote the development of new and renewable energy equipment, advanced energy storage devices, power grid transmission, and transformation and end-user types of equipment ("推进新能源和可再生能源装备, 先进储能装置, 智能电网用输变电及用户端设备发展"). Advance in the manufacturing and utilization of essential components and materials like high-power electrical parts and high-temperature superconductors ("突破大功率电力电子器件、高温超导材料等关键元器件和材料的制造及应用技术，形成产业化能力").

8) *Agricultural Machinery Equipment (*农机装备*)*

Focus on advanced agricultural machinery needed in the fabrication of staple foods such as grain, cotton, sugar and oil, and strategic economic cultivations like breeding, ploughing and sowing, planting, maintenance, collection, transport, and storage ("重点发展粮、棉、油、糖等大宗粮食和战略性经济作物育、耕、种、管、收、运、贮等主要生产过程使用的先进农机装备"). We will accelerate the development of high-

[14] www.bloomberg.com; www.forbes.com

end agricultural equipment and key components such as large tractors and their duplex operating machines, large and efficient combine harvesters ("加快发展大型拖拉机及其复式作业机具、大型高效联合收割机等高端农业装备及关键核心零部件"). Improve the ability of information collection, intelligent decision-making and precise operation of agricultural machinery and equipment, and promote the formation of an information-oriented overall solution for agricultural production ("提高农机装备信息收集、智能决策和精准作业能力，推进形成面向农业生产的信息化整体解决方案").

9) *New Materials (*新材料*)*

China will accelerate the research and development of key technologies and equipment for the preparation of advanced melting, solidification, vapor deposition, profile processing, high-efficiency synthesis ("加快研发先进熔炼、凝固成型、气相沉积、型材加工、高效合成等新材料制备关键技术和装备"). We will actively develop military and civilian sharing of special new materials, accelerate the two-way transfer and transformation of technology, and promote the integration of military and civilian development of the new material industry ("积极发展军民共用特种新材料，加快技术双向转移转化，促进新材料产业军民融合发展"). Attention should be paid to the influence of subversive new materials on traditional materials. Strategic frontier materials such as superconducting materials, nanomaterials, graphene, and bio-based materials should be laid out and developed in advance ("高度关注颠覆性新材料对传统材料的影响，做好超导材料、纳米材料、石墨烯、生物基材料等战略前沿材料提前布局和研制"). China will finally accelerate upgrading of basic materials ("加快基础材料升级换代").

10) *Bio-pharmaceuticals and High-performance Medical Equipment (*生物医药及高性能医疗器械*)*

China will promote new medical products by applying chemicals and biotechnology to treat critical diseases, such as antibody drugs, antibody coupling drugs, new structural proteins, polypeptide drugs, and new vaccines. China will also enhance innovation in traditional Chinese medicine with extended clinic benefits ("发展针对重大疾病的化学药、中药、生物技术药物新产品，重点包括新机制和新靶点化学药、抗体药物、抗体偶联药物、全新结构蛋白及多肽药物、新型疫苗、临床优势突出的创新中药及个性化治疗药物"). Improve the modernization and industrialization level of medical apparatus and tools, basing on successful diagnosis and treatment equipment (imaging equipment and medical robots), high-value medical supplies (fully-degradable stent), and mobile medical products (wearable and remote diagnosis equipment) ("提高医疗器械的创新能力和产业化水平，重点发展影像设备、医用机器人等高性能诊疗设备，全降解血管支架等高值医用耗材，可穿戴、远程诊疗等移动医疗产品"). China will also make breakthroughs in the application of new technologies such as bio-3D printing and induced pluripotent stem cells ("实现生物 3D 打印、诱导多能干细胞等新技术的突破和应用")

*11) High-end Equipment Innovation Project (*高端装备创新工程*):*

China will develop several innovative and industrialized ad hoc plans and important projects in large airplanes, aerospace-engines, gas turbines, public aeronautics, smart green trains, innovative energy vehicles, ocean planning machinery and high technology boats, intelligent energy grids, high-end digital control machine devices, nuclear power facilities and high-end medical equipment ("组织实施大型飞机、航空发动机及燃气轮机、民用航天、智能绿色列车、节能与新能源汽车、海洋工程装备及高技术船舶、智能电网成套装备、高档数控机床、核电装备、高端诊疗设备等一批创新和产业化专项、重大工程").

By 2020, China will perform independent researches and applications in the segments mentioned above. By 2025, the market share of high-end equipment with independent intellectual property will significantly grow up. External dependence of core technology will dramatically decrease. China's ability to provide first auxiliary items will substantially increase. Equipment in significant areas will reach advanced international levels ("到 2020 年，上述领域实现自主研制及应用。到 2025 年，自主知识产权高端装备市场占有率大幅提升，核心技术对外依存度明显下降，基础配套能力显著增强，重要领域装备达到国际领先水平").

7. Raise Structure Adjustment in Manufacturing (深入推进制造业结构调整)

China will promote traditional industries to move towards high-end, gradually eliminate excess capacity, improve the coordinated development of large enterprises and small and medium-sized enterprises, and further optimize the layout of the manufacturing industry. These goals will be realized through the realization of three steps:

1) Continuously Promote Enterprises Technology Upgrading: China will:

Promote major strategic projects and high-end equipment technology upgrading ("明确支持战略性重大项目和高端装备实施技术改造的政策方向"). Improve the policy system to support technology upgrading by promoting legislation regarded to technology upgrades and strengthening incentives and restraint mechanisms ("推动技术改造相关立法，强化激励约束机制，完善促进企业技术改造的政策体系"). Support technological transformation in key industries, high-end products, and key links, guiding enterprises to adopt advanced and applicable technologies and optimizing product structure ("支持重点行业、高端产品、关键环节进行技术改造，引导企业采用先进适用技术，优化产品 结构"). Extensively enhance the design, manufacturing, technology, and management in industries such as steel, petrochemicals, engineering machinery, light industry, and textiles to drive Chinese products to the top of the value chain ("全面提升设计、制造、工艺、管理水平，促进钢铁、石化、工

程机械、轻工、纺织 等产业向价值链高端发展"). China will draft and formulate investment guidelines and key project-oriented plans for the technological transformation of key industries in order to attract social funds and optimize the structure of industrial investment ("研究制定重点产业技术改造投资指南和重点项目导向计划，吸 引社会资金参与，优化工业投资结构"). Spread and apply new technology, new technology, new equipment, and new materials to improve the production technology level and efficiency of enterprises ("推广应用新技术、新工艺、新装备、新材料，提高企业生产技术水平和效 益").

2) Promote a Coordinated Development between Large, Medium and Small Enterprises: China will:

Increase the dominant position of enterprises in the market, support strategic cooperation among enterprises, cross-industry and cross-regional M&A and reorganization, to improve the level of large-scale and intensive operation, and cultivate a number of enterprise groups with strong core competitiveness ("强化企业市场主体地位，支持企业间战略合作和跨行业、跨区域兼并重组，提高规模化、集约化经营水平，培育一批核心竞争力强的企业集团"). Stimulate the entrepreneurial innovation vitality of small and medium-sized enterprises, and develop many specialized "small giant" enterprises with outstanding main business, strong competitiveness, good growth and focusing on a niche market ("激发中小企业创业创新活力，发展一批主营业务突出、竞争力强、成长性好、专注于细分市场的专业化"小巨人"企业"). Promote cooperation between Sino-foreign small and medium enterprises and support them to become international and attract foreign investments exploiting bilateral and multilateral collaboration systems ("发挥中外中小企业合作园区示范作用，利用双边、多边中小企业合作机制，支持中小企业走出去和引进来"). Develop some high-quality small and medium enterprise clusters ("推动建设一批高水平的中小企业集群").

3) Optimize the Layout of Manufacturing: China will

Improve the industrial transfer roadmap, create a national industrial transfer information service platform and build several demonstration parks to guide industry transfer and stimulate coordinated development of eastern, central and western manufacturing ("完善产业转移指导目录，建设国家产业转移信息服务平台，创建一批承接产业转移示范园区，引导产业合理有序转移，推动东中西部制造业协调发展"). China will actively promote the coordinated development of industries in the Beijing-Tianjin-Hebei and Yangtze River economic zones ("积极推动京津冀和长江经济带产业协同发展"). In accordance with the requirements of new industrialization, the existing manufacturing agglomeration areas should be transformed and upgraded to promote the transformation and upgrading of industrial agglomeration to industrial clusters ("按照新型工业化的要求，改造提升现有制造业集聚区，推动产业集聚向产业集群转型升级"). Build some new technical industrial demonstration bases with high-efficiency industrial chain synergies, strong core competitiveness and sound public service systems ("建设一批特色和优势突出、产业链协同高效、核心竞争力强、公共服务体系健全的新型工业化示范基地").

8. Actively Develop a Service-oriented Manufacturing and the Product Service Industry (积极发展服务型制造和生产性服务业)

The acceleration in the joint development of the manufacturing and service sectors and the promotion of business model innovation and structural innovation will enable China to strengthen manufacturing productivity and convert it into service-oriented manufacturing. China will increase productive manufacturing services and promote service functional zones and service platforms.

China considers three steps as fundamental in the realization of the goals mentioned above:

1) Promote the Development of Service-Oriented Manufacturing: China will:

Study and formulate guidelines for promoting the development of service-oriented manufacturing and implement action plans for service-oriented manufacturing ("研究制定促进服务型制造发展的指导意见，实施服务型制造行动计划"). Encourage manufacturing enterprises to increase investment in service sectors, develop personalized customization services, life cycle management, network precision marketing and online support services ("鼓励制造业企业增加服务环节投入，发展个性化定制服务、全生命周期管理、网络精准营销和在线支持服务等"). Promote the transformation of eligible enterprises from equipment providers into integrated system contractors and from product providers into total solution providers ("支持有条件的企业由提供设备向提供系统集成总承包服务转变，由提供产品向提供整体解决方案转变"). Support eligible manufacturing enterprises in the construction of financial institutions such as financial service and financial leasing companies to enhance finance and leasing services for large manufacturing equipment and production lines ("支持符合条件的制造业企业建立企业财务公司、金融租赁公司等金融机构，推广大型制造设备、生产线等融资租赁服务").

2) Speed Up Development of Manufacturing Services: China will:

Vigorously improve capabilities for manufacturing-oriented IT services, project design, and information application system development and assimilation in major industries ("大力发展面向制造业的信息技术服务，提高重点行业信息应用系统的方案设计、开发、综合集成能力"). Enterprises such as Internet enterprises are encouraged to develop innovative business models around mobile e-commerce, online customization, online-to-offline, and actively develop dynamic monitoring and forecasting and early warning of products and markets, to achieve seamless coupling with manufacturing enterprises and innovative business collaboration processes and value creation models ("鼓励互联网等企业发展移动电子商务、在线定制、线上到线下等创新模式，积极发展对产品、市场的动态监控和预测预警等业务，实现与制造业企业的无缝对

接，创新业务协作流程和价值创造模式"). Speed up technology improvement of service supporting examination and design, technology transfer, innovation incubation, IPR and technology consultation, so much as production service industries like third-party logistics, energy saving and environmental safety, investigation and detection, certification, e-commerce, service outsourcing, investment and leasing, hrm, after-sale service, and brand management to fortify support for manufacturing transformation ("加快发展研发设计、技术转移、创业孵化、知识产权、科技咨询等科技服务业，发展壮大第三方物流、节能环保、检验检测认证、电子商务、服务外包、融资租赁、人力资源服务、售后服务、品牌建设等生产性服务业，提高对制造业转型升级的支撑能力").

3) Reinforce Service Functional Zones and Public Service Platforms: China will:

Create manufacturing service functional areas that concentrate on modern services such as research and design, information, logistics, business, and finance to enhance influence capacity ("建设和提升生产性服务业功能区，重点发展研发设计、信息、物流、商务、金融等现代服务业，增强辐射能力"). Stimulate manufacturing firms in the eastern zone to improve service-oriented businesses ("区企业加快制造业服务化转型，建立生产服务基地"). Support central and western areas to build specialized and competitive manufacturing services and develop service facilities to gain collaborative development between manufacturing and service industries ("支持中西部地区发展具有特色和竞争力的生产性服务业，加快产业转移承接地服务配套设施和能力建设，实现制造业和服务业协同发展").

9. Improve Internationalization of Manufacturing (提高制造业国际化发展水平)

The stipulation of an overall plan is fundamental to take advantage of international and domestic resources and markets. By accelerating the realization of the "opening up" strategy and merging the ideas of "going out" and "bringing in", China will expand into new areas and improve international cooperation. China will also

stimulate the internationalization of major industries and will lead enterprises to reinforce global competitiveness.

The realization of this goal is reached through the fulfillment of three main steps:

1) Improve Utilization of Foreign Capital and International Cooperation: China will:

Further, liberalize the general manufacturing industry, maximize the "open up" structure to improve the performance ("进一步放开一般制造业，优化开放结构，提高开放水平"). Support foreign capital to invest in high-end manufacturing like next-generation IT, high-end equipment, new materials and bio-pharmaceutical, as well as stimulate foreign enterprises and research institutions to establish global research institutions in China ("引导外资投向新一代信息技术、高端装备、新材料、生物医药等高端制造领域，鼓励境外企业和科研机构在我国设立全球研发机构"). Supporting legible enterprises to issue stocks and bonds overseas and encouraging them to carry out various forms of technical cooperation with overseas enterprise ("支持符合条件的企业在境外发行股票、债券，鼓励与境外企业开展多种形式的技术合作").

2) Enhance Transnational Operation Capability and International Competitiveness: China will:

Develop Chinese multinational firms and enhance their core competitiveness by taking advantage of global sources, business process re-engineering, industrial chain integration, and capital market operations ("支持发展一批跨国公司，通过全球资源利用、业务流程再造、产业链整合、资本市场运作等方式，加快提升核心竞争力"). Stimulate enterprises to carry out mergers, equity investment and FDI overseas. Promote the establishment of research centers, experimental bases and global marketing and service operations overseas by enterprises. Support enterprises to perform Internet design, precision marketing, value-added service innovation, and media brand promotion which depend on the internet and build global industrial chain system to improve international operation and service ("支持企业在境外开展并购和股权投

资、创业投资，建立研发中心、实验基地和全球营销及服务体系；依托互联网开展网络协同设计、精准营销、增值服务创新、媒体品牌推广等，建立全球产业链体系，提高国际化经营能力和服务水平"). Stimulate strong enterprises to improve overall international contract and total integration ("鼓励优势企业加快发展国际总承包、总集成"). China will lead enterprises to merge into local culture, reinforce knowledge of social responsibility, enhance investment and operation risk management and improve their ability to localize in foreign countries ("引导企业融入当地文化，增强社会责任意识，加强投资和经营风险管理，提高企业境外本土化能力").

3) Deepen International Industrial Cooperation and Internationalization: China will:

Actively co-operate and support international industrial cooperation, carry out major strategic plans such as the Silk Road Economic Belt and the 21st Century Marine Silk Road, to speed up the construction of infrastructure for interconnection with neighboring countries and deepen industrial cooperation ("积极参与和推动国际产业合作，贯彻落实丝绸之路经济带和 21世纪海上丝绸之路等重大战略部署，加快推进与周边国家互联互通基础设施建设，深化产业合作"). We will encourage the transfer of high-end equipment, advanced technology and strong production capacity overseas ("鼓励高端装备、先进技术、优势产能向境外转移"). Consolidate the policies guidance and set up industrial cooperation to extend from processing and manufacturing to cooperative R&D, joint-design, marketing, and brand development to improve international cooperation levels ("加强政策引导，推动产业合作由加工制造环节为主向合作研发、联合设计、市场营销、品牌培育等高端环节延伸，提高国际合作水平").

Example: 一带一路 "One Belt One Road": "China's Belt and Road Initiative (also known as One Belt, One Road (OBOR) is one of President Xi's most ambitious foreign and economic policies. It aims to strengthen Beijing's economic leadership through a vast program of infrastructure building throughout China's neighboring

regions. Many foreign policy analysts view this initiative largely through a geopolitical lens, seeing it as Beijing's attempt to gain political leverage over its neighbors. No doubt is part of Beijing's strategic calculation. One of the overriding objectives of OBOR is to address China's deepening regional disparity as the country's economy modernizes. Beijing hopes its transnational infrastructure building program will spur growth in China's underdeveloped hinterland and rustbelt. The initiative will have a heavy domestic focus. The Chinese Government also wants to use OBOR as a platform to address the country's chronic excess capacity. It is more about migrating surplus factories than dumping excess products. One of the least understood aspects of OBOR is Beijing's desire to use this initiative to export China's technological and engineering standards. Chinese policymakers see it as crucial to upgrading the country's industry" (Peter Cai, 2017).

• Strategic Support and Guarantee (“战略支撑与保障”)

The creation of a manufacturing power is linked with China's will to put the socialist system in the position to make an efficient use and to mobilize all the social forces. China needs to strengthen reform further and improve policies and standards. The transformation of the Chinese manufacturing system from big to strong requires a flexible and efficient implementation mechanism and the precise cultivation of an innovative manufacturing culture, portrayed with Chinese peculiarity.

The realization of the aspects mentioned above will be possible for China following and realizing eight critical steps, discussed in the following paragraphs.

1. **Deepening Institutional Mechanisms Reform (深化体制机制改革)**:

China will: Speed up the transformation of government functions, innovate government management methods, strengthening the formulation and implementation of manufacturing development strategies, plans, policies, and standards ("加快转变政府职能，创新政府管理方式，加强制造业发展战略、规划、政策、标准等制定和

实施"). Assign more powers to lower-level governments and society in general by further improving the review of administrative revision and approval plans, regulating approval systems, and facilitating procedures ("简政放权，深化行政审批制度改革，规范审批事项，简化程序，明确时限"). China should also improve collaborative research mechanisms involving government, industry, university and research centers, it will also reform the mechanism of technological innovation management system and the mechanism of allocation of project funds, evaluation, and transformation of achievements, promote the capitalization and industrialization of scientific and technological achievements, and stimulate the innovation vitality of manufacturing industry ("完善政产学研用协同创新机制，改革技术创新管理体制机制和项目经费分配、成果评价和转化机制，促进科技成果资本化、产业化，激发制造业创新活力"). Accelerate the market-oriented reform of factor prices, improve the mechanism of determining prices mainly by the market, and rationally allocate public resources ("加快生产要素价格市场化改革，完善主要由市场决定价格的机制，合理配置公共资源"). Rectify trading systems for pollution discharge, carbon emissions, and water rights, enhance resource tax ad valorem collection, and transform environmental safeguard charges into taxes ("推行节能量、碳排放权、排污权、水权交易制度改革，加快资源税从价计征，推动环境保护费改税"). China will also deepen the reform of state-owned enterprises, improve the corporate governance structure, develop the mixed ownership economy in an orderly manner, further eliminate various forms of industrial monopoly and remove unreasonable restrictions on non-public ownership economy ("深化国有企业改革，完善公司治理结构，有序发展混合所有制经济，进一步破除各种形式的行业垄断，取消对非公有制经济的不合理限制"). Improve the industrial safety review mechanism and legal system ("健全产业安全审查机制和法规体系"). Reinforce the safety review of investment and financing, mergers and acquisitions, bidding and procurement in important areas of manufacturing industry related to the lifeline of the national economy and national security ("加强关系国民经

济命脉和国家安全的制造业重要领域投融资、并购重组、招标采购等方面的安全审查").

2. Create a Fair Market Environment (营造公平竞争市场环境):

China will: Implement a scientific and standardized industry access system, formulating and improving access standards for energy-saving, land-saving, water conservation, environmental protection, technology and safety in the manufacturing industry, and by strengthening supervision and inspection of the implementation of national standards ("实施科学规范的行业准入制度，制定和完善制造业节能节地节水、环保、技术、安全等准入标准，加强对国家强制性标准实施的监督检查"). Effectively strengthen supervision, prevent manufacturing and selling of counterfeit and faulty practices, severely punish market monopoly and unfair competition, and create a good production and operation environment for enterprises ("切实加强监管，打击制售假冒伪劣行为，严厉惩处市场垄断和不正当竞争行为，为企业创造良好生产经营环境"). We will accelerate the development of technology markets and improve the mechanisms for the creation, use, management and protection of intellectual property rights ("加快发展技术市场，健全知识产权创造、运用、管理、保护机制"). Reduce the burden on enterprises by realizing a fee list system, creating a national fee list library, removing unreasonable fees and apportionments, and reinforcing supervision and accountability ("进一步减轻企业负担，实施涉企收费清单制度，建立全国涉企收费项目库，取缔各种不合理收费和摊派，加强监督检查和问责"). Promote the construction of the credit system for manufacturing enterprises, build the database of manufacturing credit in China, and establish and improve the dynamic evaluation, incentive and punishment mechanism for dishonesty ("推进制造业企业信用体系建设，建设中国制造信用数据库，建立健全企业信用动态评价、守信激励和失信惩戒机制").

3. Improving Financial Support Policies (完善金融扶持政策):

China will: Support the Export-Import Bank of China to increase its services for manufacturing "going out" industry in its scope of business ("支持中国进出口银行在业务范围内加大对制造业走出去的服务力度"). China Development Bank should be encouraged to increase loans to manufacturing enterprises, and financial institutions should be guided to innovate products and businesses that conform to the characteristics of manufacturing enterprises ("鼓励国家开发银行增加对制造业企业的贷款投放，引导金融机构创新符合制造业企业特点的产品和业务"). Guide venture capital and private equity investment to support the innovation and development of manufacturing enterprises ("引导风险投资、私募股权投资等支持制造业企业创新发展"). Support large manufacturing enterprise groups in key areas to carry out pilot projects of integration of industry and finance, and promote the transformation and upgrading of manufacturing industry through financial leasing ("支持重点领域大型制造业企业集团开展产融结合试点，通过融资租赁方式促进制造业转型升级"). With the premise of controllable risk and sustainable business, increase support for manufacturing enterprises to execute overseas resource research, set up research centers, and perform mergers and purchases applying offshore financing versus internal guarantees, foreign exchange and RMB loans, debt financing and equity financing under the requirements of controllable risk and sustainable business ("在风险可控和商业可持续的前提下，通过内保外贷、外汇及人民币贷款、债权融资、股权融资等方式，加大对制造业企业在境外开展资源勘探开发、设立研发中心和高技术企业以及收购兼并等的支持力度").

4. Improve Fiscal and Taxation Policy (完善金融扶持政策):

China will: Make full use of existing channels, strengthening financial support for manufacturing industry, focusing on key areas of transformation and upgrading of manufacturing industry, such as intelligent manufacturing, "four-base" development, high-end equipment, to create a good policy environment for the development of

manufacturing industry ("充分利用现有渠道，加强财政资金对制造业的支持，重点投向智能制造、"四基"发展、高端装备等制造业转型升级的关键领域，为制造业发展创造良好政策环境"). Utilize public-private partnerships (PPP) for the distribution of social capital to major projects, technology improvement, and key manufacturing infrastructure ("运用政府和社会资本合作（PPP）模式，引导社会资本参与制造业重大项目建设、企业技术改造和关键基础设施建设"). China will deepen the management reform of science and technology plans (special projects, funds, etc.), support R&D and demonstration applications in key areas of manufacturing industry, and promote technological innovation, transformation and upgrading of manufacturing industry and structural layout adjustment ("深化科技计划（专项、基金等）管理改革，支持制造业重点领域科技研发和示范应用，促进制造业技术创新、转型升级和结构布局调整"). Improve and implement government procurement policies to support innovation and promote research and development and large-scale application of innovative products in the manufacturing industry("完善和落实支持创新的政府采购政策，推动制造业创新产品的研发和规模化应用"). Fulfill taxation policies in favor of manufacturing change, advance added-value tax improvement and develop the estimation and auditing schemes of research costs to lessen manufacturing enterprise tax duties ("实施有利于制造业转型升级的税收政策，推进增值税改革，完善企业研发费用计核方法，切实减轻制造业企业税收负担").

5. Perfect Multi-Level Talent Training System(健全多层次人才培养体系):

China will: Strengthen the training of professional and technical personnel, managerial personnel and skilled personnel, train and cultivate a group of excellent entrepreneurs and high-level managerial talents ("加大专业技术人才、经营管理人才和技能人才的培养力度，培养造就一批优秀企业家和高水平经营管理人才). Focus on the high-level and urgent need for professional and technical personnel and innovative talents, implement the knowledge personnel improvement project for professional and technical personnel and the training plan for advanced manufacturing

outstanding engineers ("以高层次、急需紧缺专业技术人才和创新型人才为重点，实施专业技术人才知识更新工程和先进制造卓越工程师培养计划"), China will also create a number of engineering innovation training centers in colleges and universities to develop a group of high-quality professional and technical personnel ("在高等学校建设一批工程创新训练中心，打造高素质专业技术人才队伍"). Reinforce education and skill training by allowing undergraduate universities to turn into related technology universities and by creating training bases to carry out new apprenticeship pilot demonstrations ("强化职业教育和技能培训，引导一批普通本科高等学校向应用技术类高等学校转型，建立一批实训基地，开展现代学徒制试点示范，形成一支门类齐全、技艺精湛的技术技能人才队伍"). Encouraging cooperation between enterprises and schools to train scientific researchers, technical and skilled personnel and compound talents urgently needed by the manufacturing industry ("鼓励企业与学校合作，培养制造业急需的科研人员、技术技能人才与复合型人才"). We will deepen the reform of the mode of enrollment and training for postgraduates with engineering doctorates and master's degrees in relevant fields, and actively promote the integration of industry, education, and research ("深化相关领域工程博士、硕士专业学位研究生招生和培养模式改革，积极推进产学研结合"). Improve industrial human resources demand to forecast, reinforce personnel databases and make up an industrial talent assessment systems and information distribution platforms, define talent incentive mechanism, and strengthen the recognition and reward of outstanding talents ("加强产业人才需求预测，完善各类人才信息库，构建产业人才水平评价制度和信息发布平台建立人才激励机制，加大对优秀人才的表彰和奖励力度"). Build up talent incentive mechanisms and augment recognition and rewards for excellent talents ("建立完善制造业人才服务机构，健全人才流动和使用的体制机制"). Carefully choose talented young professionals and students, principally the ones with professional and technical education, to go overseas for study and training, while

creating international training bases in China ("采取多种形式选拔各类优秀人才重点是专业技术人才到国外学习培训，探索建立国际培训基地").

6. Improve the Policy of Small and Medium-sized Enterprises (完善中小微企业政策):

China will: Implement and perfect preferential fiscal and taxation policies to support the development of small and micro enterprises and optimizing the key points and ways of using special funds for the development of small and medium-sized enterprises ("落实和完善支持小微企业发展的财税优惠政策，优化中小企业发展专项资金使用重点和方式"). Enhance available private capital to build many financial institutions such as small and medium banks and stimulate commercial banks to improve specialized financial services for small and micro enterprises, for example leasing guarantee systems and innovative financial products ("支持符合条件的民营资本依法设立中小型银行等金融机构，鼓励商业银行加大小微企业金融服务专营机构建设力度，建立完善小微企业融资担保体系，创新产品和服务"). Create and improve the entrepreneurial basis for small and medium enterprises and drive firms investment funds to invest small and micro enterprises ("建设完善中小企业创业基地，引导各类创业投资基金投资小微企业"). Stimulate universities, research institutes and engineering centers to open and share all kinds of testing facilities for small and medium-sized enterprises ("鼓 励大学、科研院所、工程中心等对中小企业开放共享各种实（试）验设施"). Reinforce the creation of total service system for small and medium-sized enterprises, improve the network of public service platform for small and medium-sized enterprises, define an information interconnection mechanism, and provide professional services for small and medium-sized enterprises focusing on themes as entrepreneurship, innovation, financing, consulting, training and talents ("加强中小微企业综合服务体系建设，完善中小微企业公共服务平台网络，建立信息互联互通机制，为中小微企业提供创业、创新、融资、咨询、培训、人才等专业化服务").

7. Further Expanding the Opening-up of Manufacturing Industry (进一步扩大制造业对外开放):

China will: Deepen the reform of foreign investment management system and create a stable, transparent and predictable business environment ("深化外商投资管理体制改革，营造稳定、透明、可预期的营商环境"). Support manufacturing enterprises to introduce advanced technology and high-end talents through commissioned development, patent authorization and crowdsourcing ("支持制造业企业通过委托开发、专利授权、众包众创等方式引进先进技术和高端人才"). Renew the utilization of foreign capital to highlight joint ventures, collaborative development, outbound M&A, and recruiting top talent to operate in China ("推动利用外资由重点引进技术、资金、设备向合资合作开发、对外并购及引进领军人才转变"). Reinforce legislation on foreign investment, strengthen legal protection for manufacturing enterprises to "go out", standardize their overseas operations and safeguard their legitimate rights and interests ("加强对外投资立法，强化制造业企业走出去法律保障，规范企业境外经营行为，维护企业合法权益"). Improve the early warning and coordination mechanism for dealing with trade frictions and major issues of overseas investment ("完善应对贸易摩擦和境外投资重大事项预警协调机制").

8. Improve the Organization and Implementation Systems (健全组织实施机制):

China will: Establish a leading national group for rejuvenating Chinese manufacturing and will let the group headed by the chief of the State Council, with group members assigned from relevant departments of the State Council ("成立国家制造强国建设领导小组，由国务院领导同志担任组长，成员由国务院相关部 门和单位负责同志担任"). The main responsibilities of the leading group are: to coordinate the overall work of building a strong manufacturing country, to consider major plans, major policies, major projects, major issues and major work arrangements, to strengthen

strategic planning, and to guide departments and local governments in their work ("领导小组主要职责是：统筹协调制造强国建设全局性工作，审议 重大规划、重大政策、重大工程专项、重大问题和重要工作安排，加强战略谋划，指导部 门、地方开展工作"). This group will: promote multi-level, multi-area and multi-form think tanks with Chinese features including social think tanks and firms think tanks to provide intellectual support to rejuvenate Chinese manufacturing ("支持包括社会智库、企业智库在内的多层次、多领域、多形态的中 国特色新型智库建设，为制造强国建设提供强大智力支持"). Establish a mechanism for supervision and inspection of the implementation of MIC 2025 and third-party evaluation, and improve statistical monitoring, performance evaluation, dynamic adjustment and supervision, and assessment mechanisms. Establish the mid-term evaluation mechanism of MIC2025 and make necessary adjustments to the target tasks in time ("建立《中国制造 2025》任务落 实情况督促检查和第三方评价机制，完善统计监测、绩效评估、动态调整和监督考核机 制。建立《中国制造 2025》中期评估机制，适时对目标任务进行必要调整").

CHAPTER 3

MADE IN CHINA 2025 & INDUSTRY 4.0

"Germany's economy is characterized by its strong industrial base, particularly its machinery and plant manufacturing, automotive and energy industries. Implementation of Industrie 4.0 will be absolutely key to its future development, we cannot allow industry to come to a standstill."

Ernst Burgbacher

After having exposed the newest and most respected thesis (theorized by some of the most essential and relevant authors) about Industry 4.0, and having meticulously analyzed Made In China 2025 masterplan, this chapter will briefly focus on the "Recommendations for implementing the strategic initiative Industrie 4.0: Final report of the Industrie 4.0 Working Group" program in Germany, highlighting the most critical issues, the main aspects of the strategy, and defining the major steps for the implementation.

After this brief introduction, one comparative research on the differences and the similarities of these two significant plans will be performed, trying to define the different context, the different strategies, the paths of adoption, and the different goals that each project is fiercely trying to achieve.

3. GERMANY INDUSTRY 4.0 PROGRAM

The concept of Industry 4.0 first emerged in Germany at Hannover Messe in 2011 when Professor Wolfgang Wahlster, Director and CEO of the German Research Center for Artificial Intelligence, greeted the opening ceremony audience. Industry 4.0 was introduced as the name of the strategic program promoted by the Federal Government for the high-tech manufacturing industry.

This program was born in a country with one of the most advanced manufacturing industry in the world, and which was recognized as a global leader in the manufacturing equipment sector. Since the competition in the manufacturing engineering segment was getting fiercer, and because several countries were starting to taking measures to strive against the "deindustrialization" through the development of advanced manufacturing, Germany decided to elect itself as the first-mover in the theorization and application of the concepts analyzed in the first chapter of this work.

The foundation of the whole strategy is the development, implementation, and the integration of Cyber-Physical Systems (CPS) in the manufacturing environment.

CPS involve smart machines, storage systems, production equipment capable of autonomously interchanging information, triggering activities and checking each other independently, and all those facilities critical to the creation of the smart supply chain and to the establishment of smart factories. To realize the transformation from industrial production to Industrie 4.0, Germany requires to adopt a dual strategy. Germany's manufacturing industry should try to maintain its global market leadership by continuously integrating information and communication technology into its traditional high-tech strategy so that it can become the leading supplier of smart manufacturing technologies. At the same time, it will be inevitable to build and serve new leading markets for CPS technologies and goods.

The trip through Industry 4.0 will demand Germany to invest a considerable amount of effort and funds into the R&D area. If Industry 4.0 aims to be successfully performed, industrial policy decisions must step-by-step follow these activities.

The Industry 4.0 Working Group, specially created for this project, identified eight key areas in which action is needed:

1) Standardization and reference architecture;

2) Managing complex systems;

3) A comprehensive broadband infrastructure for industry;

4) Safety and security;

5) Work organization and design;

6) Training and continuing professional development;

7) Regulatory framework;

8) Resource efficiency.

For Germany, the journey towards Industry 4.0 will be an evolutionary process. Modern basic technologies and experience will need to be adjusted to the particular demands of manufacturing engineering, and innovative solutions for new locations

and new markets need to be investigated. The realization of these goals will enable Germany to improve its global competitiveness and protect its national manufacturing industry.

The structure of the Germany 4.0 Program

German Industry 4.0 plan is divided as follow:

1) The vision: Industry 4.0 as a part of a smart, networked world ("Die Vision: Industrie 4.0 als Teil einer vernetzten, intelligenten Welt");

2) The dual strategy: becoming a leading market and supplier ("Duale Strategie: Leitmarkt und Leitanbieterschaft");

3) Research requirements ("Forschungsbedarf");

4) Priority areas for action ("Handlungsfelder");

5) How does Germany compare with the rest of the world? ("Internationaler Vergleich")?

6) Outlook ("Ausblick").

In the following paragraphs, the most important parts will be shortly analyzed.

• The Vision

"Industrie 4.0 allows Germany the possibility to further reinforce its position as a manufacturing country, manufacturing equipment supplier and IT business solutions supplier. It is reassuring to notice that all the stakeholders in Germany are now operating closely together through the Industry 4.0 Platform in order to move ahead with implementation" ("Die Fabrik der Zukunft bietet eine ungeahnte Flexibilität bei optima- lem Ressourceneinsatz. Industrie 4.0 ist eine Chance für Deutsch- land, als Produktionsstandort, Fabrikausrüster und Anbieter von Business-IT noch stärker zu wer- den. Es ist ermutigend, dass in Deutschland nun mit der Platt- form Industrie 4.0

alle beteiligten Akteure in enger Kooperati«on mit der Umsetzung beginnen") (Kagermann, 2013).

The high competitiveness of Germany manufacturing is given by its capacity to handle complicated industrial processes where different partners execute various tasks in different geographical areas.

Industry 4.0 program in Germany is designed to realize some specific aims:

1) Meeting individual customer requirements ("Individualisierung der Kundenwünsche");

2) Flexibility ("Flexibilisierung");

3) Optimized decision-taking ("Optimierte Entscheidungsfindung"): providing real-time notification and transparency;

4) Resource productivity and efficiency ("Ressourcenproduktivität und- effizienz");

5) Creating value opportunities through new services ("Wertschöpfungspotenziale

durch neue Dienstleistungen");

6) Responding to demographic change in the workplace ("Demografie-sensible Arbeitsgestaltung");

7) Work-life balance ("Work-Life-Balance");

8) A high-wage economy that is still competitive ("Wettbewerbsfähigkeit als Hochlohnstandort".

The principal purpose fixed by the partners in the Industry 4.0 Platform (an exclusive platform that encourages all the stakeholders to continue investigating the opportunities given by Industry 4.0, so to achieve revolutionary vision) is to be ready to secure the future of German manufacturing industry.

Industry 4.0 program is concentrated on the production of smart goods, procedures, and processes. Smart factories, which can manage complexity, less inclined to disruption, and prepared to manufacture goods more efficiently, constitute a fundamental peculiarity of Industry 4.0. In these intelligent plants, human resources, machinery, and products interact with each other "as naturally as in a social network" ("wie in einem sozialen netzwerk"). If the German industry wishes to survive and advance, it will become fundamental to play an active role in developing this fourth industrial revolution.

Industry 4.0 is characterized by greater flexibility and robustness, combined with the necessary quality standards in engineering, planning, manufacturing, operational and logistic processes. Some crucial aspects define the overall vision for Industry 4.0:

1) A new level of socio-technical interaction: between all the actors and resources included in manufacturing (through autonomous machines, robots, production facilities, able to control themselves in different situations, and self-configuring);

2) Identifiability of the smart products: this means that, in certain areas, smart products will be capable of controlling semi-autonomously the individual stages of their productions;

3) Incorporation of individual customer specific features into the design, the configuration, ordering, planning and production phases. Another important aspect is the possibility to incorporate last-minute requests for changes, making it possible to manufacture one-off items and minimal quantities of good profitably;

4) More space to the creativity: employees will be freed up from having to perform routine tasks, enabling them to concentrate on creative, value-added activities. This is fundamental for maintaining quality standards.

Industry 4.0 will also open new business opportunities and models, models that can allow SMEs to handle services and software systems that they are incapable of managing under actual licensing and business models.

"Last but not least, the development of this program will bring several innovations to a country that is in the throes of demographic change: indeed, Germany has the second oldest population in the world, and the number of young employees is in constant decline, and there is already a shortage of skilled labor and applicants for apprenticeships in certain professions. Moreover, If productivity is to be maintained and increased over the course of longer working lives, it will, therefore, be necessary to coordinate and transform several different aspects of the workplace, including health management and work organization, lifelong learning, and career path models, team structures and knowledge management. This is a challenge that will have to be met not just by businesses but in particular also by the education system" ("Die Innovationen von Industrie 4.0 treffen auf ein Land im demografischen Wandel: Deutschland ist nach Ja- pan das Land mit der ältesten Bevölkerung, in vielen Produktionsbetrieben liegt das Durchschnittsalter der Beschäftigten bei Mitte 40. Die Zahl der jungen Beschäftigten nimmt stetig ab und bereits heute herrscht ein Fachkräftemangel in bestimmten Berufsgruppen und bei Lehrstellen. Um Produktivität in einem längeren Arbeitsleben zu erhalten und zu steigern, müssen deshalb viele betriebliche Bereiche verzahnt und transformiert werden: Gesundheitsmanagement und Arbeitsorganisation, lebenslanges Lernen und Laufbahnmodelle, Teamzusammenset- zungen und Wissensmanagement").

• The Dual Strategy

The implementation of the Industry 4.0 program will allow Germany to follow a leading two-way plan, with the aim to increase the market potential for the domestic manufacturing industry:

1. Leading supplier strategy: this strategy relates to the deployment of CPS in manufacturing. The key is to find out new methods of connecting excellent technological solutions with the potential given by information technology, to reach an incredible advancement in innovation. To achieve this goal: existing basic IT technologies must be adjusted to the particular demands of manufacturing and continue

to be improved with this appropriate statement in mind. Research, technologies, and training initiative should be promoted as a priority, developing methods and pilot applications in the field of automation. The technology must be used to create new value networks, developing new business models.

2. Leading market strategy: is defined as the marketing of CSP technology and products to reinforce Germany's manufacturing equipment industry on the other. The principal market for Industry 4.0 os Germany's national manufacturing industry. For the expansion of this leading market, close networking of parts of businesses settled at various places will be required, together with closer interaction between different companies. One hard challenge will be to accomplish simultaneous integration into these new value networks of both large-scale that are already operating globally, and SMEs that often still perform at a regional level, and that are not well prepared for implement the structural changes that Industry 4.0 requires.

One critical procedure for integrating SMEs into global value networks is the design and implementation of an overall knowledge and technology transfer initiative.

The implementation of the "Dual Strategy" involves three key features:

1) Develop inter-company value chains and networks through horizontal integration;

2) Digital end-to-end engineering beyond the complete value chain of both the goods and the connected manufacturing system;

3) Development, implementation, and vertical integration of flexible and reconfigurable systems within businesses.

These points are the crucial enablers for manufacturers to achieve a stable position and will allow firms to make rapid, on time, fault-free production at market prices in the context of a highly dynamic market.

• Priority Areas for Action

Industry 4.0 is a complicated plan that includes many partially coinciding fields. The Industry 4.0 Working Group presented a full collection of medium and long term research recommendations. In this part of the chapter, we'll concentrate on essential priority areas where the Working Group concludes that there is the demand for real industrial policy and business decisions to be taken, to fulfill the recommended instructions.

Eight areas are defined:

1) Standardization and open standards for a reference architecture ("Standardisierung und offene Standards für eine Referenzarchitektur"): Standardization efforts will need to focus on stipulating the collaboration mechanisms and the information that is to be transferred. The comprehensive technical explanation and implementation of these requirements are referred to as the reference architecture (a universal model that applies to the products and services of all the partner firms, and which furnish a skeleton for the structuring, improvement, integration, and operation of the technological systems relevant to Industry 4.0).

Because the value network in Industrie 4.0 incorporates various enterprises with very distinct business models, the function of the reference architecture is to unify these different strategies into one single, shared approach. This needs the partners to agree on the underlying structural principles, interfaces, and data.

Challenges and recommended actions

The primary challenge is to combine the different ways of seeing things (production, automation engineering, IT and Internet...) and establish a common approach. For the realization of the above purpose, the Industry 4.0 Working group suggests the creation of a working group, to deal exclusively with the topic of standardization and a reference architecture, and which must fulfill the following tasks: agree on a common basic terminology; build a shared understanding of the goals,

benefits, potentials, and risks, creating the mutual confidence needed to support the implementation of these measures; create a bottom-up map describing the standardization bodies that currently exist today; product a top-down roadmap, taking account of cost-benefit considerations and time limitations; develop an "industry 4.0 community" with member from several different companies. Finally, the founding of appropriate pilot projects, to demonstrate the successful development, is required.

Besides, it will be essential to build trust in the reference architecture, an aspect particularly important in know-how protection.

2) Managing complex systems ("Beherrschung komplexer Systeme")

As a result of increasing functionality, customization, increasing delivery requirements, and the rapidly changing forms of cooperation between different companies, pr, and their related manufacturing systems, are getting more and more complicated. Because of this dynamic, the use of models represents an important strategy in the digital world and is of central importance in Industry 4.0 program.

Two types of model are defined:

1- Planning models, which provide transparency with regard to the original value added generated by engineers.

2- Explanatory models, which describe existing systems in order to acquire knowledge about the system through the model (typically involves using processes like simulation).

"One of the benefits of models is that they enable manual activities to be automated, and permit actions to be executed in the digital world that previously had to be done in the real world" ("Damit besteht ein Nutzen von Modellen darin, manuelle Tätigkeiten zu automatisieren beziehungsweise. Tätigkeiten, die bis- her in der realen Welt erfolgten, nun in der digitalen Welt durchführen zu können").

Moreover, models give huge potential: allow the reduction of risks, by the early detection of errors and provide transparent information flow.

Challenges and recommended actions

Especially in SMEs, the application of model-based simulations to configure and optimize manufacturing processes is not so developed. Derives that the raising of awareness about models' potential needs to be persecuted.

Another critical challenge is that models and simulations must be executed by qualified experts, and have high costs.

The steps to do for the fulfillment of these challenges are identified by the Industry 4.0 Working Group. First of all, a Working Group that exclusively deal with this topic must be founded. The tasks of this group are: carry out a survey, to identify the most critical demands in the field of modeling; implement best practice sharing, especially among SMEs, to stimulate the importance of modeling. Appropriate events should be organized, to enable discussion. Working Group should encourage the foundation of common user groups for tool users, tool manufacturers, and trainers, and should also work on the development of appropriate guidelines. Finally, many flagship projects need to be established.

3) Delivering a comprehensive broadband infrastructure for industry ("Flächendeckende Breitbandinfrastruktur für die Industrie"):

"It will in general terms be necessary to build an infrastructure that enables significantly higher-volume and higher-quality data exchange than provided by current communication networks. A core demand for Industrie 4.0 is, therefore, the improvement of existing communication networks to give guaranteed latency times, reliability, quality of service and universally available bandwidth" ("Durch den flächendeckenden Einsatz von CPS wird ge- nerell eine Infrastruktur benötigt, die einen wesentlich höheren und qualitativ hochwertigeren Datenaustausch ermöglicht, als dies existierende Kommunikationsnetze können. Eine grundlegende Voraussetzung für

Industrie 4.0 ist deshalb der Ausbau der bestehenden Kommuni- kationsnetze bezüglich garantierter Latenzzeiten, ihrer Ausfallsicherheit, ihrer Qualität (Quality of Services) und mit einer flächendeckend zur Verfügung stehenden Bandbreite").

Challenges and recommended actions

The overall demands for an efficient broadband infrastructure that is available to a wide number of users are simplicity, scalability, security, availability, and affordability.

The Industry 4.0 Working Group recommends to carry out investigations on real applications, in order to secure the real-time capabilities required for Industry 4.0. It also suggests the expansion of Germany's broadband Internet infrastructure.

4) Safety and security as critical factors for the success of Industrie 4.0 ("Sicherheit als erfolgskritischer Faktor für Industrie 4.0"):

Safety and security are two critical features regarding manufacturing facilities and the products they make.

The development of Industry 4.0 will be possible only if the following points are implemented:

1- Security by design as a key design principle: all the features linking to safety, and in particular security, require to be designed into the system from the outset.

2- IT security strategies, architectures, and standards need to be developed and implemented: in order to confer a high degree of confidentiality, integrity, and availability on the interactions between these highly networked, open components. A dual strategy is also required with regard to safety and security: first of all existing plants have to be upgraded with the safety and security measures, needed to meet new requirements. Secondly, solutions for new factories and machinery will have to be developed.

Challenges and recommended actions

Nowadays, the industry lacks fully standardized operating platforms for implementing adequate safety and security solutions. It will also be necessary for partners (because the involvement of networks and because the cooperation between several partners) to possess a higher level of reliance in each other's capability (security & trust) and for them to produce hard evidence of their competence. Moreover, industrial IT security has only started to be discussed, and knowledge about IT threats must be incremented.

The Industry 4.0 Working Group has worked with several experts to produce a list of eight priority areas for action:

1- Integrated safety and security strategies, architectures and standards: Industry 4.0 requires modified protection and security strategies, a shared knowledge pool should be developed as the basis. Research is needed to improve safety and security strategies. It is essential to ensure that R&D of the critical strategies and systems will be adjusted with other safety and security research plans on topics such as cyber-security or security of crucial infrastructures.

2- Unique and secure IDs for products, processes, and machines: necessary for products, processes, and material to have unique electronic IDs.

3- A migration strategy from Industry 3.0 to Industry 4.0: gradually improve the security of current industry 3.0 facilities, and convert them to Industry 4.0.

4- User-friendly safety and security solutions;

5- Safety and security in a business management context: safety and security must be considered as cost factors. It is necessary to improve methods that will enable a more precise calculation of the risks linked to Industry 4.0.

6- Secure protection against production piracy;

7- Training and (in-house) CPD;

8- Community building for data protection in Industry 4.0.

5) Work organization and work design in the digital industrial age ("Arbeitsorganisation und Arbeitsgestaltung im digitalen Industriezeitalter"):

Because employees will represent an essential role in the implementation and assimilation of technological advancements, innovation requires to be extended to incorporate smart organization of work and employees' skills. Their role will shift significantly as a consequence of the development of virtual work platforms and wide human-machine and human-system cooperations. Work content, work processes, and the working environment will be transformed in a way that will have effects in flexibility, working time regulation, healthcare, demographic variation, and people's private lives. To gain successful integration of future technologies, they will need to be smartly embedded into an innovative social organization (within the workplace).

Challenges and recommended actions

Employees will be expected to be able to manage complexity, abstraction, and develop a robust problem-solving mindset. They will also be demanded to be able to work much more on their own and to have outstanding communication abilities and the capacity to plan their work. This will produce a qualitative enhancement of their work, a more stimulating working context, higher autonomy and more possibilities for self-development. The needs of the new, virtual workplace also manifest a threat to the preservation and safeguarding of human resources.

Indeed, the danger of employees being required to be more flexible and perform more demanding tasks, as well as growing tension between the interactive world and the workers' arise. This can result in an increasing sense of alienation.

The Industry 4.0 platform study this issue through an interdisciplinary expert working group, which goals are: document the impact on work and employment; provide

guidelines for implementation; promote innovative approaches to participative work organization and lifelong learning, that includes the entire workforce. The platform should also set up a regular dialogue between the social partners, to enable transparent identification and discussion of critical technologies, problems, and potential solutions.

6) Training and continuing professional development for Industrie 4.0 ("Aus- und Weiterbildung für Industrie 4.0"):

Industry 4.0 will significantly change the job and skills profiles. It will also need fundamental changes in the way IT experts are prepared. The capacity to recognize application demands in various industries and recruit improvement partners from the whole world will take priority over purely technological expertise. In this context, it will be fundamental to develop professional adult provision (teaching methods, career profile). Skills assessments should be used to improve mobility between vocational and academic education. To guarantee that individuals' training potential can be understood and explained transparently, it will be necessary to develop standards for the recognition of informal and informal education. The aim is to educate people about the beliefs of a new, holistic organizational model and guarantee that methods are described transparently so that employees are convinced in what they are doing.

Recommended actions

The Industry 4.0 Working Group recommends to: promote model projects; establish and promote the best practice networks, to ensure knowledge transfer and sustainability; investigate new approaches to knowledge and skills acquisition in the workplace, develop of digital learning acquisition; promote cross-cutting approaches to work organization; promote Industry 4.0 specific learning content and interdisciplinary cooperation.

7) Regulatory framework ("Rechtliche Rahmenbedingungen"):

The new manufacturing processes will confront themselves with the existing regulatory framework. From a determined point of view, uncertainty regarding the

legality of new technology could inhibit its acceptance; conversely, the power of new technologies could be so high that it becomes impossible to enforce existing legislation. Two things are expected to harmonize regulation and technology: the formulation of standards to assure that the new technologies comply with the legislation and development of the regulatory structure in a way that aids innovation. In the context of Industrie 4.0, it will frequently be reasonable to obtain this through common law contracts. Both factors need the regulatory investigation of innovative technologies to start as early as possible during the R&D stage rather than being left until they are already in use.

Challenges and recommended actions

Some challenges need to be faced in the realization of the goals mentioned above:

1. Protecting corporate data;

2. Liability;

3. Handling personal data;

4. Trade restrictions (As more and more intricate systems are used in Industrie 4.0, it becomes increasingly plausible that different components may be ruled to national and international trade limitations).

One aspect that will be particularly important for SMEs is the improvement of practical guidelines, checklists, and model contract clauses. The new contracts need to guarantee the protection of business and trade secrets and ensure that any value-added created through the new business models are shared out equitably.

There is also an urgent demand for harmonization in the field of trade restraints, particularly concerning encryption goods. To guarantee that Germany can successfully maintain a position as a leading supplier for Industrie 4.0, efforts should be made in the medium to long term to develop common international regulations, for example through the World Trade Organization. It will be essential to ensure that legal specialists are

included in the initial steps of the R&D process. Engineers will increasingly require to obtain a basic knowledge of the legal matters so that they can join in full discussion with their legal equivalents.

8) Resource efficiency ("Ressourceneffizienz"):

The manufacturing industry is the largest consumer of raw materials in industrialized nations. It is also the main consumer of primary energy and electricity. This situation involves risks to the environment. The industry is consequently making efforts to diminish its waste of energy and resources. This will include changes in manufacturing processes and the design of plants and machines. The principal point is that the focus on the number of resources used by manufacturing companies (divided into raw materials, human resources, and financial resources), will be on maximising the output achieved with a given quantity of resources (emphasis on calculating resource productivity) or on using the lowest possible amount of resources to produce a given output (focus on calculating resource efficiency).

Challenges and recommended actions

Industry 4.0 will need to analyze and improve methods of decreasing resources consumed during manufacturing processes. It is necessary to consider productivity (preventing unstable processes that result in quality issues) and availability (resources may not be easily accessible) in the reducing of energy consumption process.

The Industry 4.0 Working Group recommends that a working group should be founded to deal completely on this topic. Its tasks are: prove resource savings in terms of improved resource productivity and profitability in the manufacturing environment; determine and evaluate trade-offs within resources needed to use CPS and their associated infrastructure and the possible savings produced; it will also be essential to take account of multiple metric KPIs (key performance indicators) that are being utilized to appraise resource productivity and profitability and eco-friendliness in

modern projects and initiatives. Development of KPIs such as the Green Production Index should also be taken into account.

3.1. COMPARATIVE RESEARCH: GERMANY INDUSTRY 4.0 PROGRAM AND MADE IN CHINA 2025

This section of the work will focus on the differences and the similarities between the two masterplans analyzed in the previous chapters.

To understand what are the directions and which plan is achieving the most impressive outcomes is essential to define how the two programs are taking different ways of development and what are the substantial cultural differences.

Starting from the beginning, the first divergence is the issue time of the two national projects: while "Recommendations for implementing the strategic initiative Industry 4.0" was published for the first time in Germany in April 2013, Chinese "Made in China 2025" was issued in May 2015, two years later. Even if both the plans focus on the acceleration of innovation and the speed up of automation, the implementation period of the two masterplans differs: the German program will be completed in 10/15 years, while Chinese' will be extended to 2049, the year when the People's Republic of China will celebrate her 100 year anniversary.

Last but not least, China is known in the world for the implementation of the national five-year plans. In its history, China is familiar with this strategy, and with the step-by-step implementation, fixing a pilot city and then expanding the program to other cities (remember, for example, the SEZs program in 1980).

The next paragraphs will deal with a more in-depth analysis of the main diversities, divided as follow:

- National Background and Context;
- Masterplan's Aim and Strategic Goals;
- Strategic Implementation;
- Application and Outcomes.

• National Background and Context

"与世界先进水平相比，我国制造业仍然大而不强，在自主创新能力、资源利用效率、产业结构水平、信息化程度、质量效益等方面差距明显，转型升级和跨越发展的任务紧迫而艰巨" (Made in China 2025).
Confronted with a high-level level in the world, China's manufacturing industry is still large but not strong. There are obvious gaps in independent innovation ability, resource utilization efficiency, industrial structure level, information level, quality, and efficiency. The task of transformation, upgrading and leapfrogging development is urgent and arduous.

"Deutschland ist einer der konkurrenzfähigsten Industriestandorte und gleichzeitig führender Fabrikausrüster weltweit" (Recommendations for implementing the strategic initiative Industry 4.0).
Germany has one of the most competitive manufacturing industries in the world and is a global leader in the manufacturing equipment sector.

The two sentences reported above respectively represents the beginning of the two national plans.

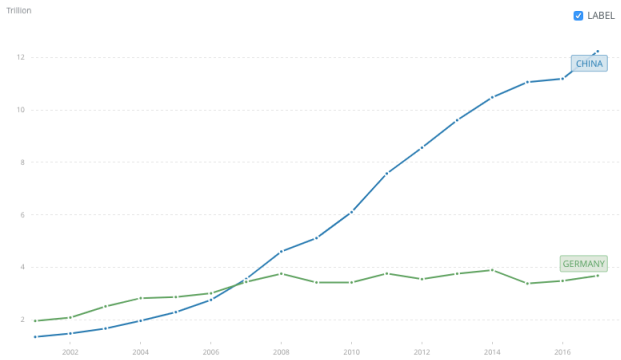
From these statements is already possible to define a significant difference, which is the basis for all the divergencies that follow. Assumed that both the countries understood

that a new period of transformation, development, and innovation would have steadily come, in the period in which the masterplans were issued, Germany already was one of the biggest manufacturing producers in the world, her manufacturing capability already was strong, and Germany products were already globally well-known for its reliability, quality, and stability.

On the other hand, China's situation was not so advanced. China was still famous for its low-wage workforce, its low innovation ability, and its low-quality products.

Moreover, the Germany enterprises general framework was various but developed. Germany by that time had some well-known multinational companies, and brand quality was already strong. Companies like BMW, Volkswagen, Mercedes, Bosch, Holmag, Siemens, Allianz, were already leaders of their related market, and their products were already famous for their quality, their security, and their innovation. For what concerns SMEs, their development was influenced by the context: Germany's companies operate in an active, dynamic, and creative context, in which discoveries, new technologies, and new theories emerged daily. Derives that SMEs were already competitive both in the National and Global market, and their technology level, even if in some cases too expensive and difficult to reach, was pretty high. In 2013, 90% of Germany industrial manufacturing companies were already supported by ICT (Information and Communications Technology).
But unlike Germany environment, China's situation was almost the opposite. Even if China already showed impressively and encouraging data, in that period China didn't have any well-known brands, or better, they were just known and famous in China, but their importance in the global environment was very low. China's environment was starting to develop new trends, China's companies were finally beginning to create some domestic new technologies and ideas, the number of patents and applications in China local market was growing, and several investments were directed increasingly in R&D field. But in a context like the one described, SMEs didn't have the opportunity to improve their situation, the working environment (excluding the one in the big cities, like Shenzhen, Shanghai or Beijing) was still archaic (and still is in some cases).

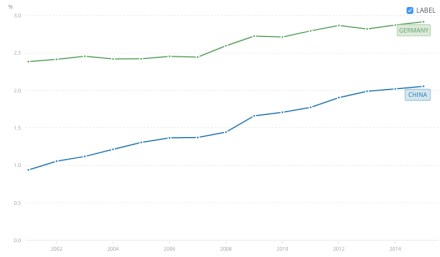
At the same time, an important measure to evaluate a nation's economic performance is GDP (Gross Domestic Production). By 2007, the size of China's GDP was the world's third-largest, in 2009 its GDP was ranked the second largest and the same year, China's GDP surpassed that of Japan and became the world's 2nd largest economy.



3.1 China and Germany GDP (World Bank Data)

In 2015, China's GDP was $11 trillion and was 3.27 times that of Germany's. This difference shows that at the dawn of the 21st century the more industrialized nations made strategic turns to focus on high-tech products and technology, and reduce the proportion of labor-intensive, low-value-add, low-profit-margin production. This decision led to global manufacturing reconfiguration (Li, 2013). The epicenter of manufacturing moved from industrialized nations in North America and Europe to Southeast Asian countries.

Another significant difference, as we can see from the graphic below (3.2) is the percentage of expenditure on R&D. As we can see, Germany has always invested a massive amount of funds in R&D, while on the other hand, since 2001 (the year in which China entered the WTO), also China is increasingly investing more and more funds on this field.



3.2 China and Germany R&D Expenditure (World Bank Data)

By the way, the problem is that if Germany contributed to several technological innovations, and formed researchers with high capabilities in this field, China still lacks procedures, processes, and well-qualified researchers.

Another critical difference (which will be deepened in the next paragraphs) is the human capability. To realize the goal of “Made-in-China 2025”, human resource development is a key. Human resource systems with commitment orientation help create an adequate work situation to improve human capital creativity and innovativeness. Human capital is crucial to promote the appearance of exploitative and explorative work. There are also differences in formulation methods. "German Industry 4.0" is a large multinational enterprise group, such as Siemens and Bosch, which gathers some think tanks, experts, professors to study, discuss and put forward. It has been approved by the German government, that is, "bottom-up", so it is more in line with the actual situation. Of course, the formulation and implementation of "Industry 4.0" first considers the interests of enterprises and their position in the world manufacturing competition. Made-in-China 2025, which was put forward by hundreds of experts and professors organized by the Chinese Academy of Engineering after two years of hard work, was approved by the state. At the same time, after adjusting according to the actual situation, as a national development strategy, it seems to be "top-down". Now many provinces and municipalities have indeed formulated implementation plans for the development of the manufacturing industry in the region. From the experience and lessons, we should avoid homogenization, duplication of production and duplication of investment, which ultimately results in an enormous waste of social resources.

• Masterplan’s Aim and Strategic Steps

《中国制造 2025》，是我国实施制造强国战略第一个十年的行动纲领.

Made-in-China 2025 is the program of action for the first decade of implementing the strategy of manufacturing power in China.

The plan signals China's purpose to start an industrial conversion from labor-intensive production to knowledge-intensive manufacturing and leader in a major breakthrough at a fast speed. “Made-in-China 2025” is the first stage of a “three- phase” grand plan, which will lead China to become a world manufacturing power from the current grand production workshop of the world.

On the other hand, Germany's program aim is to develop a dual strategy (leading supplier and leading market), securing the future of the German manufacturing industry ("Deutschlands Zukunft als Produktionsstandort sichern"), developing new methods of organization and control over the entire value chain of the lifecycle of products, using the IoT and IoS in manufacturing ("Das Internet der Dinge und Dienste für die Produktion nutzen"), and integrating the physical basic system and the software system, combining these systems with other branches and economic sectors, and with other industries and industry types.

For what concerns the strategic goals of the two master plans, even there we can define some differences. First of all these divergencies are evident in the definition of the vision of the two projects: on one side, China, which through Made in China 2025 will substantially improve quality, innovation level, and manufacturing power, focus more on aspects like guided innovation ("创新驱动"), quality first development ("质量为先"), green development ("绿色发展"), structural optimization ("结构优化"), and talent-oriented advancement ("人才为本"). On the other side Germany, which still produced high-quality products, has several talented experts, focus more on shaping the vision of Industry 4.0, theoretically focusing more on the vast potential that Industry 4.0 initiative has: meeting individual customer requirements ("Individualisierung der

Kundenwünsche"), increasing flexibility ("Flexibilisierung"), optimized decision-taking ("Optimierte Entscheidungsfindung"), resource productivity, and efficiency ("Ressourcenproduktivität und -effizienz"), creating value opportunities by new services ("Wertschöpfungspotenzialedurch neue Dienstleistungen,") responding to demographic change in the workplace ("Demografie-sensible Arbeitsgestaltung"), work-life balance ("Work-Life-Balance").

Even more, Made in China 2025 (German plan doesn't) defines step by step the goals that the Chinese manufacturing industry must reach during the three stages of the project:

1) 第一步：力争用十年时间，迈入制造强国行列: Step 1 (until 2025): Attempt to enter the ranks of manufacturing powers in 10 years: 到 2025 年，制造业整体素质大幅提升，创新能力显著增强，全员劳动生产率明显提高，两化（工业化和信息化）融合迈上新台阶。重点行业单位工业增加值能耗、物耗及污染物排放达到世界先进水平。形成一批具有较强国际竞争力的跨国公司和产业集群，在全球产业分工和价值链中的地位明显提升: By 2025, the overall quality of the manufacturing industry will be significantly increased, the innovation strength will be enhanced considerably, the labor productivity of the entire staff will be substantially advanced, and the integration of industrialization and informatization will take a new level. The energy waste, material consumption and pollutant discharge of industrial added value in key industries have reached the advanced level in the world. China will have then created a group of multinational corporations and industrial clusters with great international competitiveness and will have improved their position in the global industrial division of labor and value chain.

2) 到 2035 年，我国制造业整体达到世界制造强国阵营中等水平。创新能力大幅提升，重点领域发展取得重大突破，整体竞争力明显增强，优势行业形成全球创新引领能力，全面实现工业化: Step 2: By 2035, China's manufacturing industry as a whole will reach the middle level of the world's manufacturing power camp.

Innovation capability has been dramatically improved, breakthroughs have been made in critical areas, overall competitiveness has been significantly enhanced, a leading capacity of global innovation has been formed in profitable industries, and industrialization has been realized in an all-around way.

3) 新中国成立一百年时，制造业大国地位更加巩固，综合实力进入世界制造强国前列。制造业主要领域具有创新引领能力和明显竞争优势，建成全球领先的技术体系和产业体系: One hundred years after the founding of the People's Republic of China (1949), the position of a manufacturing power will be more consolidated, and its general strength will enter the forefront of the world's manufacturing power. Significant areas of the manufacturing industry will have innovative leadership and distinct competitive advantages and will build a leading technology and industry system in the world.

This organization and this planning are not meticulously studied and defined in German's plan, that probably, living an already innovative and robust period, preferred to focus on other aspects. Indeed, German's program is likely to say is more theoretical, this also because Germany's enterprises and more in general Germany's manufacturing industry is already strong and innovative enough to concentrate its efforts on less practical goals, that it has already achieved in past years.

• Strategic Implementation and Strategic Tasks

First of all, it is hugely relevant to define the concept at the basis of the implementation of the two programs.

For the definition, it's important to define two different methods of development:

1) Path Driven Development;

2) Leapfrogging Development.

Germany, with well-known brands, high-level technology companies, in its history has adopted a Path Driven Development. This means Germany has passed through the First Industrial Revolution, then has faced the innovations of the second, and finally has gradually implemented all the technologies and the services involved in the Third Industrial Revolution. This is the reason why, today, Germany is facing this new industrial challenge with the awareness of its strength, focusing more on research, development and the creation of innovation and smart factories and products.

On the other hand, China has seen in the Fourth Industrial Revolution, " a historic opportunity to implement a strategy of reinvigorating Chinese manufacturing and reinforce planning and forward deployment", but the background was different. China, indeed, embraced the Leapfrogging Development strategy, which means not to follow a step-by-step implementation of technologies, but taking advantage of the historical period, trying to reduce the gap with other advanced countries, accelerating the process and missing some steps.

Today China is still in the middle and late stages of industrialization, urbanization is still in progress, industry and manufacturing industry are large but not strong, and products are mostly in the middle and lower end of the industrial chain. Labor technology and labor-intensive technology industries and products have comparative advantages, while labor, resources, energy and pollution-intensive industries have gradually lost their powers because the costs of all parties are too high. There are still many gaps between the competitiveness of high-tech and capital-intensive industries and products and the developed manufacturing countries. China didn't pass through the Third Industrial Revolution, the implementation of the Internet in the work environment and its integration have not been gradually explored in this Country.

Made in China 2025 also try to fix this, defines the steps to achieve the IoT and the Internet of Services implementation, and try to ultimately reduce the differences and the gaps that China has with other countries.

Another difference is that China has acquired a rich experience in fulfilling national strategic programs. Its economic reform in 1978 began with a pilot city in Shenzhen Special Economic Zone (SEZ). The special economic zone tested with free market business models matched with a state planning policy, providing subsidiary, and preferential tax benefits to foreign companies that were interested in doing business in China (Li, 2013). This approach has also been chosen to implement “Made-in-China 2025”. Ningbo, a port city, was determined to be the first pilot city to accelerate the construction of its own industrial and manufacturing capability, cooperate with regional innovation systems, personnel training systems, and policy support systems, to create a healthy ecological environment and achieve diversity in development. Then, the second group of 20 to 30 cities will be selected to join the plan.

Opposite to this, Germany has not selected a pilot city from which develop the whole plan. Its project is issued for all the companies and areas which want to adopt this strategy, wherever they are and operate (an example is the city of Frankfurt, also called the "green city").

“人才为本：坚持把人才作为建设制造强国的根本，建立健全科学合理的选人、用人、育人机制，加快培养制造业发展急需的专业技术人才、经营管理人才、技能人才。营造大众创业、万众创新的氛围，建设一支素质优良、结构合理的制造业人才队伍，走人才引领的发展道路”

China should persist in taking talents as the basis of building a strong manufacturing country, establish and improve a scientific and rational mechanism for selecting, employing and educating talents and accelerate the training of professional and technical personnel, managerial personnel and skilled personnel urgently needed for the development of manufacturing industry. China will create an atmosphere of mass entrepreneurship and innovation, build a team of manufacturing talents with excellent quality and reasonable structure, and take the development path led by talents.

"Die Umsetzung der Zukunftsszenarien bietet den Beschäftigten die Möglichkeit, die intelligent vernetzten Produktionsressourcen und -schritte nach situativen und

kontextabhängigen Zielvorgaben zu steuern, zu regulieren und zu gestalten. Die Mitarbeiter können sich auf die kreativen, wertschöpfenden Tätigkeiten fokussieren, da sie von Routineaufgaben entlastet werden. Die Beschäftigten spielen damit die entscheidende und vor allem die qualitätssichernde Rolle. Gleichzeitig bieten flexible Arbeitsbedingungen Möglichkeiten zur verbesserten Vereinbarkeit mit individuellen Bedürfnissen. Ergänzend zu den Plattformaktivitäten müssen die Themen Modellierung und Systems Engineering gezielt bei der Ausund Weiterbildung aufgegriffen werden. Dies betrifft sowohl die Qualifikation junger Ingenieure durch geeignete Ausbildungsinhalte als auch die Qualifizierung erfahrener Ingenieure durch entsprechende Weiterbil- dungsmaßnahmen. Die Ausbildungsinhalte sind dabei insbesondere an den Bedürfnissen der produzierenden Unternehmen auszurichten". Implementation of the Industrie 4.0 concept will allow employees to manage, control and configure smart manufacturing resource networks and manufacturing steps based on the situation and context-sensitive targets. Employees will be relieved from having to do routine tasks, permitting them to concentrate on creative, value-added activities. They will thus preserve a key role, particularly in terms of quality assurance. At the same time, flexible working circumstances will enable greater harmony between their work and their demands.

In addition to the activities of the Platform, precise efforts should be made in terms of training and maintaining professional growth provision with regard to modelling and systems engineering. This includes both a suitable training plan for young engineers and appropriate CPD measures for qualified engineers. Training content should be exceptionally prepared for the demands of manufacturing companies.

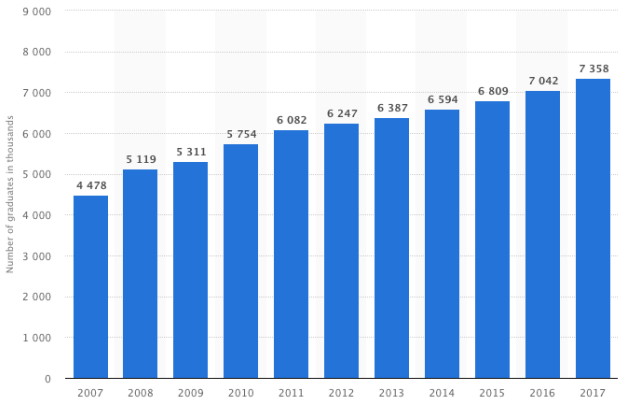
In these two sections of the two master plans, another relevant feature is underlined.

Both the plans define that a fundamental role in the application and development of Industry 4.0 is played by humans, by employees.

But if from a certain point of view, Germany has always been focused on the training, the selection, the methods of education of his human resources, and on the attraction of

international students, on the other hand, China is nowadays improving its systems, to create a future talented-leading class.

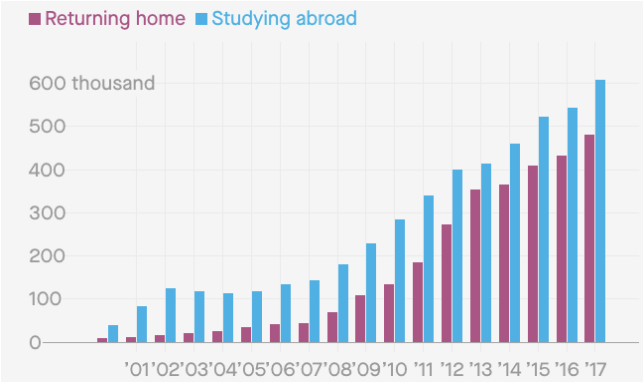
To realize the goal of “Made-in-China 2025”, China understood that human resource development is a key. Human resource practices with commitment orientation support the creation of an adequate work environment to enhance human capital creativity and innovativeness. This is also supported by the image below, which shows that the number of Chinese graduates is increasing year after year.



3.3 Number of graduates in China (Statista)

An important role is also played by the returned study abroad students. The capacity to attract the world's elite talents is a representation of a nation's strength and competitiveness. These deeply instructed people who have improved economic and social exchanges will continue to help China and the rest of the world (Li, 2013). For example, the United States has successfully captivated millions of world's talents to increase its manufacturing and high-tech industries: Pierre Omidyar, a French-born Iranian-American entrepreneur, established ebay in 1995, and one of the founders of PayPal, “Max” Levchyn, is a Ukrainian born American. To support their extension, Chinese industries demand equipped professionals from around the world to contribute to their expertise and creative potential to complete the “Made-in-China 2025” plan. The dramatically growing number in the categories of college graduates and returned study abroad students (nowadays China is the biggest supplier of students to universities in several countries, with 194,000 students on American campuses in 2011-2012,)

shows a promising picture of China's capability of attracting the world's top scientists and innovators.



3.4 Chinese returning home students (Qz)

For what concerns Germany, in the governmental plan, is exposed that it will be essential to promote professional adult education provision (teaching methods, career profile). They principally believe that the purpose is to train people the principles of a new, holistic organizational model and guarantee that systems are illustrated transparently so that employees are convinced in what they are doing.

Even if starting from two different points (Germany still have several qualified experts, while China is increasingly developing and improving this situation), both the plans put high importance on the educations and training, considering it one of the central aspect of the Industry 4.0.

• Applications and Outcomes

Starting, as we saw in the previous paragraph, from two different starting points, both China and Germany have recognized the importance of developing an adequate training system, and the relevance of spend funds and time in the R&D of new staffing, educating and training methods.

Germany, for example, has launched a project, called The Academy Cube: It is an initiative that has been started by German and international industrial companies together with public organizations to address the need for new training formats and

content arising from Industrie 4.0. The current provision specifically targets skilled workers from southern Europe, where unemployment rates are particularly high. The Academy Cube provides online information to interested parties about how they might be able to use their skills and knowledge both in their home country and abroad. Germany also defines a project, which the aim to train and educate unskilled workers or undergraduate students, and helping them in their own enrichment.

The Academy Cube offers jobless graduates in ICT and engineering the possibility to acquire targeted qualifications and supports put them directly in touch with industrial companies. This is realized via a cloud-based platform where organizations and institutions provide e-learning courses and post specific job vacancies. The platform helps job seekers to obtain the education they require to apply for specific vacancies, while also issuing them with the corresponding certificates. These documents that are based on standard curricula guarantee that possible employers can be convinced about the standard of the training and provide transparency about its content. The best candidates are automatically addressed to the highest job vacancies of the participating companies.

Education in China has evolved from the development of primary education, then secondary, then higher education. Admittance has extended enormously, and China now controls the biggest educational system in the world. In the future, as defined by the 2010-2020 National Medium and Long-Term Educational Reform and Development Plan, senior secondary education graduation rates will move to 90 percent by 2020, which, if realized, would put it forward of the U.S. high school graduation percentage, but with millions of more students. The project also asks for the construction of world-class universities. There can be no doubt about China's push and dedication to education. An important role has also been played by the Vocational Education and Training system (VET). Even if they still present some weaknesses (like the shortage of bridges between VET and academic and higher education, and between VET and companies, or such as the low status that VET has in the public mind) their revival is an explicit declaration of intents, and the opening of some pilot-centers for the education system, especially for VET is a relevant innovation for this country. We will mention just three of the most pertinent examples:

1) Tianjin Sino-German Vocational and Technical College: The Tianjin Vocational and Technical College is part of a vast Tianjin educational

Park, which incorporates several other universities and professional colleges. The organization was established as a training center in the mid-1980s, after the opening up of China. It was a joint venture between the German and Chinese governments in which Germany granted funds and technical assistance to help to develop a German-style dual method VET in many cities in China. This is the most significant collaborative project in education between Germany and China. The college proposes nine areas of study including advanced manufacturing, automation, astronautics, new energy and new materials, automobile technology, ICT, economics and business management, applied languages and culture, creativity and design.

2) Tianjin Institute of Mechanical Technology: sharing the same large educational park in Tianjin is the Tianjin Institute of Mechanical

Technology, a Tianjin City Demonstration Secondary Vocational School. Presently, the school has 7,000 students and 15 majors in numerical control, automobile systems, information technology, and electronic and mechanical systems. The school is connected to a big industrial group made up of a lot of different firms.

3) Shenzhen Polytechnic: today, it counts 30,000 students studying 80 specialties on five campuses in the following academies: electronic and communication engineering, computer engineering, mechanical and electrical engineering, economics, management, media and communications, art and design, animation, applied foreign languages, construction and environmental engineering, applied chemistry and biological technology, automobile and transportation engineering, medical technology and nursing, and humanities.

Shenzhen is designated as a top VET example by the state government. Although there is close cooperation between Shenzhen Polytechnic and industries in the study of the curriculum, work experience consists mainly of a work placement in the last semester. Training of faculty is an essential need as is producing more pathways for

students to transfer on to degrees. In fact, Shenzhen Polytechnic would like to become a university of applied sciences.

These examples, are just a short list of the environment that is surrounding China's education today. In addition to the increasing number of returned graduate students abroad, and the growing reputation that Chinese Universities are achieving (three of them, Tsinghua University, Peking University, Zhejiang University placed in the top 100 academic ranking of world universities), the development of this pilot vocational and training centers are the evidence that China really cares about education and formation.

2) Green Development

"加大先进节能环保技术、工艺和装备的研发力度，加快制造业绿色改造升级；积极推行低碳化、循环化和集约化，提高制造业资源利用效率；强化产品全生命周期绿色管理，努力构建高效、清洁、低碳、循环的绿色制造体系"

In order to perfect capabilities for researching advanced energy-saving and environmental technology and for speeding up the ecological updating of manufacturing, China will lively promote low-carbon, recycling, augment the efficiency of manufacturing resource consumption, reinforce life-cycle green product management, and build up a high-efficiency green manufacturing system.

"Generell sind bei Industrie 4.0 die gesamten industriellen Produktionsprozesse und ihre Umsetzung in Ma- schinen und Anlagen auf die Reduktion des Ressourceneinsatzes zu untersuchen und zu verändern. In der Folge bemüht sich die Industrie intensiv um Reduktion beziehungsweise Subs- titution ihres Ressourcen- und Energieverbrauchs."

Industrie 4.0 will need to analyze and develop ways of decreasing the resources consumed during industrial manufacturing processes as a whole and by the machinery and equipment used during production. Industry is undertaking major efforts to reduce its consumption of energy and resources or find alternative sources.

As we can state from the two sections of the masterplans above, both the countries have identified similar goals in the reduction of pollution.

Regarding Germany, this country has always taken care of the environment and has recently approved some essential documents that define precise guidelines for the next years: in its "Energy Concept", for example, Germany has formulated directions for environmentally healthy, safe and affordable energy accumulation. The principal factors of this are increasing the use of renewable energies and improving energy efficiency. In electricity production, for example, Germany intends to increase the share of renewables from 17% today to more than 80% in 2050, while fully phasing out electricity production from nuclear power plants by 2022. Greenhouse gas (GHG) emissions would be decreased by 40% by 2020 and at least 80% by 2050. In the area of energy performance, Germany expects to lessen primary energy waste by 20% by 2020 and 50% by 2050 compared with 2008. The "Energy Concept" includes more than 100 precise measures in the spheres of electricity, heat, and transport.

Another example is the freshly ratified "German Resource Efficiency Programme", an extensive programme discussing the sustainable use of raw materials. Germany aims to decouple economic growth as far as possible from resource utilization, both to decrease the load on the environment and to reinforce the sustainability and competitiveness of its economy. The programme involves, for example, efficiency guidance for small and medium-sized companies, promoting environmental management systems, combining resource aspects into technical standardization processes, putting more significant importance on resource-efficient goods and services in public procurement, increasing voluntary product labeling and certification practices and improving closed cycle management.

These and other relevant plans and acts (like renewable energy act, renewable heat act, and the ecodesign directive) are bringing the country closer to a renewable energy revolution, which is emphasized by the transformation of some pilot cities like Freiburg and Frankfurt.

Freiburg, for example, is widely considered the single best city for sustainable urban development, facing and learning from energy and climate change, transport and land

use, urban liveability and safety. In 2007 the Municipal Council chose to decrease its CO2 emissions by 40% by 2030. This goal was renewed in 2014 to 50% less CO2 emissions by 2030 and 100% of energy from renewable sources by 2050. To realize the task of becoming climate-neutral by 2050, the city has launched a great number of initiatives concentrated on construction, energy, private houses, transport, forestation, nature preservation, waste management, and tourism. Freiburg has a strong familiarization to walking, cycling, and public transport, with car-free zones and high levels of openness for people of all ages (also the elderly, and children).

Freiburg's development of sustainable transportation has been possible thanks to three precise decisions: limiting the use of cars in the city, giving practical transport alternatives to the car (like bicycles or public transports) and regulating land-use (e.g., sprawl) to enable public transport, cycling and walking. In Freiburg, new development must meet strict urban design guidelines. Like most European towns Freiburg uses master plans to guarantee high-quality development. Freiburg is a city of short distances, mostly because of spatial policy that emphasizes the compromise of services that allow sustainable transport and prevents sprawl. Two-thirds of Freiburg's land area is dedicated to green uses. Just 32% is utilized for urban growth, including all transportation. Forests take up 42%, while 27% of the land is used for agriculture, recreation, water protection, and other environmentally friendly purposes.

For what concerns China, as we have seen in the previous chapters, several measures and improvements have already been adopted by the institutions to decrease the most relevant problem of this decade. As we saw, China is living in a paradox: therefore, while China still is the world's biggest emitter (significant difference with Germany), due to its toxic addiction to coal, it has also started an extraordinary battle against climate change and waste consumption.

Apart from the arguments that we have already mentioned in the previous section, such as the considerable reduction of fuel cars in favor of electric cars and vehicles (remember Shenzhen case study and the future opening of Tesla's Gigafactory 3 in

Shanghai), and the increasingly augmented amount of investments that China is directing on renewables, other two interesting episodes deserve to be reported.

The first is the installation in Huainan (Anhui Province) of the largest floating solar farm in the world. The Huainan site's 160,000 solar panels were placed in 2017 by Chinese company Sungrow over a large surface of water overflowing a former coal mine. Crossing 800,000 square meters, the farm does not take possession of the land that can be used for fields, manufacturing or tourism, and the extremely mineralized water is inadequate for irrigation plans. The panels are placed a few centimeters over the water on one-meter-long rectangular plastic planks, which are connected in an enormous modular patchwork. The entire construction is secured to the water body to prevent it from floating away with the wind. The Huainan farm is now operative, with a potential of 40 megawatts (MW), and another 150 MW facility is designed for the same region by 2019.

The “wonderful symbolism” of fabricating the solar farm on a submerged coal mine is also practical. China, the world’s biggest investor in wind and solar energy, looks affirmed its central role with the creation of new space for renewable energy projects.

This project support and confirm the primary role that China is assuming in the production of renewable energies in the world. As image 3.5 shows, China has become the leader in this critical sphere.

Rank	Country	Total Renewable Energy (GWh)
1	China	1,398,207
2	United States	572,409
3	Brazil	426,638
4	Canada	418,679
5	India	195,242
6	Germany	193,735

3.5 Renewable energy by country (worldatlas)

The last example is the one concerning the partnership called "The Green Digital Financial Alliance". This project was presented for the first time in Davos, in 2017,

during the World Economic Forum, by UN Environment Programme (UNEP) and Ant Financial Services group (Ant Financial), a leading Chinese service provider of online and mobile services (part of Alibaba Group).

The GDFA will promote the acquisition of clean lighting and energy, substantial agriculture inputs, and tools. The purpose is to encourage the developments of digital technology in green finance. One example is M-KOPA Solar, a Kenyan energy firm proposing admittance to affordable solar power. The group now produces solar home systems in Kenya, Tanzania, and Uganda and utilizes technology to enable customers to pay for their energy as they use it in a micro-payment solution. The system uses embedded technology to control energy usage and charges consumers subsequently. Ant Financial has also produced goods and services to contribute to sustainable development, like their Ant Financial app. The app equips users with a carbon account in addition to credit and savings accounts. It emphasizes a carbon schedule by which users can control their carbon footprint and stimulates users to engage in footprint decrease. There are actually 450 million users in China, 72 million of which are co-operating in the carbon project. According to Erich Jing, Chief Executive officer of Ant Financial, the firm supports the hundreds of millions of users to engage in a green lifestyle by taking advantage of mobile internet solutions and cloud computing.

From the examples done during this work, from the statements and guidelines that both the masterplans give, is possible to affirm that the concept of green development is crucial for both the countries and that China and Germany are trying to provide massive support in the reduction of pollution and energy consumption in the world. Approved that, while in Germany the situation is excellent, the plans are well-defined, and all the future projects can be considered of help to the world situation, China is still the most contaminated and most polluter country all over the world, and even if the situation is quickly improving, China still has to make more efforts to make the world a better and cleaner place.

3) Global Competitiveness and Manufacturing Industry Reinforcement

In this section, we will debate the current partial or total realization of the aim at the basis of the two national plans. As we have already stated Germany and China are trying to fulfill different goals and different strategic tasks: if for Germany the implementation of Industry 4.0 program means the strengthening of its position in the global framework, the attempt to secure a future at the German manufacturing industry, and the application of a dual strategy (leader supplier and leader market), for China the full realization of Made in China 2025 has even a more critical aim: allowing China to become a world manufacturing power from the current grand production workshop of the world, implementing significant manufacturing areas industry with innovative leadership and distinct competitive advantages and building a leading technology and industry system, leader in the world.

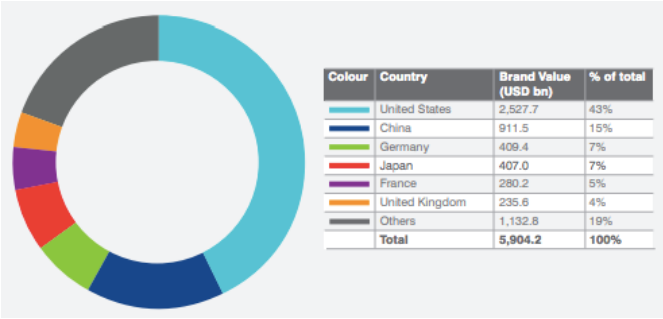
Understood this clear difference of intents, in the next paragraphs we will try to understand how these two realities effectively realize their purposes, and we will conclude with some forecasts and possible future directions.

As we already affirmed, China's development and Made in China 2025 depends on some key factors. We've previously discussed the education and training systems, and about the green growth, we will now focus on the strengthening of brands' quality and the success of some new big corporations.

Until a few years ago, Chinese companies were globally known for their low-wage workforce and their low-level innovation, and the brand strength of these firms was extremely low. With the opening up strategy, the development of new industrial paradigms, and the publishing of Made in China 2025 the situation has completely changed.

Nowadays, following the Brand Finance Global 500, in 2018 twenty Chinese companies entered the top 100 brands in the world. Companies like ICBC, China Construction Bank, Alibaba, China Mobile, Tencent, PetroChina, WeChat, Baidu, Huawei, China Telecom, have affirmed their name and their power in the global context.

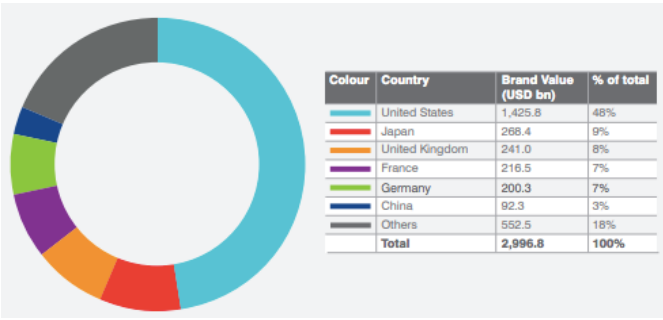
As clear from the following images (3.6/3.7) China in just ten years has become the second most powerful nation in the world, following the US. The extension of Chinese brands increases beyond the technology area as the country continues to reduce the value gap with the United States at an extraordinary rate. By 2008, China's share of global brand value has developed from 3% to 15%, increasing 888% to US$911.5 billion in 2018. It appears as no wonder that State Grid, a state-owned utility firm from China, is the most significant new player in the Brand Finance Global 500 this year, demanding 19th place with a brand value of US$40.9 billion.



Colour	Country	Brand Value (USD bn)	% of total
	United States	2,527.7	43%
	China	911.5	15%
	Germany	409.4	7%
	Japan	407.0	7%
	France	280.2	5%
	United Kingdom	235.6	4%
	Others	1,132.8	19%
	Total	**5,904.2**	**100%**

3.6 Brand value by country in 2008 (BrandFinance)

Besides, the fastest-growing brand of 2018 also comes from China. The spirit industry champion Wuliangye grew a stunning 161% to US$14.6 billion year on year, rising 184 ranks to 100th.



Colour	Country	Brand Value (USD bn)	% of total
	United States	1,425.8	48%
	Japan	268.4	9%
	United Kingdom	241.0	8%
	France	216.5	7%
	Germany	200.3	7%
	China	92.3	3%
	Others	552.5	18%
	Total	**2,996.8**	**100%**

3.7 Brand value by country in 2018 (BrandFinance)

Therefore, China had pursued a dual strategy: building homegrown brands but also acquiring underperforming international brands, like Volvo and Pirelli. Nowadays the emphasis is firmly on homegrown brands, many Chinese brands, indeed, are now being recognized worldwide as quality brands. The expectation is to see this develop rapidly in more and more sectors.

After decades in which Chinese companies weren't considered at all, nowadays they are developing essential importance in the global framework. This also derives from the strategy recently adopted by Chinese companies: in the first time, the Chinese government, for creating an international environment in big cities, facilitated the entrance of foreign enterprises in China. By this way, Chinese companies started to understand and learn new industrial and managerial secrets and began to develop a modern industrial environment.

After this first period of study, knowledge, and assimilation, Chinese companies in the last years have completely changed the way of doing business. Flush with cash, Chinese companies have started expanding rapidly abroad, and have begun doing this through acquisitions. For example, in America, what was used to be known as "Made in China" is now "Owned by China," a subtle transformation that most consumers in the U.S. haven't noticed. This strategy has worked exceptionally well in recent years. Most Americans would be amazed to learn that their Motorola smartphone is made in and owned by China.

The same thing can be said about AMC Entertainment, Ironman, Volvo, GE Appliances, Smithfield, IBM, Grindr and some of America's most important brands, like the Waldorf Astoria Hotel in New York City. The American luxury experience was acquired in 2014 by Beijing-based Anbang Insurance Group, a group which was recently taken over by Chinese regulators. So, we can say that when the new Waldorf opens, that experience will be given by the Chinese government. After the election of Trump, this trend is slowly decreasing, and China is trying to reproduce the same strategy in other countries.

For example, this strategy was adopted by Chinese firms not just in America, but also in France, Italy, Germany and in all the advanced countries: in the first six months of

2018, the value of Chinese M&A in Europe beat $22 billion, nine times larger than that in North America. Chinese overseas investments have declined a staggering 92% in the U.S., dropping from $24 billion to just $2 billion in one year. Although Chinese firms continue to take the M&A route, there is a definite turn away from North America (M&A by Chinese companies of Italian Pirelli, Swiss Syngenta, Germany's Kuka and Daimler and so on).

In addition to the strengthening of its brands, China is also quickly implementing breakthroughs in critical areas, as we have already shown in the second chapter of this thesis. The implementation of robots in the working environment, the development of specialized equipments for aeronautic and oceanographic exploration, the high-speed advanced railway system, the progress in the communications (5G), and the promotion of electric vehicles and cars, are just the first part of the advancements that China has planned to implement in its environment.

China seems to have not intention to stop this strategy, and also with the expanding of the BRI (One Belt One Road) China will probably expand its influence in the Eurasian region and beyond (buying also shares in infrastructure, as Tirana International Airport, Piraeus Port Authority in Athens, and some other terminals in the Netherlands).

On the other hand, is Germany reinforcing its position in the global framework? How is Germany facing this new era of revolution and innovation?

Advanced manufacturing has been a power of the German economy, and it continues to be an essential area for the German government to preserve its status as a world leader in high-technology manufacturing industries and exports. Keeping a manufacturing foundation is crucial to maintaining the ability to innovate. Following the Manufacturers Alliance for Productivity and Innovation, manufacturing counts for almost 21% of the German economy, contrasted with 13% for the United States and 12% for the United Kingdom. The massive overseas request has recently counterbalanced lower demand from within the Eurozone. German manufacturing includes a wide variety of industries, luxury automotive, machinery, electrical equipment, and chemicals, with a deep mixture of company dimensions and structures.

Germany is notable in consumer products, and also has powers in capital goods, and industrial durables, which further sustain the nation's manufacturing capacities and emphasizes a broad diversity of company sizes and structures. While Germany owns some of the most famous large multinational companies involved in manufacturing worldwide, most outstanding are the small and medium-sized firms (SMEs) usually known as the Mittelstand, which estimate for around 70% of total manufacturing exports and nearly 80% of employment. These companies hold reliability for quality, with over a thousand German SMEs taking the first or second position in the world in their respective niche markets.

For what concerns the top 100 most valuable brands, Germany in 2018 still presents ten companies: multinationals like Mercedes-Benz, BMW, Deutsche Telekom, Volkswagen, Siemens, Allianz, Bosch, Porsche, SAP, and Audi have increased their brand value and are still considered like touchstones, benchmarks in their related field in the global context.

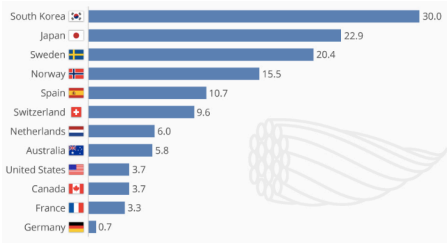
We've already discussed the education and training system, and the development of green products and solutions in Germany.

An interesting point, central to the Industry 4.0 plan, is Germany's broadband deficit.

Germany's struggles to get broadband coverage beyond the country had failed due to a combination of corporate avarice, government administration, and that unique German inclination for having everything excellently planned out before they started. The government's latest target to have national broadband by 2025 is also falling behind, and Telecom firms have little motivation to begin the massive investment because their stock price gets a hit.

As we can see from the images 3.8/3.9 Germany has one of the lowest rates of adoption for fiber-optic cable in the world. Politicians promised to do something to stimulate connection speeds, both for companies and people in rural areas, but the situation is still undefined and not so developed.

3.8 Coverage with glass fiber optic cable, in percentage



3.9 Where fiber broadband is most relevant (OECD)

How is possible to understand, both Germany and China are realizing their primary tasks. Therefore, China is extensively enlarging its manufacture industry, strengthening the quality, improving its brands, modifying its training and education systems to create a high-level leading class, making efforts to develop sustainable green manufacturing and aiming to reach the advanced level in the world.

On the other side, Germany is still reinforcing its position in the global framework, both as a market leader, both as a supplier (dual strategy), and its continuously expertise research and development will guarantee the country the leadership in some areas for the next years. Even if the growth rate is slowly decreasing (European Commission Forecast put Germany as the second worst in the ranking for the economic growth for 2019, with just a percentage of increase of 1.1%) Germany will continue playing a central role in the world market, due to its technology, its quality, its good's stability and solidity, and its advanced researches.

4) Automation and Smart Factories Development

We will conclude our work with the section regarding the real advancements and developments that China and Germany have done (or are doing) in the field of automation and building of smart plants.

As we saw in the previous paragraphs, both China and Germany put the innovation and the improvement of workers conditions as a core point in their plans. Germany Industry 4.0 Program and Made in China 2025 both focus on the nine disruptive technologies (presented in the first chapter of this work), and their implementation is considered vital for the realization of the larger plan.

For what concerns robotic, we've already mentioned the important acquisition of the Chinese Midea Group (Kuka acquisition), and we saw the encouraging data about the robotic market in China. But performing more in-depth analysis, China has impressively extended its preeminent position as the largest market with a percentage of 36% of the total supply in 2017. Nearly 137,900 industrial robots were traded to China in 2017, 59% higher than in 2016. This was significantly more than the entire sales amount of Europe and the Americas combined (112,400 units). More or less 34,700 units of robots were sold by Chinese robot manufacturers in China. Their sales volume was approximately 29% higher than in 2016 (27,000 units). Foreign robot suppliers boosted their sales by 72% to 103,200 units, including robots fabricated locally by the global robot suppliers in China. This is the first time that the international robot suppliers have a more significant growth rate than the local ones.

It is necessary to make some examples to make the idea being more defined:

1) Foxconn: Foxconn Technology Group is the world's biggest electronics manufacturer. It engages an estimated 1.3 million people. Foxconn has earned credit for assembling Apple Inc. goods such as the iPhone and iPad. In 2011, Foxconn published plans to substitute human workers with robots. The company designed to introduce one million robots in its plants in three years. The programs were not respected, and the strategy didn't accelerate as fast as Foxconn hoped, achieving only 60,000 robots in its factories as of 2016. However, Foxconn's automation idea helped it expand its robotic capacities. In the next years, Foxconn expects to raise more than $4 billion for its new China business unit.

2) Alibaba: Opening in 1999 as a B2B web platform for connecting local Chinese manufacturers with latent global customers, Alibaba now is the largest e-commerce business in the world, with $430 billion in total sales volume, and a market cap that has surpassed the US $500 billion. Artificial intelligence, augmented reality, facial recognition, connected vehicles, global virtual marketplaces, app-based digital payment systems, Pharmaceutical e-commerce, massive use of robots are just some of the

innovations Alibaba has developed in its factories. This is a picture of the advanced innovation work currently started from one of the world's most exciting and respected companies: the Chinese tech titan, Alibaba Group. In many ways, Alibaba can be defined as a digital innovation factory, a powerhouse skilled at quickly marketing new technology ideas, services, and ventures. One thing is clear about Alibaba: the corporation never stops. One of the beliefs that describes daily life at Alibaba Group it that there is always a sense of necessity in the air, based on the understanding that the digital technology world is rapidly advancing and that today's resolutions can become out-of-date faster than ever before. So satisfaction is not an option. At Alibaba, everyone is always trying to jump to the next thing, and the next thing, and the next thing.

On the other hand, Germany is the fifth largest robot market in the world. In 2017, the amount of robots traded expanded by 7% to 21,404 units - a new peak - if opposed to 2016 (20,074 units). Between 2014 and 2016, yearly sales of industrial robots decreased at around 20,000 units. Opposite to China, Germany has a broad base of academic researchers investigating every aspect of robotics innovation. Over a dozen important universities and other educational institutions are now involved in various aspects of robotics research. For example, The Institute of Robotics and Mechatronics, a section of the German Aerospace Center, is promoting multiple types of robots to assist people to communicate securely and efficiently with their surroundings. The robots are created to work in areas that are inaccessible or unsafe to humans as well as to aid humans in their daily lives and work. The institute intends to embrace the whole robot development process, involving systems analysis, mechanical and electronics configuration, control systems, sensor design, dynamics simulation, and software structures. The institute also carries study on perception and cognition, movement and task planning, machine learning, artificial intelligence, and application improvement. Another German research organization examining robotics is the DFKI Robotics Innovation Center. Established in 2006, the center concentrates on technologies for different challenging and risky environments, like space and underwater, as well as security, mobility, and cognitive robotics. The center accounts a staff of over 100 researchers, assistance personnel from

all around the world, and 100 student assistants. The DFKI Robotics Innovation Center operates in close collaboration with the Robotics Group at the University of Bremen.

The Technical University of Munich is the last crucial German robotics education and research department that we mention. The school's Robotics and Embedded Systems division offers degree programs covering from the undergraduate to doctorate levels. The university's research primarily directs on the following four fields: Human-robot interaction/service robotics; Medical robotics; Cognitive robotics and Cyber-physical/ embedded systems. One of department's current actions is the Myorobotics plan, which intends to develop the quality and reliability of the hardware utilized to make musculoskeletal robots readily available to researchers working in various robotics fields. Musculoskeletal robots can produce multiple advantages, especially in situations where people and robots work together. Motivated by the mechanics of the human body, a musculoskeletal design makes excellent use of viscous-elastic substances to imitate the muscles and tendons that serve to improve safety, and adaptivity in uncertain circumstances. The method also enables researchers to decrease robot weight and development expenses, while simultaneously heightening design flexibility.

One of the first and most critical smart factories in Germany is the one opened from Siemens in Amberg, a 108,000-square-foot high-tech plant characterized by efficient, digital wonder, as its smart machines. The core to creating this work, and the skill to building all future smart factories work, is forming a dense blend of technologies that are integrated and cooperating into a smarter, more efficient body. What has made the Amberg plant so prosperous, is the combination of three specific crucial production technologies: product lifecycle management (PLM), manufacturing execution systems (MES) and industrial automation. In the Amberg plant, this amalgamation between the digital and the real places product and production at the center of the digital manufacturing process (central role given to the Internet of Things). For smart factories to certainly increase production in digital space, and to pull the innovation together and let that new trend of digital voices drive efficiency, will require a platform smart enough and robust enough to take on task: the Industrial Internet. With the advent of the

industrial Internet immediately plants can balance all of their data across multiple plants, even viewing it over the web on their mobile devices and finally be able to understand and examine their performance across the enterprise and the performance of equipment across various lines.

It's clear that both China and Germany are making several efforts to develop new technologies and new working environments.

A possible difference, that derives from the author's own experience in China, is that, even if the big factories, in the big cities, are allowed and can make investments in the field of automation and Industry 4.0, for the factories outside the big cities and the small enterprises, the situation is more complicated.
During my three months stage in Shenzhen for SCM Group, a technological world leader in processing a wide variety of materials: wood, plastic, glass, stone, metal and composites, I've had the opportunity to visit some factories in China's countryside, and to talk with some managers and workers of these factories.
Opposite to Alibaba, Foxconn, and some other great realities, these factories presented extremely undeveloped working conditions, and the machinery only gave the sign of industrialization and informatization.

It's essential to have a complex and complete picture of the whole environment, this because China is a vast country, that still has several differences and disparities between the cities and the countryside, and China needs to improve also the situation in the poorest and more backward areas for reaching the aim that Made in China 2025 fixed.

CONCLUSIONS

Today the concept of Industry 4.0 is increasingly assuming more and more value. The implementation of new technologies related with this assumption, the development of the new paradigm, and the adoption of the main pillars involved in the definition of Industry 4.0 are widely spreading in all the countries of the world. As we stated in this work, the Industry 4.0 implementation process involves several and different aspects of a country, going from the educational system to the talents training, from the research and development improvement to the evolution of a green development system, from the infrastructure improvement to the implementation of big data and cloud computing services (IT abilities).

In this thesis we discussed two of the most advanced countries in the world, we have analyzed the two governmental plans, and we have performed comparative research, defining and highlighting the main differences, the similarities and the concrete improvements the two countries have already implemented.

From the framework above, results that China's program "Made-in-China 2025" has evident aims, guidelines and sector focus. Its guiding principles are to improve industrial capacity through innovation-driven manufacturing, accentuate quality over quantity, perform green development, optimize the structure of the Chinese industry, and cultivate human talent. China is quickly moving from a backward industrial situation to a developed one, and real advancements (robotic, green development, talent training and education, aeronautic and oceanographic exploration) were done in recent years. China is well organized for supporting the next developments, its National Plan will expire in 2049, and until that time China will try to put into effect all the assumptions on it. The OBOR initiative and other massive projects will also contribute to the strengthening of the masterplan, giving China the opportunity to develop new trade and market ways and broaden the concept of China as a strong manufacture power.

Last but not least, during these years China is trying to reinforce its domestic market, making the foreign companies access more complex, and strengthening the identity and the power of Chinese companies. This results in the success of some world-know Chinese companies, which today are laying down new market rules and are giving their support to the global market and the global economy.
An aspect that China must not underrate is the fact that China is one of the biggest countries in the world, and that if today the situation in the big cities like Shenzhen, Shanghai, Canton, Beijing and so on is improved, and the lifestyle is reaching the other countries big cities standards, China still is full of people who live in the countryside, and agriculture and farming are still the primary economic resource of the country. So, even if the situation in the cities is steadily improved, the condition in the farms, in the countryside, and even in the larger part of the factories (we're not talking about Alibaba, Foxconn, Suning and so on) is primitive, and the migration from the country to the cities must not be a total phenomena.

On the other hand Germany, through the implementation of this plan, is reaching the goals she wanted to achieve. China is still well-known for its quality, its security, and its high value-added products, and its position in the global market is strengthening. Most of all its contribution to the green technologies development, its reaffirm of Germany as a market leader and as a market supplier, its advanced training methods and research and development contribution, are enhancing and, if possible, improving Germany position. The foundation of smart factories does not just involve significant realities, but also small and hi-tech companies are trying to adapt their value chain and their products to the new industrial revolution. The rich background of German's industry is supporting companies in the realization of their aims and is assisting in the opening to the global market.

Both the plans have realized the use of the Internet of Things in manufacturing, employing digital networking of production to create smart manufacturing systems within and beyond the factory to both customers and suppliers, and creating a highly responsive, innovative, and competitive global manufacturing landscape. A recent study on global manufacturing competitiveness performed by Deloitte Global forecasts that the U.S. will be the most competitive manufacturing nation in the world in 2020, followed by China, Germany, Japan, India, South Korea, Mexico, Taiwan, Canada and Singapore (Deloitte, 2016). As we can see six of the ten nations mentioned are in Asia, one in Europe and the other three are NAFTA countries. This underlines how the world is shifting and moving from the western part of the world to the eastern one, and how all the countries must quickly understand that new competitors are entering (and most of them have already entered) the global market, competitors with different cultures, different practices and different (and today, in some cases, even stronger) resources.

The world is evolving, and the most advanced economies understand this: China and Germany (along with the US and other developed countries) have the vital task to guide the global market and to enrich the market with new opportunities. Thanks to these two fundamental masterplans, these two countries will play an essential role in the next years and even if in two (as we saw) different ways and methods they will affirm their authority in the global context.

BIBLIOGRAPHY

Åkeson, L. (2016) *Industry 4.0. Cyber-Physical Systems and their impact on Business Models*

Anderl R., Fleischer J., *Guidelines Industrie 4.0, VDMA*

BCG (2016) *Sprinting to Value in Industry 4.0*, The Boston Consulting Group

BCG (2015) *Industry 4.0 The Future of Productivity and Growth in Manufacturing Industries*, *The Boston Consulting Group*

BCG (2015) *The Robotics Revolution*, *The Boston Consulting Group*

BCG (2016), 工业 *4.0* ：未来生产力与制造业发展前景, The Boston Consulting Group

Bloem, J. *et al.* (2014) *The Fourth Industrial Revolution Things to Tighten the Link Between IT and OT*, VINT research report

Cai P., (2017), *Understanding China's Belt and Road Initiative*, Lowy Institute

Capgemini Consulting (2014) *Industry 4.0 - The Capgemini Consulting View*, Capgemini Consulting

China State Council (2015) 中国制造*2025 (National Programme on Made in China 2025)*

Davies, R. (2015) 'Industry 4.0. Digitalisation for productivity and growth', European Parliamentary Research Service

Deloitte (2015) *Industry 4.0 Challenges and solutions for the digital transformation and use of exponential technologies*, Deloitte

Deloitte (2017) 'Industria 4.0', Deloitte

Deloitte (2018) The fourth industrial revolution is here-are you ready?, Deloitte

系国家开发银行研究院副院长 **(Department of National Development Bank Research Institute Vice President)** (2015), 德国工业*4.0*与中国制造*2025*比较, 国际金融报

Fabbrica Intelligente (2015) *Roadmap per la ricerca e l'innovazione - Research and Innovation Roadmap*

Geissbauer, R., Vedso, J. and Schrauf, S. (2016) *Industry 4.0: Building the digital enterprise*, PwC, 2016 Global Industry 4.0 Survey

Gilchrist, A. (2016) *Industry 4.0 The Industrial Internet of Things*, Google, Apress

Heigh D.(2018), *Global 500 2018,* Brand Finance Report

Hermann, M., Pentek, T. and Otto, B. (2015) *Design principles for industrie 4.0 scenarios: a literature review*

IFR (2018), *Executive Summary World Robotics 2018 Industrial Robots*

Jeske, M., Grüner, M. and WeiB, F. (2013) *Big data in logistics: A DHL perspective on how to move beyond the hype*, DHL Customer Solutions & Innovation

Kagermann, P. D. H., Helbig, P. D. W. W. and Helbig, D. J. (2013) *Recommendations for implementing the strategic initiative INDUSTRIE 4.0*, Final report of the Industrie 4.0 Working Group

Kiltou D., Conrads J., et al. (2017), *Germany: Industrie 4.0,* Disclaimer

KPMG (2016) *The Factory of the Future*, KPMG

Kuruczleki, É. *et al.* (2016) *The Readiness of the European Union to Embrace the Fourth Industrial Revolution*, Management

李永胜**(Li Yongsheng),** (2015), 中国制造 *2025*，核心内容分析

Liao Yongxin et al. (2018), *The impact of the fourth industrial revolution: a cross-country/region comparison*, Pontificia Universidade Catòlica do Paranà

Ling Li (2018)*, China's manufacturing locus in 2025: With a comparison of "Made in China 2025" and "Industry 4.0",* Technological Forecasting and Social Change

Ling Li (2013), *The path to Made in China: How this was done and future prospects*, Production Economies

刘九卿 **(Liu Jie Qing)** (2016), 传感器是"工业 *4.0*"和"中国制造 *2025*"的核心技术

Liu S. (2016), *Innovation Design: Made in China 2025*, DMI, vol. 27

MacDougall, W. (2013) *Industrie 4.0 Smart Manufacturing for the Future*, Germany Trade and Invest

Marston, S. *et al.* (2011) *Cloud computing - The business perspective*, Decision Support Systems, Elsevier B.V.

McKinsey&Company (2015) *The case of digital reinvention*, McKinsey&Company

McKinsey&Company (2016) *Industry 4.0 at McKinsey's model factories: Get ready for the disruptive wave*, McKinsey&Company

Mrugalska, B. and Wyrwicka, M. K. (2017) *Towards Lean Production in Industry 4.0*, Procedia Engineering

Muller J. et al. (2018), *Sustainable industrial value creation in SMEs: A comparison between Industry 4.0 and Made in China 2025*, International Journal of Precision Engineering and Manufacturing-Green Technology

Murphy, R. R. (2000) *Introduction to AI Robotics*, MIT Press.

Obitko, M. and Jirkovský, V. (2015) *Big Data Semantics in Industry 4.0*, International Conference on Industrial Applications of Holonic and Multi-Agent Systems

Peressotti, V. (2016) *Il vero significato di Industry 4.0 Quali impatti avrà sulle aziende*, Sistemi e Imprese

Piller, F. T., Weller, C. and Kleer, R. (2015) B*usiness Models with Additive Manufacturing—Opportunities and Challenges from the Perspective of Economics and Management*, Advances in Production Technology

PwC (2015) *Digital Manufacturing. Cogliere l'opportunità del Rinascimento Digitale,* PwC

PwC (2015) *The Internet of Things: what it means for US manufacturing*, PwC

Roland Berger, Albur, W. and Singh, H. V. (2014) *Next Gen Manufacturing: Industry 4.0 A look at the changing landscapes in manufacturing*, Confederation of Indian Industry

Roland Berger (2014) *Industry 4.0 The new industrial revolution How Europe will succeed*, Roland Berger Strategy Consultants

Schmidt, R. *et al.* (2015) *Industry 4.0 - Potentials for reating Smart Products: Empirical Research Results*, *Business Information Systems*, Springer International Publiching Switwerland 2015

Schwab, K. (2017) *The Fourth Industrial Revolution*, The Fourth Industrial Revolution

沈烈初 **(Shen Li Chu)** (2015), 读《中国制造 *2025*》与*"*德国工业 *4.0"*后的思考, 机械设备维修 (zhizaocn)

Smit, J. *et al.* (2016) I*ndustry 4.0 - Study for the ITRE Committee*, European Parliament

Sniderman, B., Mahto, M., Cotteleer M., (2017), 工业*4.0*与制造业生态圈**,** Deloitte

Università degli studi di Padova (2016) *Smart Manufacturing & Made in Italy : la via italiana alla quarta rivoluzione industriale. Perchè un seminario?*

US Chamber of Commerce (2017), *Made in China 2025: Global Ambitions Built on Local Protections*

Wang L. (2016)*, Comparative Research on Germany "Industrie 4.0" and " Made in China 2025",* Atlantis Press

Wang, S. *et al.* (2016) *Implementing Smart Factory of Industrie 4.0: An Outlook*, International Journal of Distributed Sensor Networks

王喜文**(Wang Xiwen)** (2017), 工业 *4.0:*中国的危与机, "形势与政策"专题讲稿

Wee, D. *et al.* (2015) *Industry 4.0 How to navigate digitization of the manufacturing sector*, McKinsey&Company

Witkowski, K. (2017) *Internet of Things, Big Data, Industry 4.0 – Innovative Solutions in Logistics and Supply Chains Management,* Procedia Engineering

World Economic Forum (2015) *The 4th Industrial Revolution: Reshaping the Future of Production*, World Economic Forum

World Economic Forum (2015) *Mastering the Fourth Industrial Revolution*, World Economic Forum

Wubbeke J., Meissner M., et al. (2016), *Made in China 2025: The making of a high-tech superpower and consequences for industrial countries*, Merics

张有风 **(Zhang Youfeng)** (2017), 工业机器人遇见人工智能：融合的工业如何创造价值*?*, Robotics China

张维 **(Zhang Wei)** (2017), 工业*4.0*视角下的建筑创作探讨, Archcy

SITOGRAPHY

https://unreporter.org
https://www.forbes.com
https://www.handelsblatt.com
https://www.bcg.com
https://www.deloitte.com
https://www.cittàdellascienza.com
https://www.wto.com
http://www.worldbankdata.com
https://www.statista.com
https://www.worldatlas.com
https://www.cnbc.com/
ttps://mykita.com/
https://www.luxottica.com
https://it.mitsubishielectric.com/it
https://www.maserati.it
https://www.cimbali.it
https://www.securonix.com/
https://www.tradingeconomics.com
https://www.xinhuanet.com
https://www.bloomberg.com
https://www.techblog.com
https://www.merics.org
https://www.freshfields.com
https://www.chinadaily.com/cn