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SERVICE MANAGEMENT IN THE SYSTEM INTEGRATION ROBOTICS INDUSTRY – THE CASE OF ESSEBI AUTOMATION

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Firma dello studente

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Abstract:

This research investigates service management in robotic system integration with ESSEBI, an Italian firm specializing in automation systems, as its case study. The report begins with an overview of the worldwide robotics and automation solutions market, including the adoption of Industry 4.0 (I4.0) by Italian SME's (SMEs).

The third chapter of the report analyzes ESSEBI Automation and its implementation of Industry 4.0. (I4.0). The chapter opens with a thorough description of the organization, including its basic information, provided solutions, and target consumer categories. The study then examines the opportunities and obstacles ESSEBI confronts in implementing its solutions, as reported by the questionnaire. The chapter finishes with a questionnaire-based analysis of ESSEBI's adoption of I4.0. This chapter gives a thorough overview of ESSEBI's position in the industry and its attempts to adopt I4.0 technologies, therefore laying the groundwork for the company's future development and success.

The fourth chapter of the paper analyzes Service Management in Robotic System Integration at ESSEBI. The chapter opens with an overview of ESSEBI's service offerings and strategic thinking methodology. The report then analyzes the execution of ESSEBI's services and offers recommendations for enhancing the company's service strategy and implementation. Among the recommendations is a redefinition of the service portfolio to better match consumer requests, as well as the shift from free to fee-based services. The chapter ends with a conclusion and a list of sources.

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CHAPTER 1: INTRODUCTION

3.2 What is I4.0 and its evolution

3.1.3 Introduction: from Industry I1.0 to I4.0:

The manufacture of products can be acknowledged during human history longer than its phenomenon. Not until the silk culture was first introduced in India in 400 AD did we recognize and seriously discuss the definition of production (Textile School, 2010). Any activities engaging in turning raw materials into finished products surrounding our life can be considered product manufacture. However, as the production cycle is as old as the appearance of mankind, it has gone through a significantly longer development with remarkable transformations. Manufacturing definition is no longer attached to hand-made work as our ancestors used to think, the involvement of machines on a large scale is presently taking over. People are talking about I4.0 with tremendous resources from automation, IoT, big data, cloud computing, and human-robotics integration on all media platforms. Nevertheless, according to Rinalducci (2022), before the terminology of I4.0 was founded, we witnessed 3 remarkable stages transitioning from man-made work to machinery work in the past (so-called Industrial Revolution):

- Industry 1.0 originated in England during the period between 1760 and 1840. The introduction of water and steam power was the signature of this era. This is also the first milestone when the economy shifted from handicrafts to machinery. Due to the efficiency and cost optimization of machines, people were able to produce in a larger volume and grew their businesses. Sectors such as glass, mining, agriculture, and textile were the main beneficiaries due to this mechanization. Along with the opportunities from mechanization, obstacles started to appear with the imbalance between high customer demand for machines and limited supply, leading to more pressure on low-class workers in hazardous working environments.

- Industry 2.0 was mostly covered in Germany, Britain, and America around the 1870s (19th century). Oil and electricity were the main resources during this stage. Even though electricity was not a new invention in human daily usage, the invention of electrical machines turned this era into a different meaning. Thanks to the arising improvement in efficiency, operation, and maintenance of electrical machines, mass production was the key role of the

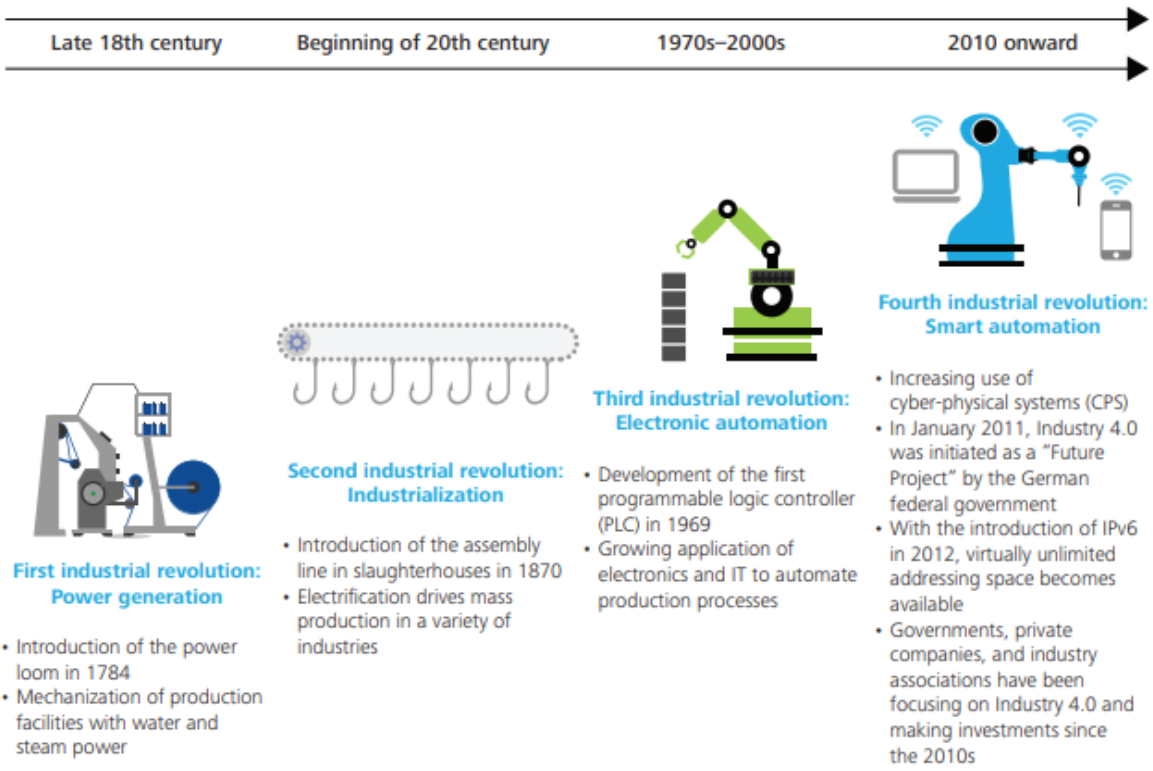
industry. Consequently, manual workers were put on the edge of unemployment due to the replacement of machines in workplaces (Tay et al., 2018).

- Industry 3.0 evolved during the 20th century with the advent of the digital revolution. Since the vast majority of today's populace is familiar with manufacturing sectors that make use of digital technology, I3.0 enjoys more visibility than its predecessors, 1.0 and 2.0. With the help of IT and electronics, a great deal of formerly manual work in manufacturing has been automated. Enterprise resource planning technologies enabled people to plan, schedule, and track product flows through the plant. Many manufacturers moved component and assembly activities to low-cost nations to cut expenses. The geographical dispersion led to the formalization of supply chain management (Thangaraj & Lakshmi Narayanan, 2018). Another example of industry 3.0 is the use of robots, which can be programmed to execute certain tasks without the need for human participation. With the current existence of robots in manufacturing, it can be said that industry 3.0 is still active today.

- I4.0 is a concept that has become ubiquitous in the industrial sector. Businesses have been grappling with the fourth industrial revolution's next stage since the early 2000s. I4.0 is the information-intensive revolution of manufacturing (and associated sectors) in a linked world of big data, people, processes, services, systems, and IoT (Internet of things) - enabled industrial assets. Automation and self-management of manufacturing facilities, data storage systems, and intelligent equipment are key components of the I4.0 paradigm. Platforms for data exchange, customer contact, and services are becoming increasingly important as a result of digitization. Online platforms facilitate market access, reduce transaction costs and enable innovation through new business models. I4.0 would be impossible without networks and data traffic because machines are connected all over the world (Fernández-Miranda et al., 2017).

In sum, we can visualize the development of the industrial revolution throughout decades by this figure:

Figure 1: A history of industrial revolutions: Industry evolution with key developments (Brenna Sniderman, 2016)



3.1.3 Definition of I4.0

I4.0 was defined for the first time in 2011 at the Hannover Messe trade show and was the topic of a German federal government-established I4.0 working group (Sniderman, nd). This concept is an umbrella term encompassing contemporary information, communication, automation, and production processes. According to McKinsey, I4.0 is the digitization of production, with sensors incorporated into almost all product components and manufacturing equipment, ubiquitous cyber-physical systems, and analysis of all relevant data. (McKinsey Digital, 2015). Cyber-physical systems, such as the Industrial Internet of Items (IIoT) and smart, autonomous systems that employ computer-based algorithms to monitor and operate physical things like equipment, robots, and vehicles, are at the heart of the Fourth Industrial Revolution. The digital connectivity of all the entities involved in a manufacturing operation's value chain (including suppliers, the plant, distributors, and the product itself) allows for a highly streamlined and

integrated process from beginning to end (Davies, 2015). German Federal Chancellor Angela Merkel has called I4.0 “a comprehensive transformation of the whole sphere of industrial production through the merging of digital technology and the Internet with conventional industry” (Merkel, 2014).

Even though I4.0 terminology originated from Germany, there have been different definitions of it discussed among researchers. For example:

I4.0 cannot be defined solely in terms of robots and automation of production; it is the digitization of business processes in their entirety; it entails the adoption of a contract over material procurement and how the product "makes its way" through production and is finally delivered to the customer (Bilgili, 2019).

I4.0 makes extensive use of emerging technologies and quick advancements in the creation of equipment and tools in order to address global concerns and raise industry standards. I4.0's central notion is to leverage modern information technology to provide IoT services. By incorporating engineering knowledge, production can function more efficiently and with less downtime. As a result, the finished product will be of higher quality, the manufacturing processes will be more efficient and simpler to maintain, and cost savings will be realized (Wang et al., 2016).

I4.0 promotes production efficiency by gathering data intelligently, making sound judgments, and carrying out those decisions without hesitation. Collecting and evaluating data will be simplified by utilizing a new technology. The interoperability operational capability works as a 'connecting bridge' in I4.0, ensuring a dependable production environment. This collective awareness is the most critical feature of artificial intelligence functions in I4.0 (Qin et al., 2016).

“However, the fourth industrial revolution is not limited to intelligent and networked devices and systems. It is much broader in scope. Waves of further breakthroughs in areas ranging from gene sequencing to nanotechnology, renewable energy to quantum computing. The convergence of these technologies and their interplay across physical, digital, and biological realms is what distinguishes the fourth industrial revolution from preceding revolutions”. (Schwab, 2016).

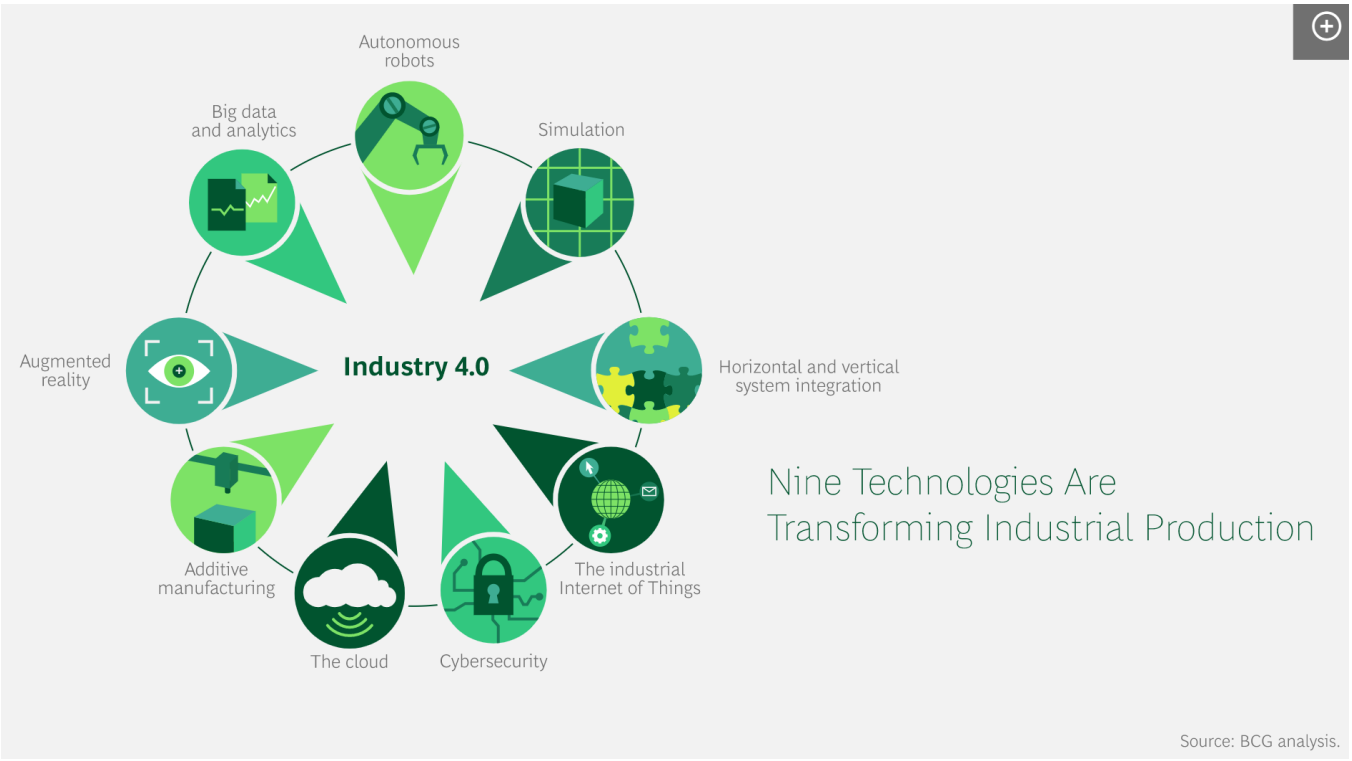
In a nutshell, I4.0 enables "smart" production and factories, as well as smart warehousing and logistics. In addition to the mentioned smart manufacturing and smart factories, the new

capabilities of I4.0 led to the emergence of the "smart anything" phenomenon, which garners the most media attention. This phenomenon encompasses everything from smart grids to smart energy to smart cities.

3.1.3 Nine technologies of I4.0

According to Boston Consulting Group, 9 technological pillars underpin I4.0. These developments enable the creation of autonomous and intelligent systems by bridging the digital and physical worlds.

Figure 2: Nine technologies are transforming industrial production (Boston Consulting Group, n.d.)



Big data and analytics: Recently, analytics based on enormous data sets have evolved in the manufacturing industry, which employs cutting-edge computer technologies to identify patterns, trends, and preferences. "Big Data" may be classified into four dimensions: volume, variety, value, and velocity (Witkowski, 2017). In I4.0, big data analytics is used in smart factories to increase production efficiency, real-time data analysis, optimize maintenance an,d to manage production automation.

BMW, for example, began using big data in 2014 to identify flaws in its new vehicle prototypes. Sensor data were gathered from prototypes and already-in-use automobiles. BMW's approach (which was likely coupled with their vehicle design and modeling software) identified flaws and mistake patterns in prototypes and in vehicles currently in operation as a result of big data analysis (Bekker, 2019).

Autonomous robot: Intelligent machines that are able to communicate among themselves and carry out their tasks in a risk-free manner even in the absence of direct human direction are referred to as autonomous robots. An autonomous robot has to demonstrate the ability to perceive its environment, make decisions about what to do in response to those perceptions, and then carry out those decisions (Robotic Magazine, 2017). These are three important characteristics to categorize it is an autonomous robot or not.

Using autonomous robots in various industries is becoming more popular than ever thanks to its automation, expense optimization and effectiveness increase. Supply Chain can be named as one of a few rising industries which is applying autonomous robots due to its expanding scale. DHL Supply Chain, for example, has used than 10 kinds of robot in their delivery and warehouse arrangement such as: Assisted Picking Robots (which display images of goods to be picked, self-learn and calculate optimal navigation routes); Indoor Robotic Transport (which boosts labor efficiency and consistency by autonomously transporting trolleys or pallets in the warehouse, reducing damage and providing new data analytics possibilities); Goods to Person Robots (which reverse the picking process moving goods to operators in a flexible and scalable manner) and so on,…

Simulation: In the development of planning and exploratory models, simulation is a fundamental technique for enhancing decision-making together with the design and operation of complex and intelligent production systems (Paula Ferreira et al., 2020). Firms need simulation technique to continuously test various scenarios in production in a short period of time and predict the result of these tests even before they are implemented. The simulation process happens in a risk-free environment, but the result can be delivered almost correctly due to the fact that it uses real-time data and is designed to replicate the physical world. That’s why the usage of simulation also often generates significant benefits for companies not only in the strategic planning stage but also in daily operation activities because the righter data input in the model, the better outcomes achieved.

One example to be named for the simulation software is SIMUL8, which has been used by HP, Plexus, FMC Technologies, Chrysler… to reduce resourcing costs or remove manufacturing bottlenecks… As an illustration, HP used SIMUL8 to find the most efficient

set-up and demonstrate delays and restrictions inside the process. As a result, the company was able to save $100,000 annually by removing tasks that did not add value to the product (SIMUL8, n.d.).

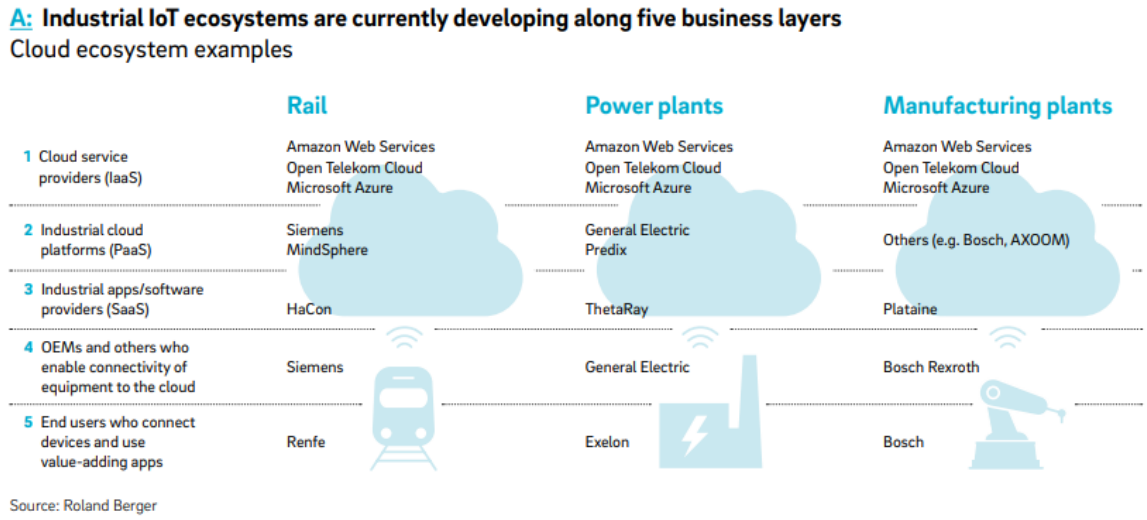
Horizontal and Vertical System Integration: Horizontal integration means expansion. In business context, it entails buying up businesses that make equivalent products or provide equivalent services. As a result, the corporation will be able to pool its resources into a bigger, more formidable whole. Similarly, vertical integration in normal context refers to the process of obtaining control over additional phases of the product manufacturing chain. It occurs when a company gains or has a significant influence on any of these processes in the manufacturing and sale of a product. Nevertheless, with an aim of smart factories in I4.0, both horizontal and vertical integration have reflected different meaning in manufacturing. I4.0 horizontal integration means combining all supply chain components. This increased alignment enhances visibility, adaptability, and productivity, while also increasing the degree of automation (McLaughlin, 2020). The goal of I4.0's vertical integration is to provide a seamless flow of data and information throughout all functional departments and stages of production, from research and development to quality assurance to product management to information technology to marketing. The data travels freely up and down these tiers, allowing for data-driven strategic and tactical decision making (*Horizontal and Vertical Integration in Industry 4.0*, 2019). The vertically integrated I4.0 firm obtains a competitive advantage by responding quickly and properly to shifting market signals and opportunities.

The Industrial Internet of Things: Internet of Things (IoT) can be generally understood as devices that interact with each other and deliver information to consumers through the Internet in a distributed network. As IoT is usually applied for commercial sector, Industrial Internet of Things (iIoT) is considered a sub-sector of IoT which mainly focuses on manufacturing facilities. All of this data - sensor output, user input, service provider availability and expertise, and more - may be combined using IIOT technology to give real-time answers that are accurate and effective (Liao et al., 2018). Since data also plays an important role in iIoT as other mentioned technologies in I4.0; human duties in a hard-working industrial environment setting will change as a result of automation, but new skillsets will be required at the same time.

Based on the common appliance of iIoT in manufacturing, there are 5 layers identified within IIoT scope: (1) cloud service providers; (2) operators of industrial cloud platforms; (3) providers of industrial applications and software; (4) OEMs and other firms enabling equipment to be connected to the cloud; and (5) end users who connect their devices to the

cloud and make use of value-adding applications. Figure 3 shows the examples of big companies using these 5 layers mentioned above

Figure 3: The example of 5 business layers in Cloud Ecosystem (Roland Berger Focus, 2017).



Cybersecurity: When the topic of I4.0 has been raised, the quantity and quality of information captured for companies who are adopting it also increases thanks to the interconnection between one computer to another, IT (Information technology) and OT (Operational Technology) system or machines and human cooperation. This brought enormous chances for attackers to move laterally across a network for their harmful actions. Bad actors can use unprotected systems for cybercrime such as: economic espionage, IP breach, or production disruption. Because of this, it is very necessary to have communications that are both secure and reliable, as well as highly developed access control for computers and user identification. I4.0 cyber dangers and threats have no easy answer, single product, or patch. Linked technologies underpin important business activities now, and they'll likely become more connected, integrated, and susceptible in the future (Deloitte Insights, 2020). Therefore, it is very necessary for businesses to make significant investments in the detection and prevention of cyber threats. One change in the organization implementation is the role of CISO (Chief information security officer) to develop and conduct information security program. According to Accenture (2021), there are 3 ways to become Cyber resilience when adopting I4.0:

(1): Promote CISOs to the Board: empowering the role of CISO in decision making instead of putting the major approval process to CEO and Board.

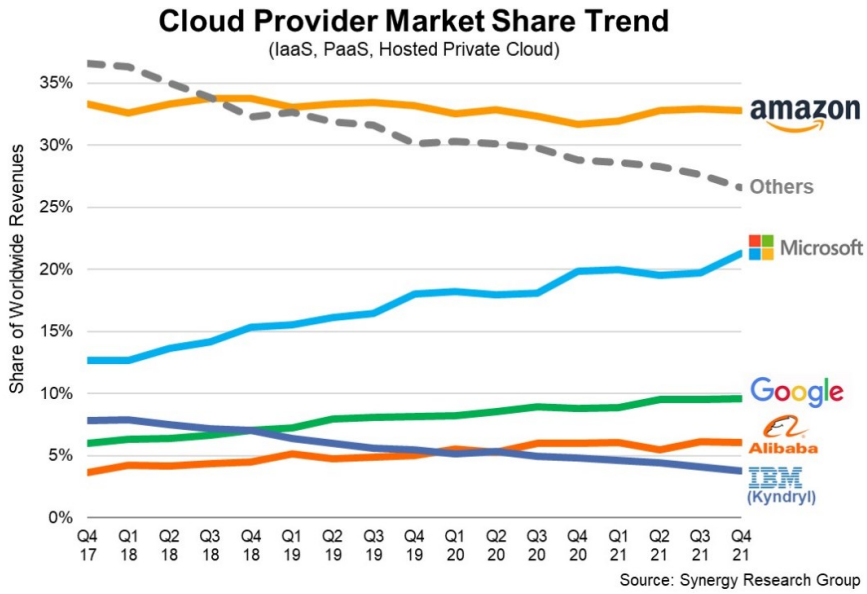
(2) Be threat-centric and business aligned: keeping track of companies' risk profiles and making that information accessible to the leadership.

(3) Leverage the security of cloud: Cloud security can help businesses achieve better results by being quick, frictionless, scalable, proactive, and cost efficient.

The Cloud: Back in the past, every employee might own a private computer where the information was created and saved separately in each hard drive. Because of this decentralization of data, factories haven't become that smart. That's why Cloud computing is one of the strongly focused bases in I4.0. The Cloud, simply understood, is a method of storing and retrieving data and applications through the internet and in multiple devices (computers, phones, tablets…). Cloud facilities make the smart manufacturing possible by their connectivity and integration throughout various departments: sale, distribution, finance, production, logistic, etc. (IBM, 2022). Thanks to this always – available information warehouse, data can be easily accessed and assessed in real time, leading to the reduction of decision-making time and the raise in business performance.

However, factories as the Cloud users are not the only stakeholder taking benefit from it. Cloud service providers are playing big in the lucrative market. Synergy Research Group shows that Q4 business expenditure on cloud infrastructure services reached $50 billion, up 36% from Q4 2020. Total expenditure rose 37% from 2020 to $178 billion. Amazon's market share is 32-33 percent globally (Synergy Research Group, n.d.). The more investment spent, the more important it becomes in this digital transformation era. Nevertheless, the more people shifted to online data storage, the higher risks it can create such as data leak… That's why we have cybersecurity as one of 9 technologies mentioned.

Figure 4: Cloud Provider Market share Trend (Synergy Research Group, n.d.).



Additive Manufacturing (AM): In a simple way, the additive manufacturing technique enables researchers to generate three-dimensional things straight from a computer design file. Using computer-aided design (CAD) software or 3D object scanners, equipment are commanded to deposit material in precise geometric formations, layer by layer (GE Additive, n.d.). People often use another term such as "3D printing" as an equal way to refer to AM, however, 3D printing is actually a subset in this technique. The production of prototypes or individual components is mostly done by 3D printing. Because of its versatility, AM enables us to develop items in small quantities that are tailored to the customer's specifications without wasting plenty of raw materials. Rapid prototyping and highly decentralized manufacturing processes are two of the main reasons why AM is gaining popularity among businesses.

Augmented Reality: Technology known as augmented reality (AR) adds new dimensions to our everyday experiences by superimposing digital data—such as text, pictures, and sounds—on top of the physical environment. The use of AR provides workers with the ability to bridge the gap between the actual world and the increasingly significant digital environment (Masood & Egger, 2019). AR in manufacturing has the potential to enhance production metrics, assist operators in working more safely and effectively, and address problems with maintenance or data gathering. Furthermore, when it requires a certain amount of time to prepare for engineers before working in industrial manufacturers, AR can also speed up the process by providing 3D interactive modules. Not only does this assist workers learn more quickly, but it also helps businesses, particularly those firms that are investing in training programs, ensure greater performance with fewer mistakes while they are in operation.

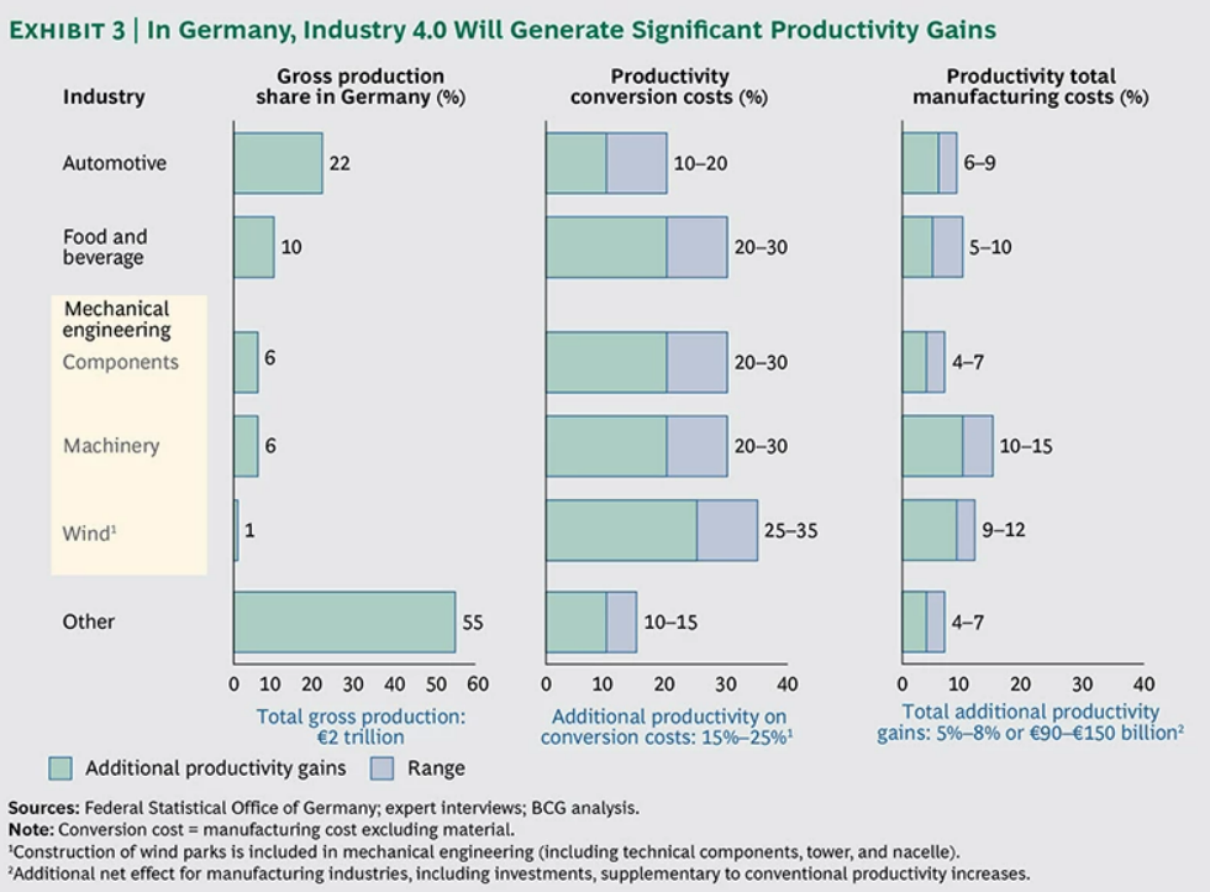
3.1.3 The impact of I4.0:

With all of the disruptive technologies applied in the entire production process, the Fourth Industrial Revolution will usher in a plethora of influences, some of which will be beneficial to civilization, while others might be challenging to overcome. Not only big countries who are deeply involved and invented the I4.0 phenomenon (such as: Germany, France, Spain, Italy,.) have been going through a big transformation in the past decade but also developing countries are in the race in order to not lag far behind this digital transformation. I4.0, enabled by technological advancements, has had far-reaching effects across a wide range of fields and stakeholder groups. From multiple research projects, three common stakeholders that can be mentioned in this thesis are organizations, supply chain and human.

1.1.4.4 Impacts to Organizations

Productivity increase: The alignment of technologies in I4.0 was believed to increase productivity in the manufactures, and this can be proved by several contexts. Big data, Cloud and iIOT allow the connectivity between on-time data and the right decision makers, help them to strive for the more strategical purposes based on a reliable and analytical evidence. Simulation can remove some unnecessary costs before the process is actually implemented and additive manufacturing is a considerable alternative in customizing and optimizing the input materials. Under the perspective of organizations, I.40 definitely boost their own productivity. Boston Consulting Group released an article in 2015 discussing the boost in productivity when more businesses embrace I4.0: "The German manufacturing sector's productivity will improve by €90 billion to €150 billion. Conversion costs, excluding materials, will decrease by 15 to 25 percent. Material prices affect productivity by 5 to 8%. Industry-specific enhancements. Industrial-component manufacturers should anticipate 20 to 30% productivity gains, and automakers 10 to 20%" (Rüßmann & Lorenz, 2015).

Figure 5: I.40 generates significant productivity gains in Germany (Rüßmann & Lorenz, 2015).



Cost optimization and revenue growth: Productivity is not the only benefit that organization gained during I4.0 adoption. The difference between traditional manufacturing and smart manufacturing is the strong cooperation between human and machines where automated technologies can reduce common human errors and robots can mostly replace human in some repetitive tasks. This also means the demand for manual worker has been shifted to the demand of autonomous robot as well as the need of high-quality personnel. It can be concluded that the costs were optimized thanks to I4.0 technologies not only by reducing manual work but also by controlling the risk of errors done by human. In terms of operation performance, research from Forbes showed that reductions in downtime (35–40%), increases in production (15–20%), improvements in quality (35–40%), increases in total productivity (65–70%), and enhancements in asset utilization (35–40%) are anticipated results of I4.0 (Damani, 2020). Does this bring a positive outcome for business in terms of money? Obviously, a reduction in operating costs and an increase in asset efficiency can drive to an increase in revenue.

Change in business model: I4.0 brings a hug benefit in business performance. Yet the core transformation in this era is surrounded by technologies and organizations also need to put a huge effort only financially but also mentally to prepare for adaption. One significant change from organizations themselves is their mindset in value creation. Factories are not purely products suppliers; they add values and services to bring customers a new experience and this is called Product-Service system or Product-Service offering. This kind of change has been proved in the survey of PWC (2016) with 2000+ respondents in 26 countries. In the key findings, PWC called this model transformation "Incremental and revolutionary product & service innovation". Based on their explanation, corporations will launch new industrial goods with digital elements and supplement their existing portfolio to achieve these additional revenues. Breakthrough revenue growth will be fueled by data-driven digital services or perhaps fully digital solutions serving an entire client ecosystem. We can look at consumer electronics industry as an example: Samsung produces refrigerators. However, fridge is no-longer a frozen hub to store food and beverage as we used to think in the past. Since Samsung introduced Smart Fridge in Family hub (Samsung Newsroom, 2017), users can track what the leftovers inside the fridge are, when these ingredients expire or what simple recipe that people can make from the leftovers. These functionalities were enabled by Big Data, iIOT and Cloud service, which keep the relation with customers go beyond the purchasing point. With that in mind, companies should be aware of current trends and innovation happening in the industry to stay competitive among competitors and stakeholders.

The case above is just an example of modifying the business model for Business-to-Consumer (B2C) companies; what about Business-to-Business (B2B) companies? Also, are they modifying their operations in comparison to twenty years ago? As this is the focus of our thesis, let's consider robotics system integrators and determine how their business model differs from that of traditional robotics enterprises. A typical robotics company offers robots as their sole product. They get the request from the client (which already includes the design and technical specifications) and then construct and deliver the robots depending on the client's specifications. Recently, we may have heard the term "robotics system integrator," whose functions extend much beyond those of a simple product seller. A system integrator is a company that combines consulting, engineering, and project management services to assist clients in achieving their business objectives. (Thakur, 2022). Companies that develop robotics automation solutions do not provide a product; rather, they provide an automated solution. This comprehensive solution includes consultancy, design, prototyping, project management, and customized products (where robots can play an important part of it). As a result, the level of involvement between customers and suppliers is significantly more than a typical give-and-take relationship. In this instance, the supplier can intervene in the client's process to study and suggest a more streamlined, comprehensive package that can include both software and hardware components to make the process smarter and more automated. Therefore, robots are only a component of the chain and not the primary product.

Since robotics is related to I4.0, system integrators also leverage I4.0 technology to make robots intelligent. Certain businesses can utilize cloud computing resources to enhance the collective learning, computational speed, collective memory, and interconnectedness of robotic systems (Enterprise Engineering Solution, 2021). By this way, robots may process and exchange data from several robots or agents when linked to the cloud (other machines, intelligent objects, humans, etc.). For example, the cloud-connected industrial robots made by Fanuc employ a technique known as reinforcement learning, which is a type of machine learning, to teach themselves new jobs (Schatsky, 2017). This whole new technique improves the interaction between humans and robots, hence increasing the whole production process's efficiency. The proliferation of robots in this context not only alters the business model of the providers (system integrator), but also the customers (manufacturers). Because they were given a smarter automation solution package, they are able to spend less effort and cost to invest more into the upgrade of their core products. This, in turn, leads to the addition of more features or

extra values, just as we discussed in the first part of this paragraph regarding the Product-Service offering in the B2C model.

Innovation and technology driven: Changing business model or changing business mindset is just a first step, applying disruptive innovation during transformation should be the next one. According to study conducted by Deloitte, an organization's total revenue has the potential to rise by up to 22 percent, and its operating income can improve by up to 19 percent, if digital transformation is properly implemented. Furthermore, organizations that are driven by innovation are almost as likely to recognize significant return on investment (ROI) from transformative digital transformations as organizations that are driven by operational and production goals. This is because innovation is a driver of both operational and production goals (Döbler, 2020). For that reason, we can see both-sided effects of innovation driven strategy while firms in the same industry can stay competitive to each other but ones across different sectors can collaborate to share best practice and keep updated with technology trends. There is an interesting example from Sweden initiative called Combient. Combient is a world-first cooperation network in which non-competing industry leaders would exchange assets and work together on their transformation was presented to a group of top Swedish enterprises that are affiliated to the Wallenberg family (Swedish Royal family). Since foundation in 2014, Combient have cooperated with 34 large enterprises to capture the growth of Data and AI capabilities, business transformation, smart supply chain, smart production and several topics around I4.0.

1.1.4.4 Impacts to supply chain

A supply chain is an entire system for creating and delivering a product or service, from sourcing raw materials through end-user delivery. Multiple levels of supply chain such as procurement, manufacturing, warehousing, transportation or logistics, and fulfillment must be synchronized and run smoothly (Patil, 2020). When the era of I.40 happens, supply chain system is also digitalized with the impacts on every level of the process. For example, procurement 4.0 is a more automated version of eProcurement. This smart technology automatically recognizes material requirement and generates an order for the provider without human intervention (Patil, 2020).

Additionally, supply chain efficiency can be improved to the point where safety stock is no longer necessary through the integration of real-time demand data from sale points, real-time performance and inventory data in manufactures. As mentioned in the example of Autonomous Robot (sub chapter 1.1.3), warehouse management becomes more organized and

optimized not only by the support of robots but also by other technologies such as Augmented reality (AR) and Internet of Things (IoT) for warehouse product selection, sorting, and tagging. Similarly, the management of logistics and transportation has the most to gain from the digitalization of supply chains and the implementation of I4.0. Real-time shipment tracking solutions will make it possible for supply chain managers to optimize routes, fleets, and the utilization of field assets. Information transparency plays a big role throughout the whole chain whereas customers can receive the up-to-minute tracking information of the order without waiting for the whole day at home. This is thanks to the smooth collaboration from sellers, logistic company and the driver itself. Especially, in response to the widespread move of online shopping during the recent COVID-19 epidemic, many factories are now developing their own e-commerce capabilities in imitation of their retail counterparts. Manufacturers may elect to use retailers' tactics for enhancing digital customer service or even switch to DTC (direct-to-consumer) sales. In short, the benefits of I4.0 to supply chain can be similarly summarize as its effects to the organization mentioned in the previous passage with the increase in productivity, the shift in business model to deal with new customer demand and the elimination of wasteful resources, both in planning and implementing stages.

1.1.4.4 Impact to human

The human definition in this thesis can be divided into 2 stakeholders who are directly involved to the growth of I4.0: Customers and employees. Under the perspective of **customers**, it is undeniable to state that customers are more connected to the manufactures to easily express their wishes more than in the past. The traditional business model happened while intermediaries (wholesalers, retailers) are the bridge between these 2 parties and therefore, there has been always a barrier between the one who produces products and the one who buy products. During I4.0 with the support of data integration, customer experience has been improved better because their behaviors, trends and feedbacks are collected, shared, analyzed and linked directly to the manufacture.

What does it mean in terms of experience? Firstly, more customizations will be involved in the process of exchange information from both sides. Promotion is related to most frequent visited or bought products for each customer rather than mass marketing. Provided services are also tailored because not everyone demands the same solutions. This does not apply only to B2C (Business to Customer) model but also with the B2B model (Business to Business). Emerging technologies such as 3D printing, for instance, may assist to promote fast prototyping with some small customization based on the standard product with substantially

decreased lead times. Additionally, suppliers can leverage simulation to have a more accurate resources planning and projection before applying mass production. Secondly, the provided services are more holistic and digitized. Customers don't need to be at the same location to get support. Whenever a query is sent, they can meet a virtual agent through chat, call or even with an automatic bot (which is much cheaper than setting up manual call center) and get the query sorted within 24 hours. Data between manufactures and delivery companies can be integrated to get the real time update until products are delivered to the customers. At this point, the use of technological solutions may assist with the dissemination of real-time information, the improvement of coordination, and, more generally, the resolution of issues that impede communication. Meeting customer's satisfaction is not limited to adding extra values to the products or maintaining smooth operation engine. It redefined the competition within firms in the same industry. For the first time ever, competitors become partners to increase customer convenience and choice through interoperability. A outstanding example to consider is "Home Connectivity Alliance" (Electrolux Group, 2022), a new initiative among leading firms in electronic appliances. Top brands such as Electrolux, GE, Samsung, Haier… have cooperated to provide a unified customer experience by facilitating cross-brand device and application use. In the future, consumers can monitor all their devices such as TV, oven, washing machine through one unique app no matter what brands these products are. In sum up, the better experience customers have, the more loyalty they keep, and the higher revenue achieved by companies if they can extend customer life cycle. This is an opportunity but also a challenge. Organizations must make sure they are collecting, monitoring, and analyzing data from all their customers' touchpoints and input channels so they can provide superior service and products.

As mentioned in the previous passage, when machines and robots are highly upgraded during the I4.0, they replace human workforce for manual tasks and reduce errors made by human. This brings a positive impact to company to ensure the efficiency and accuracy, yet a reserved effect to **employees** because some of vacancies no longer exist after the next 5 or 10 years. A research by BCG in 2016 estimated that around 610,000 jobs in Germany in assembly and manufacturing could be lost due to increased usage of robotics and computerization (BCG Global, 2015). In 2020, World Economic Forum (WEF) reconfirmed this prediction by stating that human-machine labor division may eliminate 85 million jobs by 2025 (Whiting, 2020). However, this effect doesn't bring a negative outlook. In the same research, WEF also predicted an additional 97 million occupations that are better suited to the new division of labor between humans, computers, and algorithms could come into existence. Therefore, there is always a room for high skilled workers as employees are put in the position of planning, monitoring and controlling

machines instead of simply cooperating with them as it was in the past. For instance, although robots have displaced low-skilled workers on assembly lines, they have also created new opportunities for machinists, highly trained welders, and other professionals who are responsible for the machines' upkeep and development. With that in mind, digitalization, and automation, especially when it is involved robotics replacement will cause a shift in the skills that are in demand across all work sectors (Holzer, 2022).

The majority of top 10 skills listed in the “Future of Job Report” by 2025 belongs to 2 main categories: Problem solving and Technology use and development (design and programming…). This proves the need for current workforce to have extensive knowledge and advanced skillset as fast as the rapid development of I4.0. Companies nowadays seek for hybrid employees, such as businesspeople with the ability to read data and turn it into useful ideas, or technical specialists with a firm grasp of management, finance, and operation as opposed to the siloed approach of the past. Unfortunately, even with that raising demand in technical positions, the potential candidates don’t seem to have an easier route in the hiring process. Recruitment procedure becomes strongly competitive by the utilization of technology. Automated Tracking System supported by AI can easily filter suitable candidates by matching relevant keywords between their CVs and job description in a few seconds. This means that even an experienced candidate can have high probability of being eliminated if he doesn’t know how to write a proper profile. Both recruiters and applicants need to prepare carefully in this demanding market.

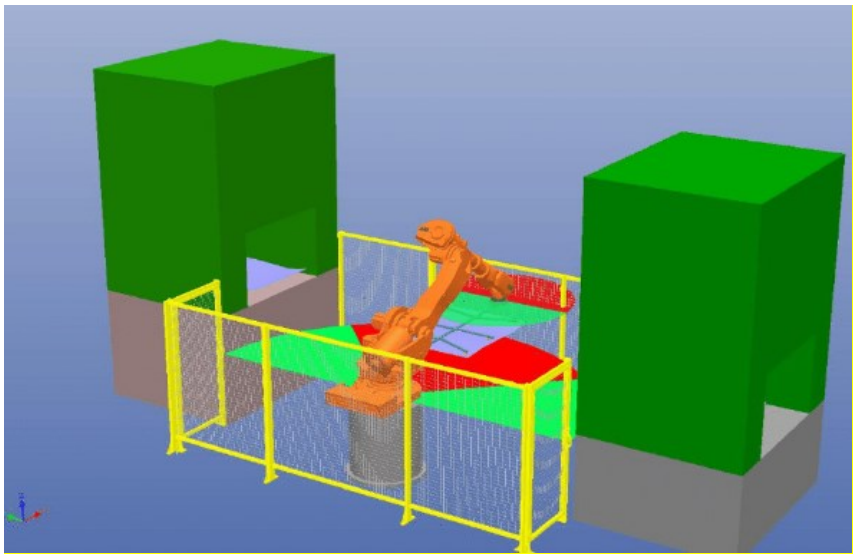
Figure 6: Top 10 job skills by 2025 (Whiting, 2020)

Hence, what would the current workforce need to prepare to deal with this transformation? Besides the strategy of attracting new hires, McKinsey suggested two sorts of workforce changes in the future work: **upskilling**, in which workers obtain new skills to aid in their existing tasks, and **reskilling**, in which staff take on different or new responsibilities (Ellingrud et al., 2020). Investing in one's own workforce through upskilling and reskilling is a shared obligation between employers, employees and even macro strategic planners. For example, Amazon has vowed to invest $700 million in technological training by 2025 to assist employees transition into higher-skilled positions (Ellingrud et al., 2020). Another instance is **Ingenjör 4.0**: a learning initiative developed by the Swedish Production Academy Produktion2030, Combient, and 13 Sweden's top universities. Since 2020, engineers from Volvo, SKF, and AFRY have taken courses in areas like Cyber Physical Systems and Digital Twins, Big Data Machine Learning, and Sensors in order to address the ensuing skill gap in I4.0. Briefly, the problems of reforming today's workforce in a rapidly changing and digitalized world are always predictable. However, the greater the difficulties, the greater the opportunity for continuous improvement for both individuals and organizations.

1.1.4.4 Impact to the safety issue:

This is not a major impact for the whole I4.0 but rather than a concerning issue related to the revolution of robots, which is also the topic of this thesis. As we can see from the evolution of robots, especially classical ones, these gigantic machines were kept apart from humans owing to their size and tasks. Therefore, industrial robots were kept in a fence or cage to protect humans from unanticipated mishaps caused by robots and to protect the robots themselves because they were not yet a complete smart system that could prevent obstacles in their working environment without an artificial vision system. Modern robots can halt when suspicious things reach their working area, but older robots couldn't.

Figure 7: The design of an ABB robot axis 6 working in a cage and safety system (Behnisch & Matthias, 2008)



However, with the emergence of collaborative robots during I4.0 or any smart robots, people have begun discussing the robot-human interaction that occurs when robots and humans work side by side in a factory. In light of this, concerns concerning the risk and safety regulations were also addressed. Galin & Meshcheryakov (2019)has identified 3 potential risks from human-robot interaction during collaboration as following:

- Risk of hazardous from robot: the trajectory covered by the robot and impediments in its path or the speed of movement of the human operator and the sluggish reaction of the robot
- Risk from industrial process: lack of ergonomic solutions for operating activities and maintenance

- Danger posed by a malfunctioning robot control system, such as obstructions to the operation of the robot's sensors or a malfunction at the control level and external effect on the control system (cyber-attack).

Therefore, the safety rules in monitoring robots in an interactive cooperation with human have been well developed (since 2016-2017) and being updated for robotic manufacture and robot – end users. We can look at the list of legal instruments and provisions provided by European Union to have a better context about these regulations. Especially, in terms of human-robot collaboration, there are 3 regulations that can be focused:

- ISO 10218-1 Robots and robotic devices – Safety requirements for industrial robots – Part 1: Robots;
- ISO 10218-2 Robots and robotic devices – Safety requirements for industrial robots – Part 2: Robot systems and integration.
- ISO/TS 15066 Robots and robotic devices – Collaborative robots;

For a system integrator, ISO 10218-2 Part 2 can be considered as the most important regulation as it set some typical definitions of which is called collaborative areas (Behnisch & Matthias, 2008), such as:

- Transfer window: The robot transfers its application into a defined region where operators are permitted to access but cannot enter.
- Handover area: The robot transfers its application to a region where the Operators may enter.
- Collaborative common area: There is no distinction between the human and robot workspaces

Or the definition of how an Operator (human) can interact with robots:

- Monitoring: the robot conducts its procedure at a decreased pace. The operator is able to monitor the operation and, if required, adjust the process settings. This is particularly applicable to welding and bonding procedures.
- Guiding the robot arms: the robot's arms are steered by the operator in automated mode at a lower pace to ensure safety. This may be accomplished by free leadership or controlled direction along a predetermined course.

Figure 8: Safe standstill of an industrial robot for possible interaction with an Operator Behnisch & Matthias, 2008)

These norms and technological requirements aim to summarize the most important considerations and use cases for protecting humans and robots while working together. Furthermore, as robot is being developed through the I4.0 with the engagement of robotics software and artificial intelligent, the European Commission intended to publish a revised machinery regulation in 2021 with intentions to address concerns over 'human-robot' cooperation and to increase the openness of AI algorithms used in robots (Stolton, 2021). With data being exchanged between smart robots and humans or between numerous robots, the EU has also stressed the significance of data protection, particularly in sensitive areas such as health care, recruiting, security, and government.... This also aligns with the third Cyber-attack-related danger we just discussed in the same paragraph. In conclusion, authorities must catch up to the growth of robots in both physical and electronical areas in order to preserve safe and secure working conditions for all parties involved.

1.2. System integration through robotics and automation solutions in I4.0

1.2.1 What is automation?

It's necessary to understand the concept of robotics and automation solutions before discussing its role in I4.0 because robotics and automation might be used interchangeably but their definitions are different. According to Groover (2020), "Automation can be defined as the technology by which a process or procedure is performed without human assistance. Humans

may be present as observers or even participants, but the process itself operates under its own self-direction". This is a very important foundation of automation when considering it revolution in I4.0 because people usually misunderstand this definition as a reference of using machines or robots to replace human's work in factories. However, as far as I4.0 revolution is being developed, automation is not only a programmed tool to perform certain tasks but a combination power, a program of instruction and a control system to automate processes (Groover, 2020).

There are different levels of automation to be discussed. In the same book along with the automation definition, the author categorized automation system used in manufacturing in 3 basic types: fixed automation, programmable automation, and flexible automation. Additionally, in another book, Grover (2019) also defined automation with 5 levels in manufacturing: device levels, machine levels, manufacturing cell or system level, plant or factory level and corporate level.

Figure 9: Level of Automation in the Process industries and Discrete manufacturing industries (Grover 2019)

TABLE 4.2 Levels of Automation in the Process Industries and Discrete Manufacturing Industries

Level	*Level of Automation in the Process Industries*	*Level of Automation in the Discrete Manufacturing Industries*
5	*Corporate level*—management information system, strategic planning, high-level management of enterprise	*Corporate level*—management information system, strategic planning, high-level management of enterprise
4	*Plant level*—scheduling, tracking materials, equipment monitoring	*Plant or factory level*—scheduling, tracking work-in-process, routing parts through machines, machine utilization
3	*Supervisory control level*—control and coordination of several interconnected unit operations that make up the total process	*Manufacturing cell or system level*—control and coordination of groups of machines and supporting equipment working in coordination, including material handling equipment
2	*Regulatory control level*—control of unit operations	*Machine level*—production machines and workstations for discrete part and product manufacture
1	*Device level*—sensors and actuators comprising the basic control loops for unit operations	*Device level*—sensors and actuators to accomplish control of machine actions

1.2.2 What is Robotics?

In the book of **"Principle of Robotics and Artificial Intelligent",** Robotics is defined as "the science of robots—machines that can be programmed to carry out a variety of tasks independently, without direct human intervention" (Press, 2018). The Czech writer Karel apek coined the term "robot" in his 1921 play R.U.R., which followed the protagonist as he creates a humanoid automated machine to perform his job. As processing power increased in the

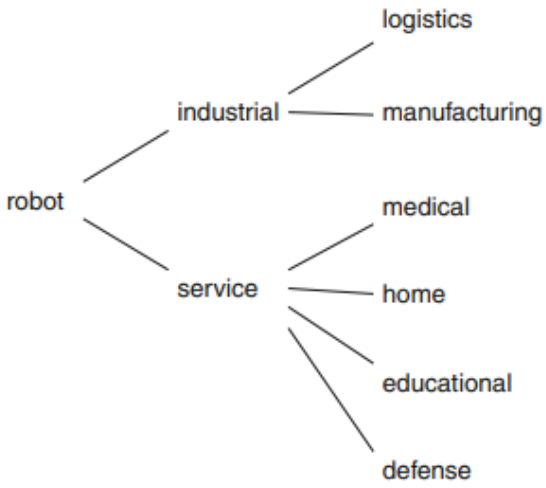
1940s, prominent science fiction author Isaac Asimov coined the term "robotics" to describe the science and engineering underlying robots.

The inspiration for robots came from the need to do labor normally performed by humans, and human bodies were used as a model for their design. The robot's executive system, sensor system, control device, and external environment are all shown in the functional diagram (Galin & Meshcheryakov, 2019).

1.2.2.1 Classification of robots:

The concept of robots is difficult to pin down. They are difficult to categorize for this same reason. There are a lot of different categories that robots might fall into. They are able to be categorized according to the manner in which they carry out responsibilities, the manner in which they apply themselves, the manner in which they walk, and so on. In the book of "Element of Robotics", robots can be categorized by fixed and mobile robots based on their environment and mechanism of interaction. Nevertheless, the most common classification applied today is based on their application field. Therefore, robots can be divided into: Industrial robots and service robots.

Figure 10: Classification of robots by environment and mechanism of interaction, M. Ben-Ari and F. Mondada (2018)



As I4.0 was surrounded by "smart manufacturing", industrial robot is the main focus to be mentioned in this context. Groover (2019) explained industrial robot as a programmed, multipurpose machine with human characteristics. The mechanical arm or manipulator is the most anthropomorphic or human-like aspect of the robot. Traditionally, there are 6 types of industrial robots tagged along with their mechanical design:

1. Articulated robots have manipulators (arms) with at least three rotary joints. It is used in the packing of food, the handling of material and equipment, the welding of arcs and spots, as well as the assembly of automobiles and the construction of steel bridges.
2. Cartesian robots, also referred to as gantry robots, have manipulators with three prismatic joints. These robots are often used for pick-and-place tasks, loading machine tools, and stacking components into bins because of their sturdy construction and high weight capacity. Cartesians may also be utilized for assembly, where the insertion of electronic components is a significant development area, and for measurement.
3. Robots using cylindrical manipulators may spin vertically on a horizontal axis. Small, cylindrical robots are often used because of their suitability for handling things with circular symmetry (e.g. wires, pipes). They can also do routine pick-and-place tasks in factories with ease.
4. Manipulators on parallel robots may move in both planes, thanks to the presence of prismatic and rotational joints. Manipulators on spherical robots can navigate spherical areas in the third dimension. Because they employ 6-axis to execute ajob, they are well-known for their pick-and-place and product transfer applications.
5. Parallel robots are mostly utilized in the food sector, as well as the pharmaceutical and electrical industries, for quick pick-and-place and product transfer.
6. Robots using SCARA (Selective Compliant Assembly Robot Arm) arms have two limbs that rotate along vertical axes. The wrist on one of their arms is really an additional joint. When both speed and precision are equally important, the SCARA robot is put to use in pick-and-place and assembly tasks. They are also used in the loading and unloading of machinery in heavy industries.

These described industrial robots are usually in a big form and separated from human working area in manufacturers due to their size and safety reason. However, when industry 4.0 is adopted and advanced robots are becoming more focus, there is new trends besides traditional robots in the fields. Autonomous robot mentioned in the previous chapter is one of the key technologies in I4.0. Nevertheless, as we are discussing industrial automation, not every robot is run autonomously. There is a mixture between human working method and traditional robots' operation that emphasize human-machine integration and therefore, collaborative robot (or "cobot') is one portfolio in the trend.

Incorporating Collaborative Robots (e.g., X-act Eu project http://www.x-act-project.eu/, Robopartner Eu project http://www.robo-partner.eu/), may provide several advantages to Industrial Operations, especially in mechanical and electrical assembly. When

defining a collaborative robot, it is mostly about a collaborative working environment, rather than merely the security measures and sensors of a collaborative robot. This description of the collaborative working environment illustrates the importance of building a suitable atmosphere for human-robot interaction. From the perspective of a collaborative robot, a human is regarded a form of mechanical colleague, and the robot's role is to aid and assist in reaching the objective (Francesco & Paolo, 2017). In addition to reducing human labor, the removal of the safety cage is the most noticeable advantage of using a collaborative robot. This not only reduces the overall cost of integrating robots but also frees up valuable floor space. While traditional robots may be difficult to set up and program, collaborative robots are far simpler in both respects. These robots are very flexible due to their simple installation; they may be moved and reprogrammed to carry out a variety of tasks with little effort. With cobots are being favored in the industry, lots of big companies are shifting to this new type of robot, in both producers and users. We can mention significant IRB 14000 YuMi model of ABB, APAS of Bosch, TX2-40 of STÄUBLI or AURA (a co-bot developed by COMAU S.p.a and cooperated with Italian universities) and so on.

1.2.2.2 Benefits of a robots:

The initial use of robots was driven by a desire to explore the technology and see what it could offer. The first adopters made decisions based on their belief in the promise of robots, not on financial considerations. Today, the increasing use of robots is driven by financial rewards, with companies basing investment decisions on benefits that can be quantified before and after investment. According to Wilson (2015), the benefits of robots can be divided into those that benefit the end user and those that benefit the automation solution provider (system integrator).

- Benefit to a system integrator:

The trend of using robots is increasing among integrators due to **their flexibility** and **the fact that they are standard products with known performance and reliability.** The published characteristics of robots allow the integrators to choose a machine that meets the needs of the application, reducing the risk and uncertainty of using a bespoke machine. The flexibility of robots, through their programmable software, makes it easy to modify their operation, even at a late stage, accommodating late design changes and mistakes in the automation system. These benefits reduce the financial contingency and increase the likelihood of orders from the end user. Additionally, the delivery of standard robots can be quicker, reducing the overall project timeline.

- Benefits to the end-user:

From the same book of “Implementation of Robot system”, Mike Wilson also mentions 10 benefits of a robot application in industrial automation:

1. Reduce Operating Costs: Automation can help reduce the operating costs associated with production, including direct costs such as labor and overhead costs.
2. Energy Savings: Robots can save energy by optimizing energy per unit of output and not requiring the same heating/cooling and lighting as manual labor.
3. Improved Work Conditions for Employees: Robots can take over dirty, dangerous, and demanding tasks, improving work conditions for employees.
4. Increased Production Output Rate: Robots provide a consistent and regular production output, allowing for increased production and flexibility.
5. Increased Product Manufacturing Flexibility: Robots are flexible and can handle variations in product or different products, allowing for small batch sizes.
6. Reduced Material Waste and Increased Yield: Robots ensure quality output, reducing material waste and increasing yield.
7. Improved Compliance with Safety Rules: Robots can take over hazardous tasks, improving compliance with safety rules and workplace health and safety.
8. Improved Product Quality and Consistency: Robots provide consistent and high-quality output, reducing inconsistencies caused by manual labor.
9. Improved Quality of Work for Employees: Robots can improve employee skills and motivation by allowing them to focus on more skilled tasks.
10. Imposes Consistency on Incoming Products: Robots can enforce consistency on incoming products, reducing waste and improving product quality.

1.2.3. System integration through robotics in automation solutions

As businesses of all sizes and in a variety of sectors search for methods to simplify and quicken production and manufacturing, demand for automation technologies rises. This opens a huge market for producers and suppliers of industrial automation and control systems, electric motors and drives, sensors, regulators, and robots. Consequently, several previously nonexistent categories of manufacturing have emerged to meet the growing need for automation. In the realm of automation, a system integration is one example.

1.2.3.1 "System selling" and "system integration":

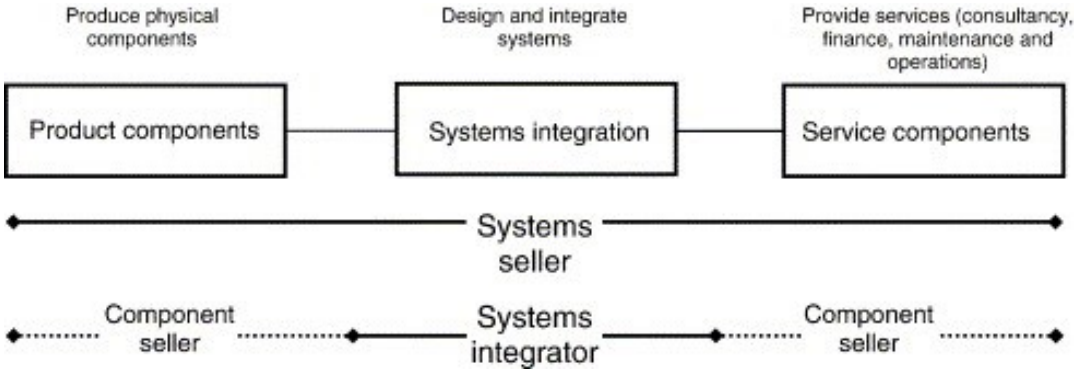
I4.0 has been pushing the change of the industrial sector, with an emphasis on the development of integrated solutions. According to the literature on industrial marketing, two sorts of firms provide integrated solutions: the "systems seller" and the "systems integrator." (Davies et al., 2007)

• A systems seller is a vertically integrated organization that produces the bulk of product and service components required for the delivery of integrated solutions, based on a single-vendor design that integrates internally developed technology, products, and proprietary interfaces.

• A systems integrator is a contractor that designs and integrates product and service components from several suppliers into a complete system. This kind of structure emphasizes the advantages of component supply specialization and modularity, interface standardization, and the ability to specify and integrate technology and product sources from many suppliers.

According to Davies et al., nd, systems integrators are responsible for the entire design of the system, the selection and coordination of a network of external component suppliers, the integration of those suppliers' products into a functioning system, and the development of the technical know-how required for future updates.

Figure 11: The distinguish between system seller and system integrator (Davies et al., nd)



1.2.3.2 What is a robotic system integrator?

Integrating means "to make into a whole by bringing all components together," as defined by Webster's. In the "Springer Handbook of Robotics" (Siciliano & Khatib, 2016), Martin Hägele et al. (2016) wrote: *"The automation scenario includes all the problems of integrating computers and their peripherals, plus additional issues that have to do with the variety of (electrically and mechanically incompatible) devices and their interaction with the physical environment (including their inaccuracies, tolerances, and unmodeled physical effects such as backlash and friction). The number of variations is enormous, so it is often not possible*

to create reusable solutions. In total, this results in a need for extensive engineering to put a robot to work. This engineering is what we call system integration."

Triantafyllou et al. (2021) claimed that system integration is often overlooked in the field of robotics research and seen as an additional burden rather than a crucial aspect of the system. Nevertheless, it is essential for a robotic system to function effectively in real-world scenarios and be integrated into a well-structured framework. If we read through the sources mentioned above, robotic system integration refers to the process of combining various components of a robotic system, such as hardware, software, sensors, and actuators, into a single functional system. This process requires coordination and collaboration between multiple disciplines, including mechanical engineering, electrical engineering, and computer science. The goal of robotic system integration is to ensure that all components work together seamlessly and effectively, allowing the robotic system to achieve its intended purpose. To put the definition in a practical context, we can also look through some websites of "robotic system integrators" such as Phoenix Robotics, JR Automation, Jabil, FANUC to identify what a robotic system integrator does in industrial automation scenario. In short, a robotic system integrator (RSI) is a company or individual that specializes in the design, implementation, and maintenance of custom robotic systems for various industries and applications. RSIs work with clients to understand their specific needs and develop a solution that meets those requirements. They often have a team of engineers and technicians who have expertise in areas such as mechanical design, electrical engineering, control systems, and software development. From the solutions and services described in those websites, RSIs are responsible for the "full lifecycle" of a robotic system, including design, development, testing, deployment, and ongoing maintenance and support.

Figure 12: Stages of system integration, typically carried out in the order listed ("Springer Handbook of Robotics", Siciliano & Khatib, 2016)

Physical	Selecting equipment based on dimensioning for mechanical size, load, and stress
	Mechanical interfacing (locations, adapter plates, etc.)
	Electrical power supply (voltages and currents for robots, effectors, feeders, etc.)
	Connections for analog signals (shielding, scaling, currents, binary levels, etc.)
	Safety design and risk assessment
Communication	Interconnections for single-bit digital I/O
	Byte-wise data communication, including latencies and bit rates
	Transfer of byte sequences
Configuration	Configuration of messages between interacting devices
	Establishment of services
	Tuning for performance and resource utilization
Application	Definition of application-level functions/ services
Task	Application programming, using the application-level services

The jobs that robotic systems integrators are able to do provide a number of opportunities for benefit to their users. A trustworthy integrator (Ralph, 2021) will have the capacity to:

- Research a (manufacturing) project's viability and provide advice on how to make it more cost-efficient.
- Determine which machines/machineries, and tools are most suited to a certain task.
- Automation may be achieved by teaching workers how to program robots and assembly lines.
- Help implement the robot infrastructure in the system.

Even though automation system integrator can be a new phenomenon only for several decades compared to the long history of industrial, the ecosystem and awareness of these integrators have been well spread across the countries and sectors:

More than two thousand automation integrators are included in Control Engineering's (2002) "Automation Integrator Guide," which is released annually. As an added bonus, every year three automation integration firms are honored as system integrators of the year.

Industrial Automation Exchange, or CSIA Exchange for short, is a directory of over 1200 member and non-member systems integrators maintained by the Control System

Integrators Association (CSIA). The Control System Integrators Association (CSIA) and the Robotics Industries Association (RIA) both provide certification programs for system integrators (CSIA, n.d.).

1.2.3.3 Difference between a "robotic system integrator" and "robotic manufacturers":

Even though it's all engaged to robots, a company performing as system integrator is different from a company manufacturing robot. The biggest difference would be their business model. While robot manufacturers put robots as a core product with extra services as added values (product – service offering); a system integrator follows a service one – a solution providing expertise knowledge and system design as an all-in service package, with robots (products) being just a part of it.

Furthermore, some comparison can be described as below:

Table 1: Difference between robot's manufacturer and system integrator

	System integrator	Robots' manufacturer
Service	Provides a full range of services, including design, engineering, implementation, and maintenance of robotic systems	Primarily focuses on the design and production of robots and related components.
Expertise	Expertise in integrating various components, softwares and systems to form a complete and functional solution	Expertise in the design and production of robots and their components.
Solutions	Provides a customized solution that is tailored to the specific needs and requirements of the customer	Provides standard solutions based on their existing product portfolio.
Cost	More expensive and customized	Cost is based on a standardize scheme

In short, while a robotic manufacturer provides robots and some limited support services, a system integrator offers a turnkey, (often) bespoke broader set of services that supports the implementation and integration of the robotic system into the customer's operations.

1.2.3.4 Components of a robotics system in an automation solution:

The components of robotics system integration typically include:

1. Robots: the hardware component that performs physical tasks
2. Sensors: networked devices that detect and measure physical quantities such as temperature, light, and sound
3. Actuators: devices that convert electrical signals into physical motion, such as motors and solenoids
4. Controllers: electronic devices that regulate the operation of the robot and its components
5. Power supplies: devices that provide electrical power to the robot and its components
6. Communication systems: hardware and software components that enable communication flows between the robot and other systems
7. End effectors: devices attached to the robot that enable it to interact with the environment, such as grippers and tooling
8. Software: configurable programs that control the robot's movements and actions.

1.2.3.5 Benefit and challenges in data integration for a robotic system integrator:

Robotics, Internet of Things (IoT), artificial intelligence (AI), and sensors are examples of Industry 4.0 technologies that enable efficient and exhaustive data collecting. According to the book "Data-Driven: Creating a Data Culture" by Hilary Mason and DJ Patil (2016), "Data integration is the process of combining data from multiple sources into a single, unified view, enabling more effective analysis and decision making". Robotics systems can gather data on production processes, machine performance, and maintenance requirements. Sensors, both within machines and as standalone devices, monitor various aspects of the production environment and supply real-time data on physical parameters. AI algorithms process and analyze the data collected, drawing insights and making predictions that can inform process optimization. IoT-enabled devices and systems facilitate the seamless exchange and integration of data from different sources, allowing for the creation of a comprehensive data landscape. In conclusion, the integration of data in robotic systems is a key factor in driving the adoption of Industry 4.0 technologies. The benefits of data integration, including system optimization, predictive maintenance, and process improvement, make it a crucial component in the development of automation solutions.

However, the benefit described above is only put in an ideal context when the data mentioned is truly utilized. In fact, at the same time, one of the major challenges faced by I4.0

adopters is to efficiently gather and use the large quantity of data created by the digital transformation process. This difficulty relates to a company's capacity to convert data into knowledge (Pauleen, 2017; Tian, 2017), since it is not an automatic process for an organization to build its learning dynamics via big data. Collecting a big data set does not mean that the company can translate them into meaningful insights which can impact their decision making (Bettiol et al., 2020). In point of fact, in order for managers to fully adopt I4.0, they need to train both themselves and their employees to interpret these data by thinking on a multidisciplinary level and by integrating information that is both operational and strategic in order to give their company a competitive advantage (Tolettini & Lehmann, 2020).

A robotic system integrator has a dual role in I4.0, both as an adopter and as a supporter driving customers towards adoption. However, in doing so, the integrator also faces the challenges of data interpretation and analysis; not only for the process improvement of their own firms but, mostly, for providing strategic suggestions for their customers. However, in Italy, the governmental incentives that help the adoption of I4.0 are only given when specific parameters are encountered that require the integration of the robotics-supported automation solution with the information system of the customer. As a result, the use and elaboration of these data, which are the most important part of a digital transformation process, is not yet widely adopted.

In technical perspective, the challenges can be described by 2 points:

- Enabling enterprise-wide data accessibility

A systems integrator's biggest difficulty may be building a specific solution to connect organization's systems, but if handled well, it may boost productivity and company operations. Establishing a consistent data methodology and language across departments to improve communication and data use is the issue. If a uniform integration method can be created, the whole company benefits from a consistent data understanding.

- Bridging the divide towards systems:

Today's systems integrator must discover the perfect technology to connect a company's on-site and cloud-based applications. Organizations may require hybrid integration solutions even if cloud-based apps are the future. These reasons may include legacy systems that the firm relies on, regulatory compliance, and cybersecurity. Hybrid integrations between legacy systems and cloud-based applications challenge systems integrators.

CHAPTER 2: OVERVIEW OF GLOBAL ROBOTICS AND AUTOMATION SOLUTIONS INDUSTRY

2.1. Industry outlook

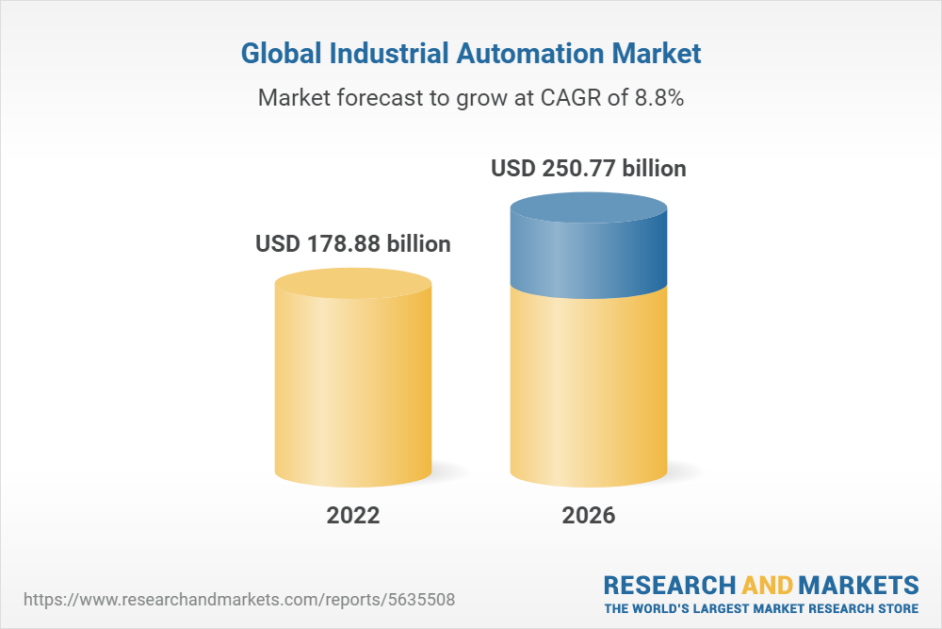
2.1.1 Industrial automation market outlook in worldwide, Europe and Italy:

- Worldwide outlook:

Based on Research and Market company, at a cumulative annual growth rate (CAGR) of 8.6%, the market for industrial automation is projected to increase from $164.74 billion in 2021 to $178.88 billion in 2022 (Research and Markets ltd, n.d.). The market for industrial automation is anticipated to reach $250.77 billion by 2026, expanding at an 8.8% CAGR. With a similar number carried by Grand View Research, a US based researching firm, the worldwide market for industrial automation and control systems was estimated at USD 158.63 billion in 2021 and is predicted to rise at a compound annual growth rate (CAGR) of 10.3% between 2022 and 2030 (Grand View Research, 2020).

Industrial robots, human-machine interfaces (HMI), industrial sensors, control valves, and other components are the primary components of industrial automation (Research and Markets ltd, n.d.).

Figure 13: Market forecast of Global Industrial Automation in 2022 and 2026 (Research and Markets ltd, n.d.).



The expansion of the industrial control sector is anticipated to be fueled by the rising importance of robots. Robotics is being increasingly used to manage the wide range of

processes and equipment found in modern manufacturing. Among these predictions is a 12 percent growth in worldwide robotics unit exports from 2020 to 2022, as reported by the International Federation of Robotics, a non-profit professional group in the field (Research and Markets ltd, n.d.)..

- European Outlook:

India-based research firm Modor Intelligence (n.d.) forecasts that the factory automation and industrial controls industry in Europe would grow at an annual rate of 8.9%. (2021 - 2026). As the sector's usage of automation develops, a growing number of major firms in the region are producing industrial automation-oriented products. Schneider Electric, a pioneer in digital energy management and automation, has unveiled the ClimaSys smart ventilation system, an innovative way to filtering and directing airflow for numerous control panels or electrical distribution cabinets in brand-new or refurbished buildings.

- Italy outlook:

A similar report (Modor Intelligence, n.d.) predicts that the Italy Factory Automation and Industrial Controls Market would expand at a CAGR of 6.7% (2021-2026).

Italy is also a special country with unique geographical existence of automated firms and strategic adoption during I4.0: Italy has clustered SMEs in which most of automated private companies are more centralized in the North. Aerospace, naval, mechanical, and automotive sectors dominate the Northwest (Milan-Turin-Genoa) area. The Central and Northeast regions of Italy, formerly rural, now feature numerous small firms with excellent workmanship and low technology, specializing in textiles, apparel, footwear, furniture, leather items, jewelry, and more. Specifically, new efforts in Italy are primarily geared on supporting the use of I4.0. For example, in 2020, new tax incentives for Industry 4.0 will replace the earlier super- and hyper-amortization.

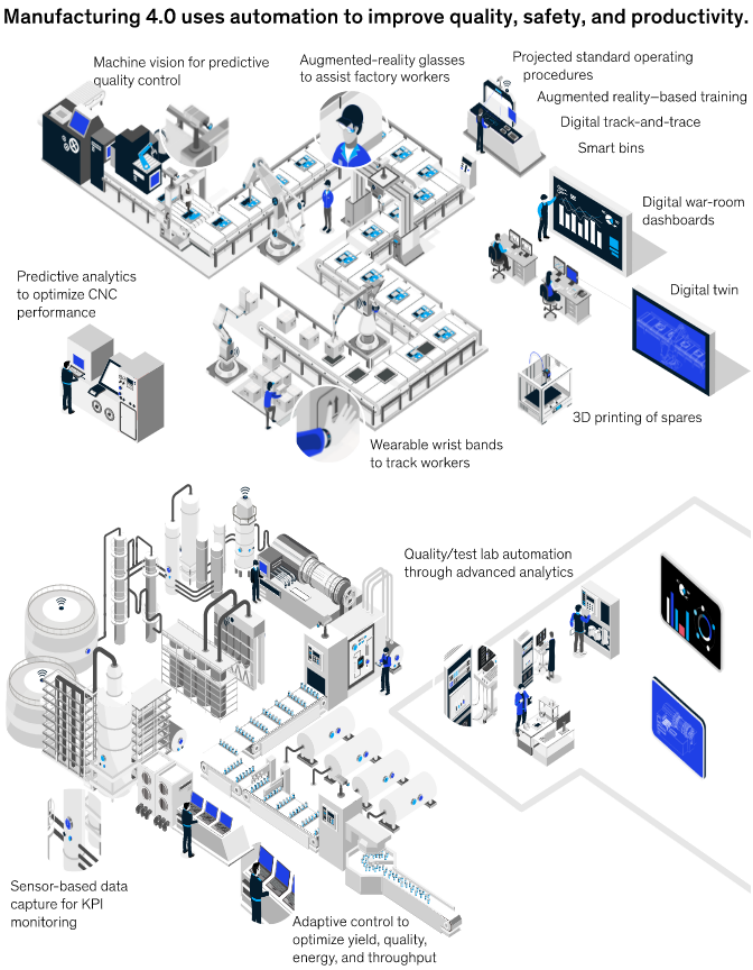
- Key market trend:

✓ COVID19 has pushed the automation processes to a new level:

COVID-19 was a hard hit to the whole macroeconomic in general. Employees were laid off, companies were shut down and the total spending of consumers sharply decreased due to the fear of unstable situation during the pandemic. Smart factory efforts have helped manufacturers overcome COVID-19 difficulties including labor reduction, revenue drop, and cost optimization as most end-user industries (mainly manufacturing and automotive) have shut down their production facilities owing to lockdown constraints. However, budget costing is never considered a long-term and healthy solution to resolve the crisis, adopting technology

should be the winning card to leverage the limited resources. According to Mckinsey, the role that Industry 4.0 plays takes on an even more vital significance in the context of an emergency such as COVID-19. Players that make use of digital solutions are in a stronger position to weather the storm than their competitors because they have advanced more quickly and farther than their competitors have throughout the crisis (McKinsey and Company, 2020). There are several ways in which digital technology may assist lessen these impacts, including improved worker security, streamlined operations, increased value from fixed assets, and higher quality final products. Machine-vision algorithms, for instance, may use predictive algorithms to perform autonomous quality inspection and control, therefore reducing the need for a large labor force and improving both the accuracy and the stringency of quality checks. (Picture below).

Figure 14: An example showing manufacturing 4.0 using automation to improve quality, safety and productivity (McKinsey and Company, 2020)



- ✓ Partnerships, Merge & Acquisition are boosting the digitalization landscape:

Not only do market players from all over the globe automate their businesses in their own unique ways, but they are also looking for methods to collaborate in order to boost the digitalization process as a whole.

For instance, Epson Robots announced in March 2020 a relationship with Air Automation Engineering (AEE) to offer technical assistance in the Midwestern United States (Grand View Research, n.d.). Another example is Mitsubishi Electric Corp. The Japanese electronics manufacturer, said in March 2022 that it will offer new industrial robotic systems incorporating Maisart AI technology, including high-precision voice recognition, to allow humans to fine-tune robot actions (Research and Markets ltd, n.d.).

Besides partnership, Merge and Acquisition are actively playing as a strategic direction for product development and market expansion. Why does M&A play an essential role for companies for only before but also after COVID-19? With the downward of Marco economic situation caused by Covid, M&A assists organizations in rethinking (investing or disinvesting in their current portfolios with stronger impacts) the strategy and reshaping their own value generation during the process of market positioning. Additionally, McKinsey expects to see seven M&A themes—areas where a firm requires M&A to fulfill its goal. Among the seven themes, we can focus on the top 3 highlights:

- Expand into services: Assistance with repairs and other needs will be supplied (such as mobility as a service and fleet management). They're going into MRO (maintenance, repair, operations), ARO (aftermarket), and P&C (parts).
- Enhance digital capabilities and digitize: Businesses will employ data analytics to boost consumer satisfaction and the quality of services they provide. Next-generation software, telematics, and digital capabilities will be used to improve products and operations.
- Acquire technology and innovate: Companies will make early investments in potential areas like artificial intelligence (AI), machine learning (ML), the industrial internet of things (IIoT), and mobility.

✓ Europe is dominating the market with the strong uses of robots and automation components:

Forecasts indicate that Europe will account for a disproportionate part of the global market for industrial automation. As of January 2021, the greatest robot density in the globe may be found in Western Europe (225 units per 10,000 workers) and the Nordic European Countries (204 units per 10,000 employees), citing the International Federation of Robotics

(IFR). Germany is the fourth most automated nation in the world, with 346 units per 10,000 employees (Fortune Business Insights, 2022).

While mentioning Germany, this country not only uses automation equipment extensively, but also ranks high among Europe's producers of automation machinery. Germany is home to a number of industry leaders in automation and control technology, including Siemens, Schneider Electric, KUKA, etc., all of which contribute significantly to the country's high level of R&D spending to Modor Intelligence (n.d.).

- Key players of industrial automation market:

According to researching firm Fortune Business Insights (2022), there are several big names in the market which were also mentioned in some examples above. As we can see that the top names mostly come from US and Europe while Japan would be considered as a key representative from Asia.

ABB Ltd. (Switzerland)

Emerson Electric Co. (U.S.)

General Electric Company (U.S.)

Honeywell International Inc. (U.S.)

Mitsubishi Electric Corporation (Japan)

Omron Corporation (Japan)

Rockwell Automation Inc. (U.S.)

Schneider Electric SE (France)

Siemens AG (Germany)

Yokogawa Electric Corporation (Japan)

2.1.2 Robotics market outlook in Worldwide, Europe and Italy

- Worldwide Outlook:

According to Allied Market Research (2020), the worldwide robotics technology industry is expected to rise from its 2019 valuation of $62.75 billion to a total of $189.36 billion, at a CAGR of 13.5% between 2020 and 2027. In terms of component, Hardware robots play the biggest contribution in 2019 revenue (which is accounted for 75% of the total revenue). However, service robots are expected to rise the most with 19.7% CAGR from 2020 to 2027. In terms of type of Robots, traditional industrial robots keep their dominant position by contributing 78% revenue in 2019. However, we will witness the rise of cobots in the following years, especially in automotive, healthcare and agriculture sector (with 30.1% CAGR) due to

their size, autonomous movement capability and the ability of being controlled remotely. The rise of cobot is also a proven impacts of I4.0 where manufacturers are emphasizing flexibility in terms of automation management. Unsurprisingly, robots used in manufacturing is leading all of the sectors with 78% revenue contribution in 2019. Healthcare sector, in the other hand, will become the fastest growing industry in terms of the use of robots with 19.9% CAGR from 2020 to 2027. Aerospace & defense is the second most promising sector with 19.2% CAGR in which cobots also contribute a large number to be used.

Figure 15: Market forecast of global robotic technology (Allied Market Research, 2020).

SEGMENT	SUBSEGMENT	REVENUE-2019 ($Million)	FORECAST-2027 ($Million)	CAGR (2020-2027)
By Component	Hardware	46,750.03	1,29,415.24	14.90%
	Software	6,637.23	23,941.98	18.80%
	Service	9,364.23	36,005.52	19.70%
By Type	Traditional Industrial Robots	48,820.39	1,11,146.00	12.10%
	Cobots	824.52	6,619.82	30.10%
	Professional Service Robots	9,236.65	53,470.04	25.50%
	Others	3,869.92	18,126.88	22.50%
By Application	Manufacturing	49,045.36	1,41,668.29	15.50%
	healthcare	3,081.85	12,048.11	19.90%
	Aerospace & Defence	1,343.58	4,991.90	19.20%
	Media & Entertainment	1,446.18	5,193.47	18.70%
	Logistics	3,791.21	11,976.31	16.80%
	Others	4,043.30	13,484.66	17.60%

Source: AMR Analysis

According to IFR (2022), Asia continues to be the greatest market for industrial robots worldwide. In 2021, 74% of all newly deployed robots were placed in Asia, up from 70% in 2020. In the top 15 nations with the biggest number of industrial robots deployed, Asia has more representatives than any other continent. The top 3 countries can be mentioned as China, Japan and South Korea.

- European Outlook:

In terms of regional performance, Asia Pacific is the leading region in both 2019 revenue contribution and CAGR % from 2020 – 2027. The main reason of this is the strong demand of “low cost” and “high quality” robots which is a unique advantage of Asian suppliers due to the low-cost labor in the region. European continues to play the second position in terms of revenue contribution. However, in consideration of CAGR, Europe can not compete with other regions

until 2027 as cost optimization is not a winning strategy for this reason. Nevertheless, we appreciate the stable development of Europe in the investment and R&D effort in heavy sector like automotive.

Table 2: Robotics Technology Market by Revenue, 2019 – 2027 ($ Million) adapted with data from AMR Analysis (Allied Market Research, 2020).

Region	**North America**	**Europe**	**Asia Pacific**	**LAMEA**	**Total**
2019	6544.98	11301.5	42081.2	2823.82	62751.49
2020	6902.69	11607.2	44816.5	2957.94	66284.39
2021	7927.78	12971.5	51973.7	3373.93	76246.94
2022	9130.4	14524	60437.6	3858.84	87950.84
2023	10550.1	16300.95	70506.82	4427.67	101785.51
2024	12233.64	18342.23	82539.75	5097.97	118213.69
2025	14242.02	20699.7	97002.9	5892.54	137837.16
2026	16639.81	23418.32	114403.97	6834.96	161297.05
2027	19504.36	26548.66	135356.49	7953.24	189362.74
CAGR 2020 - 2027	**16%**	**12.5 %**	**17.1 %**	**15.2 %**	**16.2 %**

Specifically, from the same report of Allied Market Research, there are some worth noticing findings for European regions:

a) The increase in the number of startups in Europe complements the expansion of industrial robots in Europe. The market's abundance of SMEs provides several undiscovered opportunities. The requirement for robotics in this industry, however, differs, since they want low-cost, high-quality, light robots ideal for smaller manufacturing units. Key players should target these businesses and offer tailored solutions to them.

b) Robotics R&D creates new products for consumers. To decrease human touch and increase operational efficiency, European industrial corporations are investing substantially in Al-based robots technology. The increasing epidemic and rigorous lockdown in most European nations have severely disrupted supply and demand in the supply chain sector, forcing enterprises to heavily employ robotics technology.

Additionally, from the report of IFR 2021, we can see the peak of robots' installation in European countries. In 2021, robot installations in Europe increased by 24% to 84,302 units. This signifies a new hit of all time. The demand from the automobile sector remained stable, but demand from all other industries increased by 51%. Germany, one of the five largest robot markets in the world, accounted for 28% of all robot installations in Europe. Following Italy with 17% was France with 7% (IFR, 2022).

- Italy Outlook:

The value of the robots technology market in Italy was estimated to be $ 1,456.77 million in 2019, and it is anticipated that it will reach $ 3,520.35 million by 2027, exhibiting a CAGR of 12.9% along the way. Manufacturing was the most important contribution to total revenue in 2019, bringing in $1,112.80 million. It is anticipated that manufacturing will bring in $2,500.31 million by 2027, representing a compound annual growth rate (CAGR) of 12.4%.

When it comes to the European market for robots, Italy ranks second (after Germany). The general industry was the key growth engine, expanding at a yearly pace of 8% between 2016 and 2021 (IFR, 2022). Additionally, the overall number of Italian enterprises in the robot and automation sector was 691 in 2020, a 25% increase from 20 years earlier (Businesscoot, n.d.). From the research of Marin Alice, student of Padova University, about "the geography of I.40 in Italy", we can also find out that Robotics and Artificial Intelligent mostly existed in Turin region, north of the country.

In Italy, industrial robots are mostly used in manufacturing firms, particularly in the cosmetic and textile industries. However, the COVID-19 epidemic has provided a major push to automation and robotization in Italian enterprises, especially in health care sector. In hospitals located in northern Italy, which is the epicenter of the coronavirus epidemic in Italy, robots are assisting with the monitoring of infected patients' vital signs. This helps to ease the strain on healthcare professionals (The Local IT, 2020). Specially, using robots not only prevent the affections for healthcare workers but also assist the hospital in reducing the number of times its employees are required to wear protective masks and gowns (Scalzo, 2020).

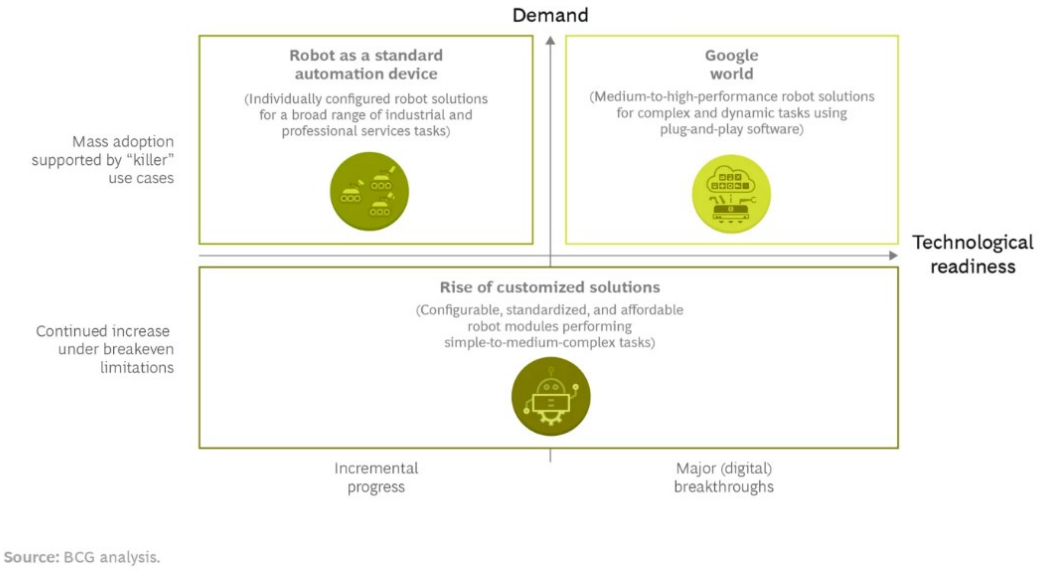
- Key market trends:

Boston Consulting Group (2021) identified 7 trends that may shape the Robotics industry until 2030. Among the 7 trends, there are 4 considerable findings:

- ❖ Professional services robots will dominate: The global robotics industry was expected to grow between $160 billion and $260 billion by 2030, with professional services robot sales reaching $170 billion and industrial and logistics robot sales reaching $80 billion.
- ❖ Advanced robotics solutions will increase as customer tastes and society trends change: Consumer desire for faster delivery of personalized items will increase robot capacity in manufacturing individualization and logistics.
- ❖ Artificial intelligence and other technical advancements will improve interactions between humans and robots.
- ❖ The capacity to learn is one of the many features that robots will have.

In the same article, BCG also explained 3 ways robotics can develop by 2030 and one of them (which is called "The Rise of Customized Solutions") is highly related to our case study – ESSEBI automation. Based on the research, there will be a very promising market for entrepreneurs and SMEs with extensive experience in niche robot applications that can be adapted to individual needs. In this case, big companies may not be a dominant player, but system integrators are already on the field since they may develop equipment to up- and cross-sell their current customers if they provide specialty technologies.

Figure 16: Three ways the robotics industry may evolve by 2030 (Boston Consulting Group, 2021)



Source: BCG analysis.

- Key players in the industry:

According to Modor Intelligence (n.d.), we can confirm the dominant position of Robotics company in Europe and Asia (in this case, Japan):

- ABB Ltd (Switzerland)
- Yaskawa Electric Corporation (Japan)
- Denso Corporation (Japan)
- Fanuc Corporation (USA)
- Kuka AG (German origin, Chinese owned)

2.2 How Italian SMEs have been adopting I4.0

2.2.1 Italian SMEs has a strong background to foster I4.0:

With a very promising and competitive landscape of Italy as analyzed in industrial automation and robotics outlook in the last paragraph, the I4.0 revolution is undoubtfully significant in terms of future perspectives for Italy. With a thriving entrepreneurial environment that is mostly composed of innovative SMEs, Italy can take pride in its position as the seventh largest industrial economy in the world (Mizzi, 2021). Therefore, when it comes to the digital transformation, Italy appears to be ahead of the curve. According to Eurostat (2022), Italy, together with Germany, the United Kingdom, and Poland, has roughly 5,400 high-tech manufacturing enterprises, making it one of the top four nations in Europe, which has approximately 46,000 high-tech companies in total. As stated in the robotics outlook above, Italy is also a leading player in European market (after Germany). Furthermore, in terms of the adoption of 4.0 technologies such as the cloud, the Internet of Things (IoT), and machine-to-machine (M2M) communication, Italy is also above the European average (Fratta & Sabatini, 2019). For example, regarding machine-to-machine (M2M) communication, Italy ranks sixth globally. Using this technology, information may be seamlessly sent across interconnected devices, including computers, machinery, sensors, and even industrial robots, in real time (OECD, 2017). According to Eurostat (2022), Italy ranked 4th in Europe (behind Nordic countries such as Sweden, Finland, Norway, Denmark) in total enterprises' use of cloud computing services in 2020 and 2021. This is a surprise when the country can surpass Germany or the average number of EU to become a strong adopter in this field. This also means that the IT infrastructure of Italy is truly competitive for further technology of I4.0 such as big data,

machine learning or artificial intelligence. In sum up, we can see that the base of Italy itself (both in hardware and software part) is really beneficial for the adoption and transformation of I4.0.

2.2.2 The investment:

Not only can a country's natural characteristics contribute to its competitiveness, but the Italian government has also made substantial investments in areas such as government policy, strategical orientation, technology & innovation, and human resources. The "Industria 4.0 National Plan" was launched by the Italian government in 2017 with the intention of facilitating industrial transformation through a number of concomitant initiatives (Europa.eu, 2017). Taking into account the ideas established by the fourth industrial revolution, the initiatives strive to encourage investments in innovation, technology, and skill development. Since small and medium-sized firms (SMEs) constitute the backbone of the nation's economy, the target audience consists mostly of SMEs, as well as entrepreneurs in general, including micro and big enterprises. As indicated in the figure below, the Italian government allocated around €18 billion for the Industria 4.0 National Plan for the period 2017-2020, with projected outcomes addressing innovative investment, R&D funding, and human capital development to prepare for the required knowledge.

Besides this old plan design for the period of 2017 – 2020, the Italian government has been more aggressive in providing patient financing for innovation and technology development. Especially after COVID-19, Italy is the country that suffered from the most serious impacts leading to the backwardness in development of most Italian firms. Therefore, the Ministry of Economic Development introduced the first national technology transfer fund in 2021, joining the Italian Institute of Technology (IIT) and the National Innovation Fund (formed in 2019 with a €1 billion budget). ENEA Tech, a new foundation, manages a €500 million fund to invest in worldwide strategic national interest technology (Mizzi, 2021). The foundation invests in cutting-edge innovations that have the potential to improve the Italian economy and society in the following four sectors: deep technology; green, energy, and the circular economy; healthcare; and information and communication technologies. Typical venture capital instruments such as equity, and quasi-equity, blended finance but also grants and purchase contracts, procurement with convertible options are used by ENEA Tech to invest in pre-commercial and pre-competitive stages, micro-enterprises, startups, and innovative SMEs. This is one of the newest government programs designed to promote the I4.0 upgrade.

It is fair to say that the country's government has made genuine efforts toward this integration, particularly regarding SMEs.

2.2.3 The transformation:

Regarding how Italian SMEs have transformed during the I4.0 and what factors have shaped their adoption and the benefits for the companies; we may depend on the study conducted by the Digital Manufacturing Laboratory at the University of Padua (conducted in 2017) for a deeper look at the context (Padova Digital Manufacturing Lab, 2018). The poll is based on a sample of 7,293 manufacturing enterprises belonging to Made in Italy sectors, hailing from Northern Italian regions and generating more than 1 million euros in annual revenue.

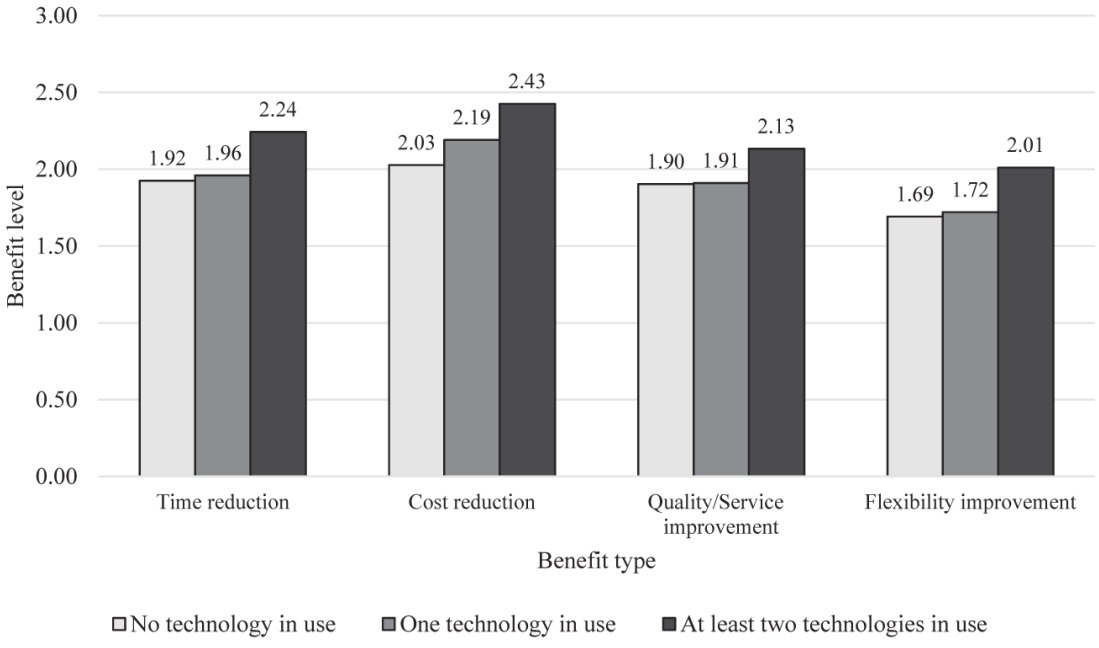
According to the survey, only limited number of firms (19% of 1000 samples) have adopted I4.0 in which more than 40% of the adopters are small firms. However, the adopters are really innovative firms who already invested in ICT infrastructure. The investment of I4.0 was mostly customized with 72.5% of firms said yes for the customization. Among of this, software is the biggest domain, following by integration and hardware. The technologies of laser cutting, robotics, big data, additive manufacturing, internet of things, scanner 3D, and augmented reality were taken into consideration, and approximately twenty percent of the sample utilized at least one of these technologies. The primary reasons why businesses have been investing in I4.0 are to improve their level of customer service and to enhance their efforts to become more efficient internally. Because of this, they also take into consideration the competitive advantages that derive from the implementation of these strategies, such as flexible production (22.6%), customer services (12.5%), and product quality (41.1%). As a consequence of this, businesses highlight three primary results produced as a direct consequence: efficiency (60%), an increase in productivity (54%), and an increase in the quality of customer service (53%), with various technologies each playing a unique role in achieving these objectives.

The adoption of technology related to Industry 4.0 is primarily focused on the production of individualized goods. Only 33.4% of adopters make ordinary products, whereas 66.6% of adopters manufacture unique or customized products. The items themselves went through a process of incremental improvement over time. The top three factors are as follows: an increased participation for the customer in the product development process (30.2%); an increased product performance with newly additional services (27.1%); and an increased level of control over the product while it is being used (25.8%).

In conclusion, the adoption of I4.0 by Italian companies had a positive impact on performance (EBIDTA/sales and sales growth), particularly with one or two technologies, when the selection of technologies was aligned with business strategy (quality over quantity, selection based on business objectives).

In parallel with the time development after 2017, we also found another research of Zheng et al. 2021 which the authors also tried to study based on a descriptive survey launched in 2017 whose results were previously discussed in Zheng et al. (2019). Macro Ardolino and the co-authors did a survey of 102 companies in 2020 (where 54% are SMEs, 29.4% are large companies and 16.7% are huge ones) with the same methodology of Zheng et al. (2019) focusing on (1) technologies adopted; (2) business functions involved; and (3) benefits achieved, and obstacles faced. Surprisingly, the conclusions are quite similar to what we found in Digital Manufacturing Laboratory of UNIPD. Specifically, the research found out that the main reason companies moved to I4.0 is because of the cost reduction and time reduction. This is also the implication of internal efficiency as mentioned in the research of UNIPD. Although cost reduction, time reduction or flexibility improvement seems not directly relevant to the findings of Digital Manufacturing Laboratory, they are the primary contributions of I4.0 enabling technologies, which facilitate the delivery of a high-quality product or service at a lower cost and can be viewed as one of the prospective factors for Italian manufacturing businesses to pursue (Zheng et al., 2021).

Figure 17: Benefits perceived by companies by adopting I4.0 enabling technologies (Zheng et al., 2021)



2.2.4 The barrier during the adoption of I4.0:

Even while implementing I4.0 may bring a variety of benefits to businesses; transformation success is not guaranteed for all. Change necessitates colossal expenditures of time and money, in addition to the dedication of all concerned parties during implementation. In earlier sections, we have acknowledged Italy's (as a country) and Italian enterprises' (as a group) enormous investments as well as the benefits they have gained. In this section, we will discuss the obstacles encountered during this incredibly difficult change based on various research.

According to the survey of Digital Manufacturing Laboratory of UNIPD, the top 3 difficulties that firms found while adopting I4.0 are: (1) Difficulties in finding appropriate professionals; (2) Lack of broadband and (3) Limited financial resources. Coincidently, the first 2 reasons were also mentioned in a survey by Deloitte Italy. In 2018, just seven percent of Italian businesses had a 100 Mbps Internet connection, which is less than half of the European average of sixteen percent (Fratta & Sabatini, 2019). Italy was unquestionably far behind its formidable European counterparts, such as Denmark, Sweden, Portugal, the Netherlands, etc.

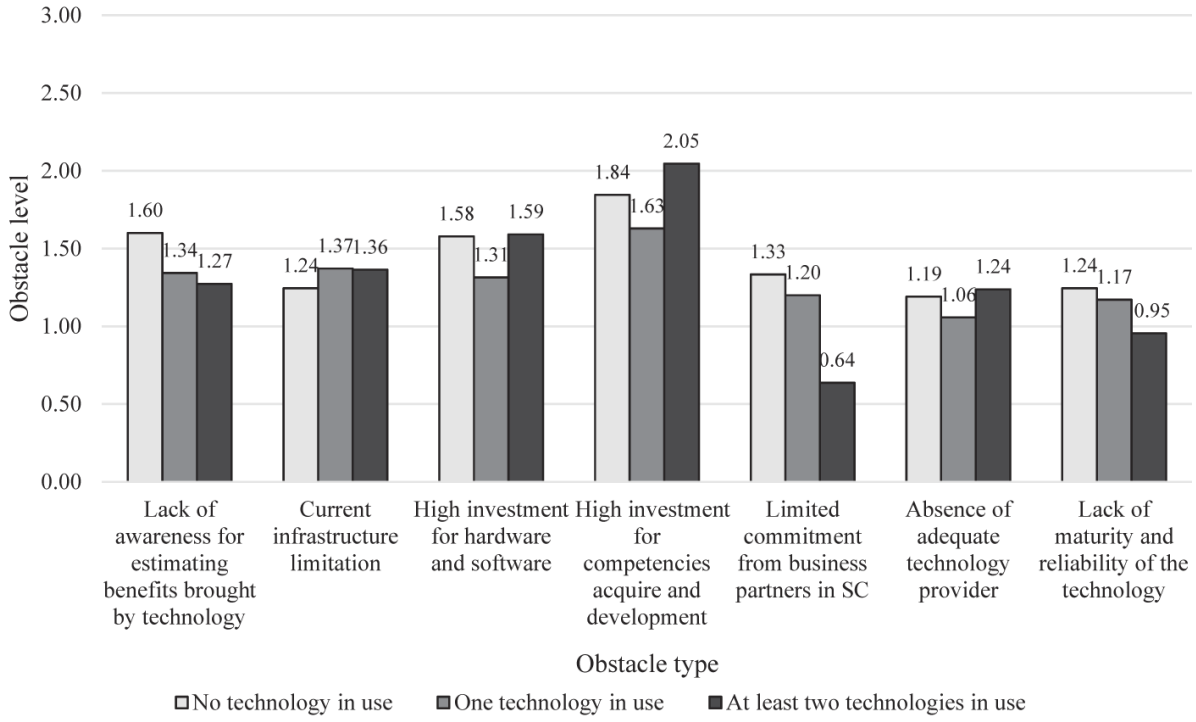
As we know that system integrator in robotics heavily depends on Internet connection (Wifi) as their components and vision systems and software need to be 24/7 connected to run the automation solution. The system integrator also needs the continuous data extracted from various devices to analyze and provide real-time performance analysis to the customers. Thus, there should be an investment to resolve the connectivity issue. According to the interview about “Building the Future with Software-Based 5G Networking, 2021”, Intel and MIT and have considered 5G and software-defined networking as “fanciful ideas of automatic, real-time, closed-loop control of an entire network”. According to Nick McKeown, senior vice president the network and edge group at Intel Corporation, private 5G has a key role to play in the future of networked devices, particularly in the context of industrial and manufacturing applications. Private 5G networks are expected to offer high data rates, low latency, and enhanced privacy compared to traditional networks, making them ideal for real-time control of robots and other machines. With its high reliability and low latency, private 5G is seen as a replacement for traditional wired connections in industrial settings, enabling devices to communicate wirelessly without sacrificing performance. In addition, private 5G is expected to process and analyze data closer to the edge, where it is generated, rather than relying on centralized data centers, leading to new possibilities for machine learning and automation applications. The example of robots in industrial settings is a prime example of how private 5G can empower networked devices. Traditionally, robots in manufacturing facilities have been

connected to the control system via a cable, an ethernet cable, to ensure sufficient connectivity and data rate. However, this can present problems in terms of mobility and safety, as the robot may need to move around the factory floor and a trailing cable could cause hazards. A wireless link using Wi-Fi technology may not provide the required quality and reliability. This is where private 5G comes in. By providing a high-quality wireless link that is comparable to a wired connection in terms of connectivity and data rate, private 5G opens up new possibilities for robotic applications in industrial settings. For example, if a robot arm needs to move in real-time, a high-quality wireless link with low latency is required to change its direction in a matter of milliseconds. This type of control is only possible with the level of reliability and low latency offered by private 5G networks. Thus, the integration of private 5G technology in the control and monitoring of robots in industrial settings represents a significant step forward in the automation and optimization of manufacturing processes.

Furthermore, Deloitte also claimed that a further key problem is the inadequacies of the Italian educational system in terms of sophisticated technology-related skills and training. The robotics sector in Italy has complained that there are insufficient specialists and technical expertise. The Ministry of Economy and Finance (2018) reports that 29 percent of Italy's workforce is digitally proficient, compared to 37 percent for Europe. Italy's 8.3% 4.0 training course participation is similarly below the European average of 10.8%. Italy is likewise far behind France (18.8%) and the UK (14.4%). Unsurprisingly, the disparity is considerably bigger compared to digital giants like Sweden, Denmark, and Finland, where more than a quarter of the workforce is schooled in digital technology.

The third rationale of Digital Manufacturing Laboratory is not directly comparable to the findings of Ardolino et al. However, as shown in the graph below, the top two obstacles cited by organizations that have already adopted I4.0 technologies are high expenditures for the acquisition and development of competencies and high expenditures for hardware and software. In this sense, "investment" does not refer to monetary factors, but rather infrastructure, human capital, etc. Nonetheless, we can also consider investment to be an umbrella phrase encompassing a company's financial resources.

Figure 18: Obstacles faced by companies when adopting I4.0 enabling technologies (Macro Ardolino, et al 2021)



CHAPTER 3: ESSEBI AUTOMATION CASE & THE ADOPTION OF I4.0

In this chapter, we will introduce the profile ESSEBI Automation, their solutions and how they can leverage the adoption of I4.0 to provide better solutions and service for the customers. Along with the introduction, we will also introduce their business model canvas to define whether the values ESSEBI positioned themselves can fit with the solutions they are offering to customers. An in-depth analysis and recommendation will be further discussed in Chapter 4.

The input for the next two chapters were mainly from ESSEBI website, the questionnaire conducted with the CEO of ESSEBI - Stefano Bisognin (December 2021) and part of the group project of Entrepreneurship & Innovation students in "Managerial Lab 2" (2019).

3.1 Company profile

3.1.1 General overview:

According to their website, **ESSEBI Automation is a systems integrator that designs, builds and implements on-site industrial automation solutions where robotics plays an essential role: the automation philosophy that we propose is based on the seamless integration of man-machine.** For further clarification, the business is not a robotics manufacturer. Their primary responsibility is to deliver automation solutions by integrating software and hardware (such as custom designed automated solutions, robots or parts of robots) to meet the requirements of their customers (usually manufacturing companies). These sorts of solutions encompass the entire manufacturing flow, and the organization employs the design thinking process to build them (typical engineering mindset). Each solution is completely distinct, and each project is partly replicable, on a modular design, cross-sector expertise base. The definition of "system integrator" and their typical business model was also discussed in Chapter 1.1.4.1 and 1.2.4.

a) Size of the company: According to CrunchBase (n.d.), ESSEBI belongs to the SME sector with only 11-50 employees operating. In fact, this is also a family company founded by 2 sibling TECHNICAL EXECUTIVES who are STEFANO Bisognin (CEO) and GIOVANNI Bisognin. When we looked back the results of I.40 adoption conducted by UNIPD, we will see that micro, small, and medium-sized businesses are the ones implementing the most I4.0-related technologies, and ESSEBI's size corresponds to this fact. As a matter of fact, ESSEBI is

the type of SME that not only performs I4.0 technologies, but also serves clients who are mostly other SMEs. Because of this, the company should keep updating which technologies will lead the market in the coming future and should be prepared to confront new implementations and new system solutions that include these technologies.

b) Business model canvas: In 2019, a group of students in Entrepreneurship and Innovation class (including me) did a group project related ESSEBI company in “Managerial Lab 2” to define its business model and the alignment between company’s strategy and its communication.

Hence, we created a business model canvas to better describe the company position:

essebi automation BM convas

Key Partners

- Firms metal and mechanical industry
- Engel
- Staubli
- Firmware platforms
- Schunk
- Cognex
- Sick

Key Activities

- Design thinking

Planning the product according to customer needs, before production and creating an integrator system

- Production and Integration

Key Resources

- engineering and technical competencies
- Suppliers
- relational skills with customers

Value Proposition

- Closeness to customer needs and high quality

Understanding customer needs in terms of production process activities and providing quality in solution engineering, strategic suppliers and raw materials.

Customer Relationships

- Customer Involvement
- Relationship based on loyalty, responsability, reliability and quality

Channels

- BTB channels

Customer Segments

- Companies in the plastics industry
- Pharmaceutical companies (inspection machines)
- Manufacturing companies
- Mechanical companies

Cost Structure

- Component purchases
- Labour costs
- Production cost for special machines

Revenue Streams

- sales of automation systems

According to the BM Canvas as well as the introduction given in previous sections, ESSEBI's primary activity is to deliver a comprehensive automation solution, which includes consulting services, the manufacturing phase of integrating software and hardware components, and after-sales services. The avenue for acquiring customers is business-to-business, as clients are corporations that need to automate industrial processes including robots. Since ESSEBI is a small business, its clientele relies heavily on the personal connections of its CEO and on the recommendations of satisfied customers. This strategy allows the organization to build a customer database that is genuinely loyal, responsive, dependable, and long-lasting. It was determined through a discussion with the CEO three years ago that ESSEBI's clientele comes from the following industries and locations:

• Europe and Asia: Russia, China, Romania, Ireland
• Italy: Veneto accounts for 90% of Italian clients
• America: Puerto-Rico

Since ESSEBI is a system integrator that offers an all-inclusive package, their competitive advantage is evidently their design skills allowing them to draw a big picture from various elements from different suppliers (who are actively contribute to the service's ecosystem). One thing to notice here is that not all of the system integrators are serving the same solution in the same industry, especially when it’s related to Robot. Due to the different characteristic of robots provided by manufacturers (for example: robots from ABB will be different from those from FANUC or KUKA due to their sizes and sector appliance). Therefore, the expertise of system integrator also depends on how well they are connected to the supplier’s products. As a result, the organization has remarkably close relationships with key partners (and intensive knowledge with some kinds of robots), including:

• Standard suppliers: Hager, Vibro (Sorter), Festo (pneumatic), Glinder (Linear modules), Siemens (software)
• Partners: SCHUNK (clamping/gripping), Engel (presses), Staubli (robotics), and certain additional vendors particularly specified by clients or project specifications.

In addition to their tight relationship with their suppliers, ESSEBI's personnel is notable and a vital role in the development of their reputation, as they have accumulated a large number of engineers with extensive experience in robotics and software. The fact that the founding members have an engineering background has bolstered the company's strategy and technical attitude for implementing I4.0 in order to provide superior solutions and client service.

In terms of Value proposition, ESSEBI Automation places a premium on providing high-quality service to satisfied customers. In most cases, when a potential client makes a request, they have a good notion of what they want and what steps need to be taken to get it.

3.1.2 Company's solutions and customer's segment:

- **Company's solutions:**

The objective of this part is to take a picture of ESSEBI Automation system integration offering in I4.0: types of implemented automation solutions supported by robotics and all other plug-ins (for objects detection, moulding, gripping / handling, welding accessories), as well as challenges or opportunities in implementing.

Along with breaking down the input of solutions from ESSEBI website, we also asked the CEO five questions about the impacts of their solutions to the customers and the output will be discussed in the following part. As ESSEBI's job is highly customized case by case, we need to understand what the typical process is when the company need to work with customers. The typical sequence of activity is the following:

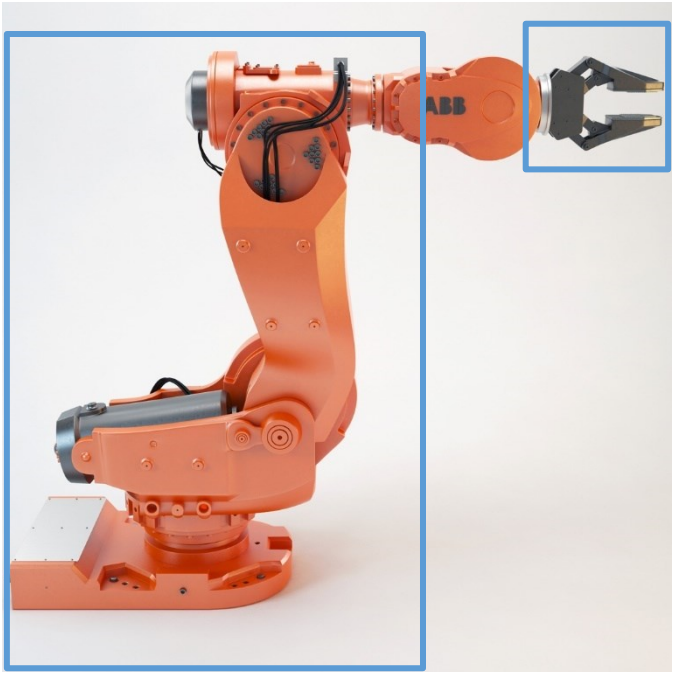
1. Understanding the needs.
2. Sketching out of app layout.
3. First prototyping (after order approval).
4. Production.
5. Refining.
6. Testing (in house and on site).
7. Consignment (close the deal, last part of money)

After getting acknowledge customer's inquiry, the solutions are usually categorized in 4 types:

(1) Personalized, advanced machine tool automation solutions:

Using vision / scanning technologies, the business designs and manufactures accurate gripping solutions (SCARA and anthropomorphic robots) for plastic and metal containers, lines, conveyor belts, and machinery. In a simple explanation, the company is designing the robotic arms to grip the objects such as metal containers or machinery based on the personalized requests. We can see the picture below as an example for gripping robot arms.

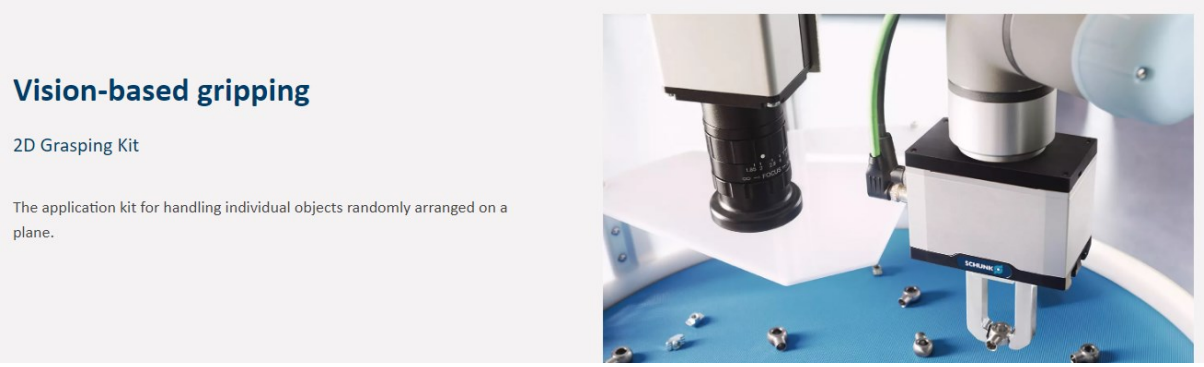
Figure 19: ABB IRB 7600 industrial robot (Turbosquid, n.d.)



What makes this gripping solution from ESSEBI standout from other standard robotics solution?

- ESSEBI is not the manufacturer of this robotic arm. As seen in the image above, a robot arm consists of a body and a head (plugs-in part). ESSEBI purchased the arms from Staubli and the plugins from SCHUNK (their two primary partners) and modified the machine based on the inquiries.
- Typically, conventional gripping arms lack a scanning system. Consequently, they can only do the same function again without quality control. In addition, ESSEBI can integrate a vision/scanner system (often a camera or laser sensor) for product error detection, to determine if plastic or metal moles have holes or cracks. This is a revised version for quality assurance.

Figure 20: Vision based gripping kit from SCHUNK (n.d.)



- As a system integrator, ESSEBI not only develops its own gripping solutions, but also performs control operations and communicates with the machine (press, lathes, grinders, etc.), the conveyor belt, and the end-of-line devices. This means that the arm will be configured to work with other machines in the production process in a manner that is highly automated and under minimal human control.

(2) Personalized, advanced plastic molding automation solution:

As the name speaks for itself, this is an automatic solution for plastic molding. In this segment, the company is capable of making plastic-related machines.

For example, a production line to manufacture a plastic milk carton lid involves a mold with the shape of a plastic cap, a machine to suck and melt plastic beads, and a machine to spray and press the mold. After pressing, the plastic cap must be visually inspected (using a scanning device) to check that it conforms to the criteria. After the product has passed quality inspection, it will be packed by a separate machine before being shipped.

Before manufacturing these machines mentioned above, ESSEBI will firstly design how many machines needed for the production line, what functionalities that the machines can perform (from molding insertion, packaging, and quality control…) and how these machines can work aligned with each other through the use of vision, measuring and movement systems (convey belt). It is also noted that they will customize the robots with different plug-ins: the welding head, the molding shape… and that's why it's important to have a strong partnership with robots' supplier like SCHUNK and Staubli.

The automation of plastic injection molding is more complex than the previous method for gripping because it involves the entire production line and not just a single machine. Therefore, it necessitates careful planning and preparation. As the customer does not seek a product offering, but rather an all-inclusive package, it makes the job of ESSEBI unique and highlights the company's selling proposition when they can leverage their knowledge by

working with different business cases to apply and design customized systems for the customers.

The example of Plastic molding can be also found on their Youtube channel: (773) PINS PREPARATION FOR PLASTIC MOLDING - YouTube

(3) Personalized assembly automation solutions:

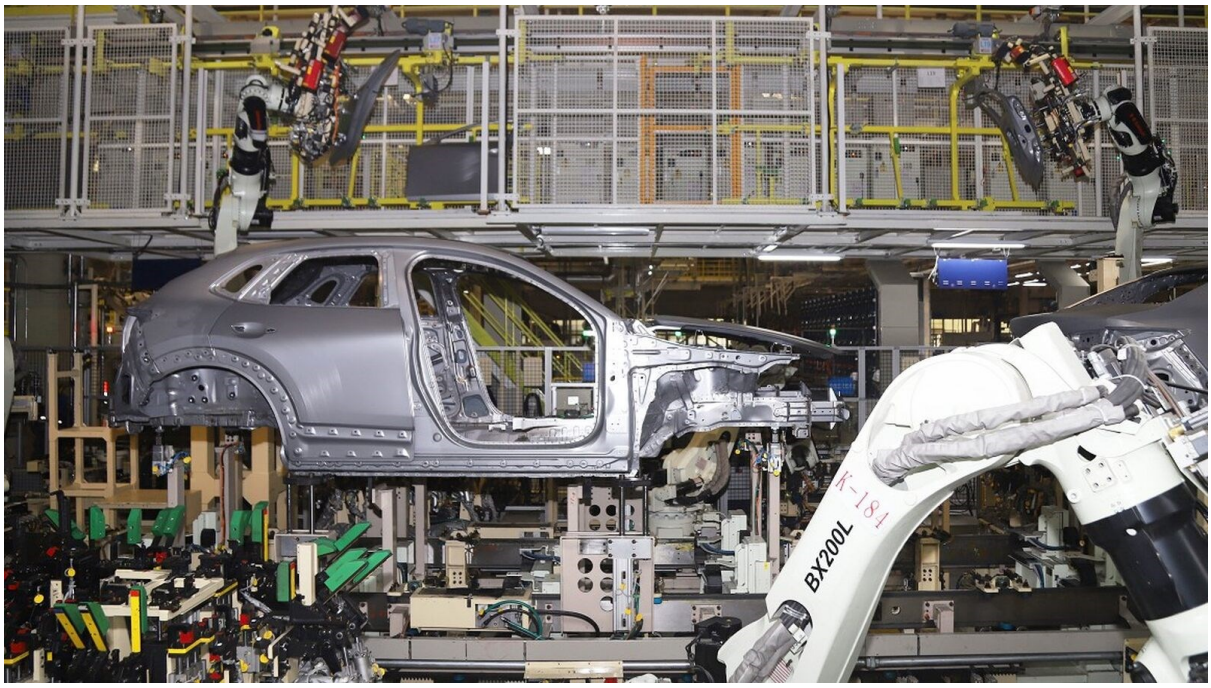
Manufacturing processes may be optimized for efficiency, safety, and output by employing assembly automation, which is the integration of robots, software, digitalized data, and engineering into the design of a production facility (Siemens, n.d.). An assembly line can be fully automated (devices and systems that do most or all of the work without any human involvement) or semi-automated (after components are manually loaded into fixtures or other tools, the system requires further human engagement to activate machine commands). No matter what type of the automation a company can design, it does not come in a universal "off-the-shelf" form because automation solution is to address a unique challenge faced by each company at each stage of production (JR Automation, n.d.).

In addition to the plastic molding automation solution described in the preceding section, ESSEBI also takes care of requests to create automated solutions for other areas of manufacturing, such as plastic or metal joints, selecting the individual parts from containers, electronic warehouses, and vibrating feeders. End-of-line testing is performed by these machines, using either mechanical or electrical devices or artificial vision equipment.

The company doesn't publish any case studies related to assembly automation on their website. However, we can watch a video on their Youtube channel ((773) ASSEMBLY MACHINE - YouTube) to understand their working principle.

Furthermore, one of the most common examples when thinking about automated assembly is car manufacturing when all of the car components are fully automated assembled in a separated environment without human intervention. For example: in Mazda Automobile Co., Ltd.'s door/hood/lid assembly and adjustment line, the four doors, engine hood, trunk lid, bumpers, and bolts are fully automatic. This automated manufacturing line changed 80 production employees from heavy manual laborers to trained operators and decreased the production enterprise's labor cost by RMB 15.6 million per year (IFR, 2021).

Figure 21: Automated solution for door/hood/lid assembly from Mazda Company (IFR, 2021)



(4) Tailor-made special machines:

As a customized solution offer, ESSEBI does not only manufacture small and medium machines but also special machines from the scratch, with a particular emphasis on systems for manipulation, marking, reordering, and control that aim to optimize the flow of production.

What makes ESSEBI really unique is the fact that some of its components and pieces are directly created in-house. There is a specific space that is dedicated to production, and it is often utilized for the manufacturing of specialized machinery. This is ESSEBI's one-of-a-kind competitive advantage, as it enables the company to cut down on the number of suppliers they work with (the bargaining power of small businesses like ESSEBI is quite low in comparison to large suppliers, which is why waiting lists are a part of the process) and to increase the level of responsibility they have toward their customers.

In sum up, we can point out 3 specialties in terms of function from the 4 solutions that ESSEBI offer customers:

- Customized plug-in parts for objects detection, molding, gripping / handling, welding accessories

Figure 22: The plug-ins kit from partner SCHUNK that can be modified by ESSEBI.

- Artificial vision system which is the combination of hardware (camera, laser, sensor…) and software offering operational direction for the execution of image capture and processing-based device activities. This has a variety of advantages when integrating with robots, including object detection, and reducing or eliminating the need to store components in fixed positions for robots to supervise, since they are able to identify and place them on their own (Iberdrola, n.d.).

  Another example in using AI or machine learning in robotic controlled can be a welding robot (one of many applications that ESSEBI is designing). Obviously, if a robotic welder is welding the frame of a vehicle and completing a large number of welds, they must be completed swiftly and with good quality to be efficient. In the past, ensuring that these welds were of acceptable quality required a significant amount of physical intervention and manual inspection. Now, not only can we have a camera monitoring the welder to assess the quality of the weld, but we can also respond and correct a weld in real time, or rapidly reject a weld and bring in a person to examine and then fix it if necessary.

Figure 23: Example of artificial vision system in ESSEBI's robots:

- Seamless integration of human-machine:

As stated on their website, the merging of human and technological functions into everyday life is key to the company's ideology. This is highly dependent on the software and Human-machine interface that operates the robot, launches programs, and loads new programs, among other capabilities. Thus, certain touchscreen displays (**technical term: user interface**) on the ESSEBI website serve as a platform that enables the interaction between a user and a machine's software. The greater the amount of automation needed, the more sophisticated ESSEBI's design or customization of this HMI must be.

Figure 24: An example of HMI on ESSEBI website

- Industry solutions:

Based on the extensive customization highlighted throughout this thesis, it can be inferred that not all robotic system integrators offer identical solutions. Their knowledge and expertise of the workforce and the sector they serve distinguish them. Some integrators excel in the automotive and food and beverage industries, while others have distinguished expertise in healthcare and medical services... All depends on the company's customer service history

during its whole existence. From what can be seen on their website and in their business model canvas, ESSEBI has established credibility serving the plastics, metals, and mechanical, and pharmaceuticals sectors. We are able to provide two examples:

- Utilizing machine tools and finishing equipment, they offer quality control of all components and bin selecting using 3D systems in the mechanical industry.
- They develop and install equipment for manipulating pharmaceutical components, such as de-nester and re-nester lines.

3.1.3 The opportunities and challenges while implementing these solutions: (Questionnaire involved)

As the notoriety of robotics automation rises daily, it seems that organizations are making optimal use of industrial robots. Obviously, companies like ESSEBI also gain a great deal from assisting clients in driving automated solutions via robots. To get a deeper understanding of the implications, I asked five questions to the CEO to identify the company's possibilities and obstacles while adopting the solutions indicated above. As ESSEBI operates through the implementation of I4.0, it is crucial to monitor their effects while pushing I4.0 to industrial clients. Due to the fact that their customers are the end-users of their service, some inquiries are directed to them instead of ESSEBI. The subsequent section provides a discussion of the finding:

1, What are the most requested robotics / industrial automation solutions?

Among the 4 options, the CEO chose 3 solutions which are the most requested from their customers:

- ☐ *Anthropomorphic robots (arms)*
- ☐ *Automation solutions (tapes, sledges…)*
- ☐ *Automation plug-ins: objects detection, molding, gripping / handling, welding accessories…*

In particular, automation systems and automation plug-ins are more popular than robotic arms. This fully matches the third (and maybe fourth) company solution stated in the preceding section. The customer's selection of automation solutions demonstrated, once again, that end users prefer a holistic approach to the whole system over the sale of individual goods. This is both an advantage and a difficulty for the firm, as it demands ESSEBI to analyze several perspectives of a business while providing solutions, as opposed to concentrating on product development (robots).

On the other side, the inclination to request plug-in components is to their advantage, since one of their strengths is the capacity to manufacture components in-house. In addition, ESSEBI must consider how to maintain and replace these components once the goods are delivered, since their buying power diminishes proportionally to the uniqueness of the components.

2, Where do you implement your automation solutions, in terms of Customers Departments?

Among the 6 given options in this question, the CEO chose 3 options which are all related to technology development rather than the business operation of a company:

- ☐ *Operations*
- ☐ *Prototyping*
- ☐ *New Product Development (R&D)*

This understanding indicates neither an opportunity nor a challenge; rather, it merely reaffirms the connection between what they do and how their clients invest in robotic solutions.

3, In what aspects is your company driving industrial customers towards the adoption of Industry 4.0?

Among the 6 options given, the CEO chose the 4 answers as following:

- ☐ *Business Models, Product & Service Portfolio*
- ☐ *Value Chains & Processes*
- ☐ *IT Architecture*
- ☐ *Organization & Culture*

In order to understand the insights of this answer, we can translate the question into: in what aspects that your solution (robotic automation) is helping your customer to adopt the I4.0. The positive signal that can be easily seen from the answer is that ESSEBI is tackling the majority of all aspects that we mentioned (4/6 were chosen). Regarding "Business models, product & service portfolio," section 1.1.4.1 provides a good description of how a system integrator might alter a client's business model over time. As more machinery is engaged, the change in business model will also affect the shift of "Value chain" (section 1.1.4.2). In addition, given that "automation integrators provide software that enables devices to connect with one another and gather and report data" (section 1.2.4), the data integration features of the implemented I4.0 automated solution supported by robotics can be a valuable contribution to redefining the IT architecture of the customers. Intriguingly, it is anticipated that the incorporation of data utilization would also alter the company's culture, as individuals must

adapt to a data-driven mentality in order to identify the appropriate difficulties and map the data required to develop solutions in line with corporate strategic objectives. Thus, from the data supplied by automation solutions (robots, software), customers will have more reliable criteria for decision-making, and the move to a new style of working and attitude will result in a new organizational culture and structure. As the impacts of ESSEBI are enormous, this is a chance for the company as long as they can demonstrate these effects to their consumers. How they may demonstrate this through their portfolios can be difficult, and it depends heavily on how they interact with businesses.

*4, How does your **customer** take advantage of I4.0 solutions?*

Among the 10 choices given, 50% were taken into consideration by the CEO:

- ☐ *Production cost reduction/ internal efficiency*
- ☐ *Increase in productivity*
- ☐ *Better customer service*
- ☐ *Increase in customer product – rate*
- ☐ *Re-organization activities*

In the previous question, we inquired about the potential area of influence; this question clarifies the context through the description of actions. Thus, we can see the link between these activities and the aforementioned fields. In accordance with the findings of a study done by UNIPD (2017), I4.0 has three major effects: efficiency (60%), an increase in production (54%) and a rise in customer service quality (53%); we can also see the similar outcomes from the impacts of ESSEBI towards their customers. Once it is demonstrated that their solution (robotics system integration) is driving their clients' I4.0 business transformation, this will be the case. Especially, the CEO emphasized that when ESSEBI get involved to customers' production line, the quantity they produce can be the same, but the manufacturing process is improving. Based on the output of this and the previous question, we can see the opportunity of ESSEBI by clearer explanation.

5, What are the main problems you encounter in your system integration activities, while implementing I4.0 automated solutions supported by robotics?

The question was given with 9 multiple choices and here we can see that the CEO chose the majority of answers (5/9) as below:

- ☐ *Difficulties in finding qualified professionals*
- ☐ *Limited availability for financial resources*

☐ *Implementation timing*

☐ *General IT maturity*

☐ *Others (please specify): Some places don't have the good Internet connection.*

The first two choices corresponded to our section 2.2.4 analysis (the barriers during the adoption of I4.0). Thus, we can observe that the issues ESSEBI faces are comparable to those faced by the majority of SMEs in Italy, namely the lack of human and financial resources. Specifically, Stefano emphasized that the specialists they require would be dispatched to work on the field. As robots are specialized machinery requiring maintenance after manufacturing, this impacts their Implementation and After-sales phases. Consequently, we can see why 90% of their consumers are based in Italy, with the majority coming from the Veneto area (the same location with the company). If ESSEBI wishes to increase their market, they must first overcome this obstacle. The implementation timeline may be significantly impacted by the talent management shortage, which is not a good indication for ESSEBI as they want to establish themselves as a provider of high-quality products and services. In addition to delivering machines to clients, ESSEBI also delivers the data created by those units. In an ideal situation, this information is also a significant asset for both parties in terms of supporting the development of new business models or innovative products. Therefore, it is vital for ESSEBI to equip its employees with broad IT expertise, and this can only be accomplished by investing in training and development in a variety of areas including simulation, system integrator applied to process automation, information and management systems....

The last problem associated with the inconsistent Internet connection in some locations also aligned with the challenge of "lacking broadband" discussed in section 2.2.4. This would be the most challenging because it depends on the result of the country's weak infrastructure. Unfortunately, not just ESSEBI, but also the majority of SMEs (or even huge enterprises) in Italy cannot deal with it without government intervention. However, as we also mentioned the technology of 5G in the discussion, there is a large potentiality of using this private network to transmit, analyze and capture data in a more controlled and high-speed environment. As a system integrator, ESSEBI can totally research this new technology and seek for the optimization when using this while designing automation solutions for their customers.

In conclusion, the customer's preference for a holistic approach to automation solutions highlights the need for ESSEBI to analyze multiple aspects of a business while providing solutions. The impacts of ESSEBI's solutions on their clients' businesses are like the effects of Industry 4.0, such as increased efficiency, production, and customer service quality. However,

ESSEBI faces barriers in adoption, including a shortage of human and financial resources, a need for IT expertise among employees, and inconsistent internet connection. It is also evident that the obstacles this company has when implementing automation solutions through robots are inescapable, as is the case for other Italian SMEs. The benefits and challenges combined in the previous analysis presents a tremendous possibility for their future development if they can devote more resources to overcoming the aforementioned challenges.

3.2 ESSEBI in the adoption of 4.0 (Questionnaire involved):

- **Theoretical background:**

I conducted an interview with the CEO of ESSEBI - Stefano Bisognin to ask about their product – services portfolio and their transformation during I4.0 journey. Especially, a part of the questionnaire was designed to measure how ready ESSEBI became when adopting I4.0 and if they have a big gap between their current situation and their goal in the next 5 years. The 10 questions in this part were inspired by the "I4.0 Self-Assessment" of PWC (I.40 Maturity model) which measures a company's actual maturity to its desired maturity across six dimensions, thereby highlighting action requirements and rating its present maturity level. The idea behind this assessment is not just about the readiness in I4.0 but also about the digitalization as PWC stated in their introduction that *"Industrial leaders are digitizing (and, today, orienting towards a day-by-day more and more mature digital transformation process) essential functions within their internal vertical operations' processes, as well as with their horizontal partners along the value chain. At the end of this transformation process, successful industrial companies will become true digital enterprises, with physical products at the core, augmented by digital interfaces and data-based, innovative services. These digital enterprises will work together with customers and suppliers in industrial digital ecosystems"* (Rumpenhorst, 2016, p.4). In another word, this part of the questionnaire can be helpful to measure how much the company (ESSEBI) has transformed themselves and their customers.
Among the 6 dimensions, some questions related to Customer Access, Product & Service Portfolio, Vertical and Horizontal value chain were chosen; and the expected outcome might also be classified based on 4 different level of maturity. Furthermore, because not all of the questions from PWC model were taken to this questionnaire and most of the chosen questions were related to the data usage across the departments of the company, we also take the Digital Transformation – Capability Maturity Model (Gökalp & Martinez, 2021) into consideration to see if the factors related to "integration of processes at different intra-company, and inter-

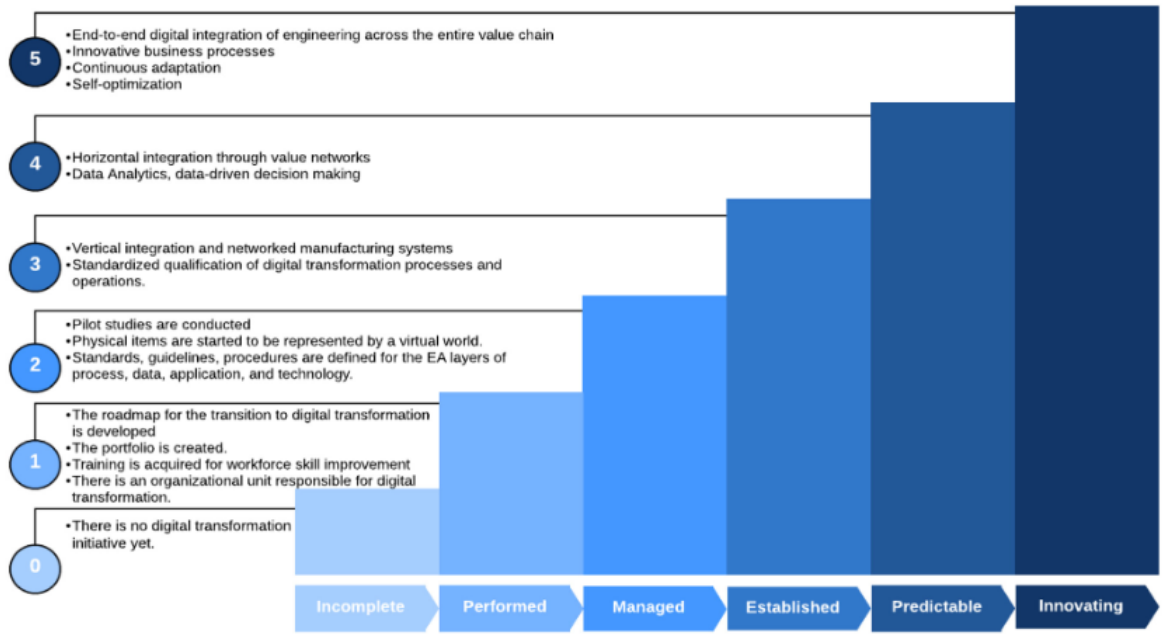
company, levels, as well as across the entire value chain" can be valid contributors to ESSEBI in their maturity of digitalization.

The definition and behaviors of each maturity level were also explained in PWC's report.

Figure 25: PwC maturity model - Industry 4.0 capabilities and the behaviors of 4 stages (2016)

	1 Digital novice	2 Vertical integrator	3 Horizontal collaborator	4 Digital champion
Digital business models and customer access	First digital solutions and isolated applications	Digital product and service portfolio with software, network (M2M) and data as key differentiator	Integrated customer solutions across supply chain boundaries, collaboration with external partners	Development of new disruptive business models with innovative product and service portfolio, lot size 1
Digitization of product and service offerings	Online presence is separated from offline channels, product focus instead of customer focus	Multi-channel distribution with integrated use of online and offline channels; data analytics deployed, e. g. for personalization	Individualized customer approach and interaction together with value-chain partners. Shared, integrated interfaces.	Integrated Customer Journey Management across all digital marketing and sales channels with customer empathy and CRM
Digitization and integration of vertical and horizontal value chains	Digitized and automated sub processes. Partial integration including production or with internal and external partners. Standard processes for collaboration partly in place	Vertical digitization and standardized and harmonized internal processes and data flows within the company; limited integration with external partners	Horizontal integration of processes and data flows with customers and external partners, intensive data use through full integration across the network.	Fully digitized, integrated partner ecosystem with self-optimized, virtualized processes, focus on core competency; decentralized autonomy. Near real-time access to extended set of operative information

Figure 26: The DX-CMM Maturity Levels. (E. Gökalp and V. Martinez, 2021)



The CEO was asked to rate 9 questions from 1 to 5 where 1 is representing the least advanced maturity level (lowest) and 5 is representing the most advanced maturity level (highest). The 10 questions were firstly asked in a random order during the interview, but then output was re-grouped into 4 categories: Data integration, Partner collaboration, Digital orientation, Sale and pricing.

- **Discussion of the results:**

From the questionnaires, there are 2 questions to identify business model and customer's access of ESSEBI:

*"(1) How important is the **usage and analysis of data** (customer data, product or machine generated data) for your business model?*

(4) How far do you collaborate with partners regarding your approach of accessing customers (exchange of customer insights, coordination of marketing activities etc.)?"

From question (1), the CEO agreed that the consumption and analysis of data should be at the maximum degree of maturity, indicating that data is the primary value generator for the business model (e.g., data on machine capacity utilization is used to determine the amount of fees). This is vital information to begin with, as ESSEBI holds a vast amount of data collected by their devices, which they may use for themselves or to advise process improvements to their clients. However, the actual degree of data utilization is only moderate (3/5) because not all consumers are prepared to compare machine data. Consumers' reluctance to use data analysis may not be attributable to ESSEBI, whose task as a system integrator is also to translate this dataset into actionable insights to convince customers to adopt it. A higher level of awareness in terms of adoption not only of the digitation, but, mostly of the digital transformation process is the hands of the customers. Therefore, the CEO graded 3 in both reality and expectation of this matter. Compared to the scale of PWC, we can see that they are providing a **physical product and a customized, solution-service portfolio with software, network (M2M) and data as key differentiator** which fits the definition of vertical integrator, but does not entirely boost the digital transformation process, yet.

In terms of Digitization of product and service offerings, there are 4 questions they we can get the implication from their results:

"(2) To which extent do you analyze customer data to increase customer insight (e. g. personalized offers to customers based on their personal situation, preferences, location, credit score, consideration of usage data for design & engineering etc.)

(3) How intense is your collaboration with partners, suppliers, and clients for development of products and services?

(8) To which extent do you use multiple integrated sales channels to sell your products to your customers?

(9) How dynamic and customer-tailored is your pricing system (consideration of customer's "willingness to pay")?"

Given that the majority of ESSEBI's customers originate from direct relationships, it is interesting to note that their interest might be to collect customer data to expand their knowledge, in the future. In actuality, we can infer that client's data are maintained in a traditional approach, and that they cope with their effective data-oriented organizational development ambitions prudently (3/5). The considerably modest result (2/5) observed in question (3) also calls up their relationship with the technical suppliers, which is an additional intriguing aspect. ESSEBI needs a close collaboration with their suppliers and clients for product development, despite the different interest the two players can have in engaging with suppliers on customer approach. Because of their status as a system integrator, they are compelled to offer a comprehensive product and service package and guarantee for its consignment. Consequently, their expectations for this collaboration are extremely high; transparent value networks have formalized also incremental, joint evolution of products with partners. Question (8) should revise their channel sales approach. If a company is fully digitalized, its different digital and non-digital sales channels (e.g., store, sales force, web-shop, etc.) should be integrated. In reality, the degree of this company's omnichannel integration is neutral due to the fact that it delivers specialized machines with tailored case studies for each customer. They have a website and Linkedin, however they are not actively utilized in comparison to other robotic system integrators. We can assume that offline connection with existing and future clients in Italy remains the primary channel.

When this section's question (9) is posed, the CEO evaluated both reality and expectation as five. This indicates he assumes ESSEBI has dynamic pricing, where automated systems calculate prices, discounts, etc. in real-time. Nevertheless, this is really a misunderstanding regarding the price structure. Individual prices can be provided by ESSEBI in response to specific customer requests; however, these prices are determined on a single base, rather than by an automated system. All of these findings demonstrate conclusively that the organization utilizes several channels for sales, has customized offers for clients, but does not yet collects value from the analysis of customer data, and has close relationships with value-chain partners for product and service future development. From this conclusion, we can see that there is presence of both vertical integrators and horizontal integrators based on the PWC scale; however, the behavior of **horizontal collaborator**, which is characterized by integrated collaboration with partners, is the type of integrator they might work on.

Regarding digitization and integration of vertical and horizontal value chains, we also have 3 questions to identify the findings:

*"5, How would you rate the **digital orientation** of your vertical value chain (from product development to production)?*

*6, How advanced is the digital orientation of your **production equipment** (sensors, IoT connection; digital monitoring, control, optimization & automation)?*

*7, How would you rate the digital orientation of your **horizontal value chain** (from customer order over supplier, production and logistic to service)?"*

When a corporation is fully digitalized, its data flow should be continuously transferred between divisions and machines should be controlled directly. Likewise, industrial equipment should be networked to enable IT-access and information should be supplied into a virtual picture of the plant. However, when asked about the current state of these aspects at ESSEBI, the CEO said that initial premises for automation and integration are lacking. In reality, all three issues received a rating of 2 out of 5. It is quite normal, especially in Italy, because of the state of the art in manufacturing companies: the system integrator starts its job based on these customer premises. They were meant to create and install a complete automation solution between equipment and software where both parties – Essebi and their customers – should not only collect, but also be oriented to exchange, and analyze data. Therefore, the optimum context could be achieved if all components linked to IT access and system information will, then, interconnected. When I examined the reasons provided by the CEO, I realised that his assessment of the poor performance is subjective, as his example only referred to the physical and infrastructure of the system (software, machines) and not the direction of data flow within the system and how to utilize this data flow. On the basis of the descriptions of both vertical and horizontal integrators in relation to this topic, I prefer to classify ESSEBI's maturity level as partly vertical. This is due to the fact that, also based on past findings, ESSEBI has clearly standardised and harmonised internal procedures and data within the organization, but we lack evidence that they have effective data integration with external partners.

- **Conclusions**

In conclusion, based on the analysis of PWC's maturity model, it is quite clear that ESSEBI still has to go a significant distance before it will be able to completely embrace Industry 4.0 and fully achieve its promise. The maturity model evaluates a firm based on their aspirations and the reality of their adoption and implementation of technology and practices associated with Industry 4.0. The results of the analysis for ESSEBI suggest that there is a significant gap between their current state and the desired level of digital maturity. The majority of the

expectations for ESSEBI were rated 4 or 5 on the scale, indicating a high level of aspiration for digital transformation. However, the reality only belongs to 2 or 3 of the scale, indicating a low level of actual implementation. This highlights the need for ESSEBI to take a strategic and focused approach to I4.0 adoption, in order to close the gap and become a true digital champion in the industry.

Regarding the business model interpretation and customers access, they are heading towards a vertical integrator perspective. Regarding product and service offering, they are mostly acting as horizontal collaborator. Regarding the vertical and horizontal value chain, they are acting as vertical integrator. Based on the descriptions of both vertical and horizontal integrators, ESSEBI's maturity level can be classified as partly vertical due to their standardized and harmonized internal procedures and data within the organization, but lack of evidence for effective data integration with external partners.

	1 Digital novice	2 Vertical integrator	3 Horizontal collaborator	4 Digital champion
Digital business models and customer access	First digital solutions and isolated applications	Digital product and service portfolio with software, network (M2M) and data as key differentiator	Integrated customer solutions across supply chain boundaries, collaboration with external partners	Development of new disruptive business models with innovative product and service portfolio, lot size 1
Digitization of product and service offerings	Online presence is separated from offline channels, product focus instead of customer focus	Multi-channel distribution with integrated use of online and offline channels; data analytics deployed, e. g. for personalization	Individualized customer approach and interaction together with value-chain partners. Shared, integrated interfaces.	Integrated Customer Journey Management across all digital marketing and sales channels with customer empathy and CRM
Digitization and integration of vertical and horizontal value chains	Digitized and automated sub processes. Partial integration including production or with internal and external partners. Standard processes for collaboration partly in place	Vertical digitization and standardized and harmonized internal processes and data flows within the company; limited integration with external partners	Horizontal integration of processes and data flows with customers and external partners, intensive data use through full integration across the network.	Fully digitized, integrated partner ecosystem with self-optimized, virtualized processes, focus on core competency; decentralized autonomy. Near real-time access to extended set of operative information

In terms of digital orientation and data integration, what we can see from ESSEBI are:

a, They realize the importance of data integration as a key differentiator in their product – service portfolio. This is a positive signal reflecting a right mindset when adopting I4.0. As we mentioned in Chapter 1) I4.0 enhances production efficiency by acquiring data intelligently, generating solid judgements, and carrying out those actions without hesitation (Qin et al., 2016). This mindset also aligned with PWC model as their findings indicate that businesses farther down the path to digitalization and integration are also more likely to be making use of data analytics. The behavior of them trying to analyze the customers data to increase customer insight has proven their effort in leveraging data in decision making process. With this foundation set, if ESSEBI can proceed the right direction in implementation, they can achieve

a successful digital transformation and positions the company well for the future of industry and technology.

However, there are still some limitations in their perception of digital transformation which are:

b, The CEO assessment in ESSEBI automation mostly referred to the integration of machine and data which is not capturing the big picture of I4.0.

When we asked the CEO to rate several aspects regarding data integration or digital orientation, we have received the poor rating from the CEO. Additionally, his explanation was mostly about the machines or robots that they delivered. For example, the usage of data is 3/5 because customers are not ready to compare these sources from the machine or the digital orientation of product equipment is 2/4 because it's not easy to automize the tailor-made machines. However, as we already discussed the definition of I4.0 in Chapter 1, I4.0 is not just robots and automation but the digitization of all business operations, including material acquisition, production, and customer delivery. (Bilgili, 2019). Therefore, we can see that the CEO of ESSEBI, as a system integrator, can still realize the role of several elements of the system itself but still can not see the whole value chains and how each element and integrate to each other in the digitalization journey. Another example can be taken from conclusion (a) when ESSEBI did collect data from customers so that they can acknowledge themselves in improving customers' insights. However, the pricing system that they made to each customer was calculated manually and, in this finding, we also found another misunderstanding from the CEO regarding the price structure. What can be implied from this summary is that the CEO himself (or even ESSEBI in general) still has limitation in translating the input to informative insights that can drive the business direction. This is a very important factor in achieving the data-driven mindset and achieving this mindset is also the key of I4.0 transformation. PWC also stated that to achieve success, businesses will need to use data in predictive, forward-looking ways that make sense of market events and customer behavior in order to enhance existing products and to build new products and services.

C, Horizontal integration of process and data flows with external partners and customers should also be emphasized.

ESSEBI's aspirations to become a digital champion through a fully digitized and integrated partner ecosystem with virtualized processes, decentralized autonomy, as well as near real-time access to operational information, are commendable. However, their poor performance in this

area is a cause for concern. This is likely due to a lack of proper understanding of the complexities involved in digital transformation and the interplay between various players of the value chain.

As we have discussed in section 2.2.4 and in question (9), 5G technology can play a crucial role in addressing this challenge. With 5G, ESSEBI can maintain a holistic view of data flow and control and ensure that data is transmitted and processed in near real-time. This can help ESSEBI to make informed decisions, optimize processes, and improve efficiency. In order to fully realize the benefits of 5G technology, ESSEBI should consider supplier collaboration in many aspects, not just in the machine and device areas. This will require a more comprehensive and integrated approach to supplier engagement, where suppliers are viewed as partners in the digital transformation journey. By collaborating with suppliers, ESSEBI can tap into their expertise and technology to enhance their own offerings and ensure that they remain at the forefront of I4.0 adoption.

When mentioning vertical integrator, we also tried to look at the DX-CMM Maturity Levels (Gökalp & Martinez, 2021) and really see the alignment in this model as well. Based on the description, ESSEBI hasn't reached to Level 4 (predictable) as they are lacking the data analytics, leading to the data-driven decision making. Instead of that, ESSEBI can fit level 3 (Established). At this level:

i. Key procedures are clearly stated and in line with applicable standards.
ii. Vertical integration has been accomplished, including the integration of IoT devices within an organization up to enterprise resource planning or customer requirement management systems.
iii. Organizational transformation is handled, and the created Enterprise Architecture is incorporated.

CHAPTER 4: SERVICE MANAGEMENT IN ROBOTIC SYSTEM INTEGRATION – ESSEBI CASE REPORT

Service management in a robotic system integrator is totally different from any product-service providers as the services was engaged from a very early stage of the business cycle. The services that a company can deliver does not only appear after a product is delivered but also from the first moment when a customer approaches that company. Service management also involves managing the lifecycle of a robot system, from planning and design to deployment and maintenance. Successful service management in this sector requires a thorough understanding of the components involved in a robotic system, including hardware, software, and network components.

This section delves into the workings of ESSEBI Automation's service offerings, examining the specific tasks involved in delivering them. It also examines the crucial role played by the Service Manager in overseeing and managing the service operations within ESSEBI. The result was based in a questionnaire that I conducted with the CEO of the company in late 2021.

4.1 Introduction of ESSEBI service offering:

ESSEBI offers customized services that are designed based on the customer's specific needs. In addition, the company is able to add extra services that are not listed in their portfolio on demand. According to the CEO, ESSEBI performs 8 different activities along with the 3 stages in the sale cycle: pre-sale; during-sale and post-sale

- **Pre-sale activities:**

(1) **Designing the solution in parallel with customer's demand:** They works closely with clients to understand their requirements in order to design a solution that meets these needs and aligns with the customer's demand. This stage involves a thorough analysis of the customer's processes and workflows to ensure that the proposed solution is optimized for their operations.
(2) **Prototyping:** Depends on the complexity of the project, the company may provide prototyping services to create a working model of the proposed solution. This enables clients to visualize and test the solution to ensure that it meets their expectations before the final product is manufactured.

- **During-sale activities:**

(3) Running internal workshop: ESSEBI may also run internal workshops to demonstrate the features and capabilities of the proposed solution. This allows clients to see the solution in action and ask questions to better understand the solution.

(4) Design the machine including mechanical and electrical and software design: They work to ensure that all components are designed to meet the desired specifications and are compatible with one another.

(5) Implementing mechanical and electrical assembly: The company is responsible for assembling the mechanical and electrical components of the machine, ensuring that all components are integrated properly and work together seamlessly.

- **Post-sale activities:**

(6) Onsite – testing, disassembly, re-assembly and startup of automation solutions for customers in Italy and abroad: This ensures that the solution is functioning properly, and that the customer is satisfied with the final product. The price of the 1st time of running machine, onsite testing, disassembly and re-assembly is included in the original offer when the contract is sign.

(7) On-site and remote assistance service: ESSEBI also provides ongoing on-site and remote assistance services to support the customer in the event of any issues or problems with the solution. This helps to minimize downtime and keep the system running smoothly.

(8) Maintenance service: This includes routine check-ups and maintenance, as well as any necessary repairs or upgrades to the system.

Along with these activities, multiple individuals are involved in the service offering process at ESSEBI Automation. These include the CEO, Service Manager, Designer, Engineer, Sale and Marketing Executive, and Accountant. This indicates that the provision of services at ESSEBI Automation is a collaborative effort involving multiple departments and personnel within the organization.

Furthermore, when I asked the CEO what services that he thinks are frequently requested/ appreciated from customers, he picked the most 4 important factors:

- ☐ *(1) Pre-sale: Designing the solution in parallel with customer's demand*
- ☐ *(4) During Sale: Design the machine: mechanical and electrical and software design*
- ☐ *(6) Post-sale: Onsite – testing, disassembly, re-assembly and startup of automation solutions for customers in Italy and abroad*
- ☐ *(8) Post-sale: Maintenance service*

Based on the result, we can see that the top 2 reasons (1) and (4) all belongs to customized design. This findings indicates that customers value services that cater to their specific demands and solutions that are designed to meet their needs. This is also the reason why customers seek for system integrators because of their capability of providing customized solution in complex projects by their technical knowledge and experiences in system design. As we can also see from the answer, the majority of most requested services belongs to after sale services. This could indicate that customers are interested in ensuring the proper functioning of the automation solutions and also want to have access to assistance and maintenance services after the machine has been delivered. Additionally, the fact that 2 out of the 4 most important factors are related to post-sale services highlights the need for ESSEBI Automation to focus on providing these services effectively in order to improve customer satisfaction and increase customer loyalty.

4.2 ESSEBI service approach in strategic thinking:

In order to understand the strategic approach of the company in terms of service management, I asked the CEO to rate internal stakeholders' perception of service management with the description below:

- ☐ *1: The team knows company service portfolio offering and what kinds of service the company is focusing on*
- ☐ *2: The team has a service management strategy to apply while approaching / working with customers*
- ☐ *3: The team has service management strategy to apply while approaching / working with customers intensively*
- ☐ *4: The team suggest continuous improvement with customer' decision makers to achieve satisfaction through services*

According to the description, the CEO has chosen option 3, indicating that they do have a strategy in service offering and they apply that strategy intensively while working with the customers. However, they have not yet achieved the optimal level (option 4) where they may provide clients advice for improving their procedures. In truth, it does not imply that they could not make process improvement advice to consumers at all, but rather that they could not develop it into a revenue-generating business. This is related to a challenge that was not mentioned in the questionnaire (2021) but in an interview with the CEO while we are doing Managerial Lab 2 (2019). One challenge for Small and Medium system integrators

(SMEs) in providing separate and fee-based service contracts is that they often find it difficult to incorporate proactive maintenance (process improvement) into the contracts. SMEs may be more inclined to offer it as a free service, rather than as a paid service, which is common for larger companies. Process improvement refers to analyzing data and parameters and making recommendations to customers, which can help to improve their systems and processes. However, for SMEs, this can be a challenge as it required data-driven mindset and expertise from the company as well as infrastructure supported by governemnt as we discussed in section 1.2.5.4.

Besides the information of the company's approach in service strategy, Stefano also provided that ESSEBI also has a strategic review of its current offer service portfolio. Due to the time-consuming in their process development, they only do this review annually. The CEO, Designer and Engineer will play active roles during the reviewing process.

When applying this service portfolio mentioned above, both ESSEBI and their customers receive some benefits for the businesses:

When customers use services from ESSEBI, they can receive benefits such as increased productivity and gain more competitives advantage against competitors. Increased productivity means that the customers will be able to produce more goods or services in a given time, improving their efficiency and profitability. This can be achieved through the implementation of new technologies and efficient processes that improve their overall performance.

On the other hand, adding these services to customers can also bring benefits to ESSEBI. The first advantage is enhanced productivity. Customers that utilize ESSEBI's solutions are able to request more than one machine at a time; creating a push for the company to handle more orders within the same resources allocation. This leads to a rise in production. The second benefit is an increase in revenue. This is because they are able to charge a fee for their services, which is a source of income for the company. Furthermore, the organization can gain from acquiring new clients. This can be achieved through repeat business from satisfied customers and the acquisition of new customers through positive recommendations. Additionally, having new customers means that ESSEBI can expand its customer base and reach a wider market, increasing its overall growth and profitability.

In conclusion, the benefits that ESSEBI receive when adding services to its customers, such as increased productivity and revenue, and the acquisition of new customers, are

aligned with the objectives of adopting Industry 4.0 technology. By leveraging digital technologies, companies can increase efficiency and competitiveness, as well as meet the changing demands and expectations of customers. ESSEBI's focus on providing services that can deliver tangible benefits to its customers demonstrates its commitment to staying ahead of the curve in the rapidly evolving industrial landscape. With Industry 4.0 transforming the manufacturing sector, companies like ESSEBI must continue to innovate and adapt their service offerings to remain competitive and relevant in the market.

4.3 ESSEBI services offering in implementation:

In order to understand the company's strategy in services management, I firstly asked two questions to clarify who are the most important stakeholders involved in each steps (among the 8 services that are explained above) and rate the importance of service types in terms of resources spending, cost structure and revenue gain.

- Question (3): Please match the most important person in charge in each process
- Question (4): What are the most important services to ESSEBI in terms of resources spending, cost structure and revenue gain? Please rank these services from 1 to 5 with 1 is the least important and 5 is the most important. So, the ranking can be: 1 – Least important; 2 – Little important; 3 – Neutral; 4 – Important; 5 – Very important
  Important level can be depended on how many people that company needs to focus on each step, how much money which was spent to ensure this service and whether this kind of service can bring a high revenue to the company

The result can be presented in this table:

Table 3: Type of service with the important rating and people engaged in each process

		Role of people					
Type of service	**Rating based on the important level**	CEO	Service Manager	Designer	Engineer	Sale and Marketing Executive	Accountant
(1) Pre-sale: Designing the solution in parallel with customer's demand. (*)	**2**	X		X			
(2) Pre-sale: Prototyping.	**3**			X	X		

(3) During-Sale: Running internal workshop.	**3**	X				X	
(4) During Sale: Design the machine including mechanical and electrical and software design (*)	**5**			X			
(5) During-Sale: Implementing mechanical and electrical assembly.	**5**			X	X		
(6) Post-sale: Onsite – testing, disassembly, re-assembly, and startup of automation solutions for customers in Italy and abroad. (*)	**5**		X		X		
(7) Post-sale: On-site and remote assistance service.	**4**		X		X		
(8) Post-sale: Maintenance service (*)	**3**		X		X		

(*) **Services that are most requested from customers given from the previous question.**
Based on this table, we can have some observation about the

Observation #1: There are an alignment but also misalignment between what customers wants and what company is prioritizing, leading to the need of re-evaluation in company strategic services.

Alignment: If we look only at the important level ranked by the CEO in terms of resources spending, cost structure and revenue gain, we can see that most of them fall into During-sale and After-sale stage. Especially the service of (4) During Sale: Design the machine and (6) Post-sale: Onsite – testing, disassembly, re-assembly, and startup of automation solutions… are also the most popular services from the customers. With this alignment, it is a good fit for a company so that they can know which kind of service they can focus on in terms of financial aspect and human aspect. By a general look, we can suggest that they should continue to

prioritize and allocate resources to During-sale and After-sale services as these are the main revenue drivers for the company.

Misalignment: Surprisingly, there are some misalignments for some services between CEO's priority and customer's request and that also highlights a disconnection between the company's focus and what customers value:

In the case of (7) Post-sale: On-site and remote assistance service, the CEO ranks it highly despite it being low in demand from customers. This could indicate a need to re-evaluate the company's priorities and focus on offering services that customers are requesting.

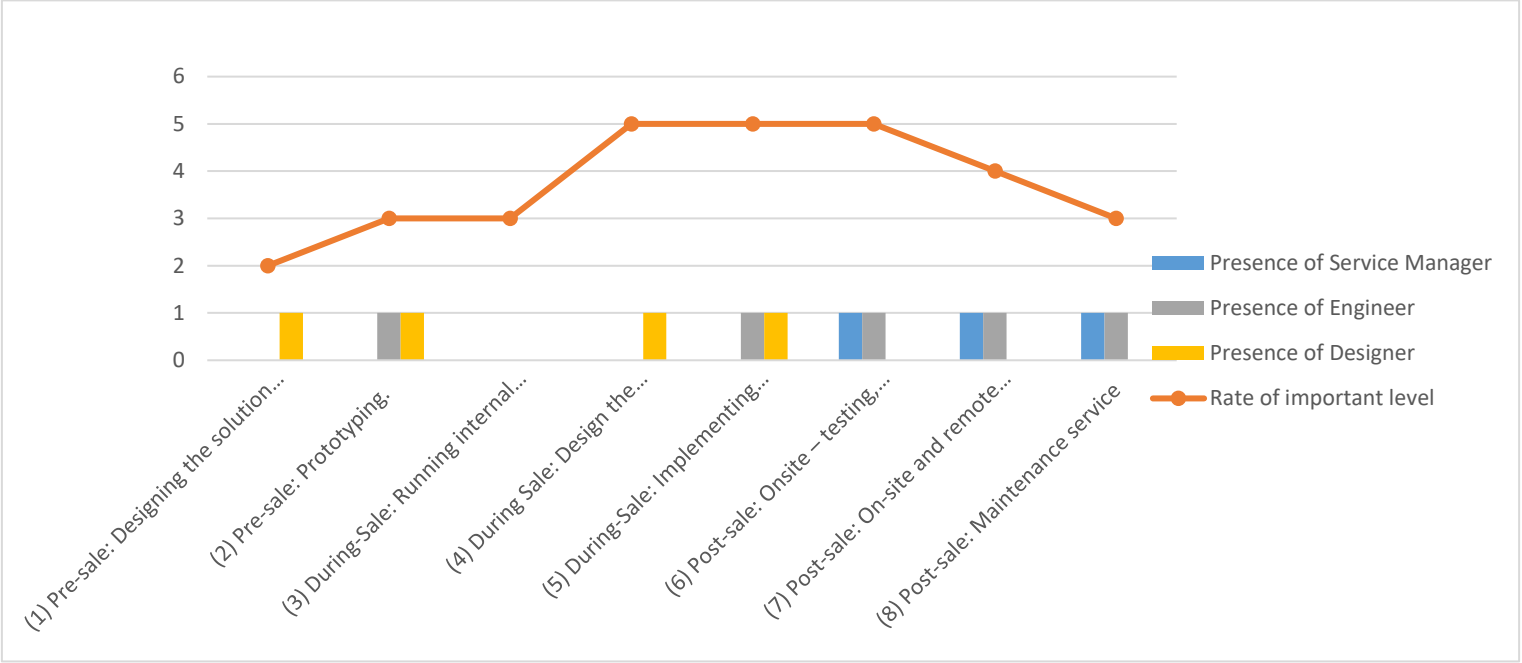
On the other hand, (1) Pre-sale: Designing the solution in parallel with customer's demand and (8) Post-sale: Maintenance service are highly requested by customers but are only ranked as neutral or low in importance by the CEO. Additionally, he said that the reason why he considered service (1) with little importance is because they don't spend much time on designing a real machine in this step. This implies a limited understanding of the design process from the CEO and its importance in ensuring a successful solution. The design process involves not just the creation of a machine but also considers factors such as the customer's needs and requirements, cost, and the overall success of the solution. Neglecting the design process can lead to issues in the final product, which can negatively impact the customer's satisfaction and the company's reputation. ***Therefore, we can have a brief suggestion from the analyzed insight that the company should have re-evaluated the entire service process, including the pre-sale, during-sale, and after-sale stages, to determine which services are most critical to meet both resource allocation and customer demand.*** This will help the company to focus its efforts on the most valuable services and maximize its return on investment. Who should be included in this re-evaluation process will be further discussed in the following session that provide more insights for company structure and workforce.

Observation #2: Engineer, Designer and Service Manager play a critical role in most of the strategic services. However, in order to align with the key services based on customer's demand, the workforce allocation should be adjusted strategically.

The table above shows the allocation of workforce in various strategic services offered by the company. It is evident that supporting roles such as the CEO and Sale & Marketing Executive have limited involvement in the services, with the CEO having only two steps of involvement and the Sale & Marketing Executive having only one step of involvement. On the other hand, the support role of the accountant, who is responsible for the financial perspective, is not seen to play an important role in any of the steps. **This highlights that the critical roles in**

delivering the services are primarily played by the Service Manager, Designer and Engineer, who have more significant involvement in a larger number of steps. The limited involvement of the CEO and Sale & Marketing Executive in the services could indicate that they focus on overall management and marketing strategy, while the execution of services is handled by the key roles.

Graph 1: The presence of Service Manager/ Engineer and Designer in each service.



When we try to visualize the presence of 3 key roles mentioned in each service, we can also see that these roles were aligned equally and depending on sale cycle:

- Engineer is the most involved role in the services offered, being present in 5 steps across the pre-sale, during-sale, and post-sale stages.
- Designer takes the second spot, with a focus on the pre-sale and during-sale stages.
- Service Manager is only important in the post-sale stage, which means that the after-sale services have a higher reliance on the Service Manager.

Nevertheless, there are still some misalignments of this human allocation compared to the strategical services considered by the CEO/ customers:

- **The Engineer is not considered as an important role in step (1) and (4):**

Based on the information provided, the CEO considers services (4), (5), and (6) to be very important and the customers also highly appreciate in (1), (4), (6), (8); we can see the important places in service (1) and (4) compared to the whole service process of the company. However, in step (1) and (4), only the Designer is considered the most important role, while the Engineer

is not. This lack of involvement of the Engineer suggests a misalignment in the allocation of workforce, as the Engineer is involved in a significant number of services (5) but is not included in key stages demanded from customers or the CEO. More importantly, this misalignment could result in various drawbacks such as insufficient technical expertise, delayed service delivery, and reduced customer satisfaction.

Furthermore, even though services (1) and (4) are primarily focused on the designing process, the involvement of an Engineer is still crucial in these key strategic services. Engineers bring a technical expertise to the table, and their contributions can play a crucial role in the overall success of the service. They are able to provide a different perspective, offer problem-solving skills and bring innovative ideas to the table that can improve the design of the solution. In addition, Engineers can provide a deeper understanding of the technical feasibility of the design, ensuring that the solution meets all the necessary requirements and specifications.
Additionally, Engineers can also be involved in the implementation of the solution, making sure that it is not only designed effectively, but also executed properly. This is particularly important in services (4), (5), (6) and (8) where the focus is on the implementation of the solution, including mechanical and electrical assembly, testing, disassembly, re-assembly, and maintenance. In these services, Engineers can provide valuable support and troubleshooting skills to ensure the smooth operation of the solution. Overall, while Designers play a key role in the design process, the involvement of Engineers is also critical in ensuring the overall success of the key strategic services.

- **CEO, Engineer, Designer and Service Manager should equally contribute for service (1) as it decides whether the customers will take the deal or not:**

Following the idea discussed above, we can also realize that service (1), the Pre-sale stage of Designing the solution, is a crucial stage in the sales cycle as this is where the customers make the decision whether to proceed with the deal or not. Because of this, ESSEBI is not giving this adequate attention and focus to ensure its success.
Specifically, the involvement of the CEO, Service Manager, Engineer, and Designer should be all considered in this stage, as each of these roles brings a different set of skills and expertise that can contribute to the overall success of service (1). The CEO brings strategic vision, while the Service Manager helps to coordinate the various technical and customer-facing teams. The Engineer brings technical expertise, and the Designer provides a creative and design-focused perspective.

By collaborating closely with each other and the customer, these key individuals can ensure that the solution being proposed meets the customer's needs and expectations.

- **The role of Service Manager shouldn't be limited to only after-sale services:**

Similarly, when we look at the places of Service Manager, we will see that he is only playing a significant role in 3 services belonging to the After-sale stage. Consider the potentiality of this role in encompassing both solution design and implementation of the automation solution, as well as ongoing and extraordinary maintenance; it is important to suggest that ESSEBI should extend the role of Service Manager throughout the entire sales cycle instead of limiting him in only 1 stage.

The Service Manager should be actively involved in the process by collaborating closely with both customers and technical teams, including the design and engineering departments. They assist the engineers in the implementation of the solution, ensuring that the customer's needs are met and that the solution is executed successfully. The Service Manager also plays a crucial role in ongoing maintenance, working to ensure the smooth operation of the automation solution over time. In some cases, the Service Manager can also explore new service offerings that can be provided to customers, such as maintenance upgrade packages which can bring a new revenue stream. Overall, the Service Manager is a vital member of the team, helping to bridge the gap between technical and customer-facing functions, and ensuring the successful implementation and ongoing maintenance of the automation solution.

4.4 Suggestions for services strategy and implementation for ESSEBI:

4.4.1 Redefine the service portfolio to fulfill the demand of customers

Redefining the service portfolio is crucial in order to fulfill the demand of customers and meet their evolving needs. It's also an important reflection of which type of service that can generate the most revenue for the company. Because of this, the whole process shouldn't be just 1 regular meeting and decided by the CEO but rather than multiple stakeholders who have customers related tasks. In fact, before jumping to discuss to the portfolio itself, the company need to put an effort in some pre-works in order to transform from the core values of the organization. Christian Kowalkowski and Wolfgang Ulaga (2017) even suggest a road map with 1f2 steps in defining the strategy and according to the authors, it takes 6 steps of prework including changing the culture, assessing the vision and leadership, assessing the workforce competences before the company can do their assessment in service types and service pricing.

Figure 27: Roadmap for Service strategy in action (Christian Kowalkowski and Wolfgang Ulaga, 2017)

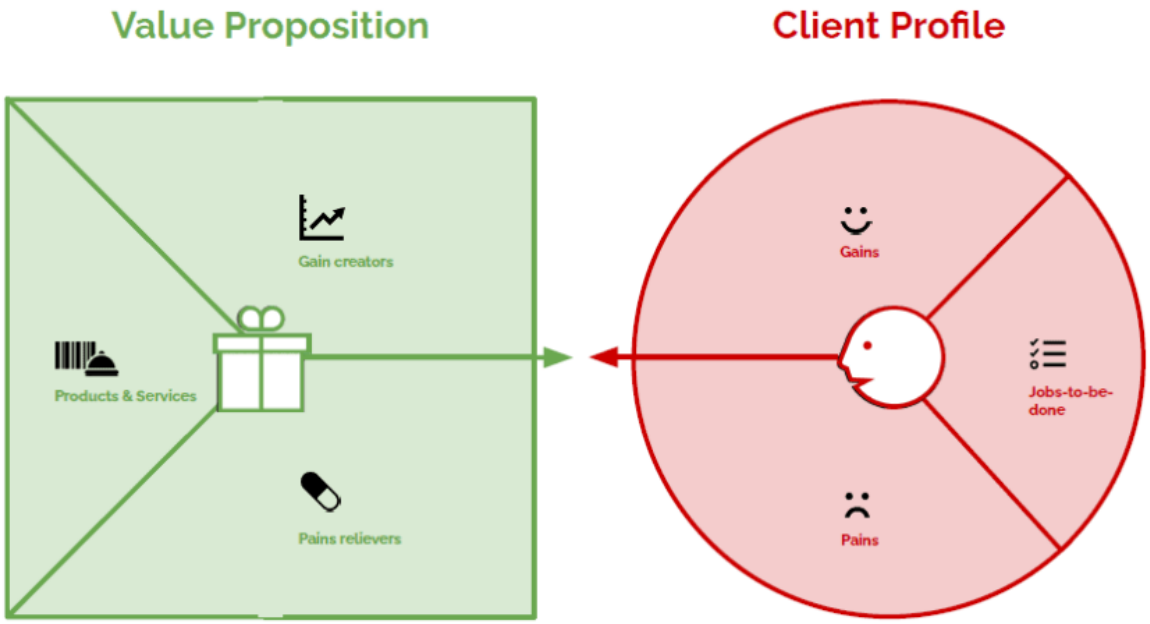
The Roadmap for Service Strategy in Action

As an SME, the approach for can be much more simplified instead of conducting 12-step service strategy. The important steps can be set as: assessing and planning.

The assessment of the current service portfolio and identify gaps between customer needs and service offerings can be analyzed as we did in 4.2 and 4.3 where we can identify the gaps as the summary above. ESSEBI should also consider customer feedback (by reviewing case by case), market trends and competitors' services in order to determine the best service portfolio strategy. For example, we know that service (4) and (6) were highly rated from customers and the CEO but service (1) and (8) are the misalignment between two stakeholders. So there should be a divestment or investment about these services after the revaluation. Furthermore, one potential question should be asked during the assessment is the type of payment. ESSEBI used to provide customers with 1-time payment including 8 services mentioned in their portfolio. However, there are obviously some services that have higher demand than the other. Thus, the company can also consider which one they should put in one time payment or which one in extra payment (basic package or premium package). Another model that businesses use to design and develop while assessing values with customer demands is Value Proposition Canvas (Alexander Osterwalder et al, 2014) which consists of two parts: the customer profile and the value map. The customer profile defines the target customer segments, their jobs, pains, and gains. The value map outlines the company's value proposition in terms of product or service features, customer benefits, and the value chain to deliver the value proposition. The value

proposition canvas helps companies to identify the unique selling points of their offerings, what makes them different and what they can offer that others cannot.

Figure 28: Value proposition canvas (Alexander Osterwalder et al, 2014)



In terms of the way to categorize their services in the planning phase, ESSBI can consider several approaches:

- Low-risk, low-cost services: ESSEBI can begin by offering basic services that are in high demand and have low complexity. These services will help establish a foundation for the service portfolio and provide a source of revenue to fund further growth. Service (8) can be an example because it's considered as optional values (not all machines need annually maintenance). However, as customers used to request it, they can split this service from the total package and provide it as extra cost for only complexed integration.
- A mix of product-related services and non-product related services. Product-related services could include maintenance and repair (service 6,7 and 8), while non-product related services could include training and consulting (service 1 and 3). As ESSEBI has good experience in working with SCHUNK and Staubli robots, they can offer training sessions (example: safety procedures) who don't use their automation solutions but current using the same robots with similar integration. We can look at the training service of ABB as a leading example.

In order to improve customer satisfaction and differentiate from competitors, ESSEBI could also offer value-added services such as predictive maintenance and back up programming (when the robot programming was lost or damaged).

In conclusion, redefining the service portfolio is an important step in fulfilling the demand of customers and ensuring customer satisfaction. No matter what activities the company would conduct for assessment/ planning phase or which types of service that ESSEBI choose to prioritize, the alignment should be met so that they can deliver a consistent value to the customers.

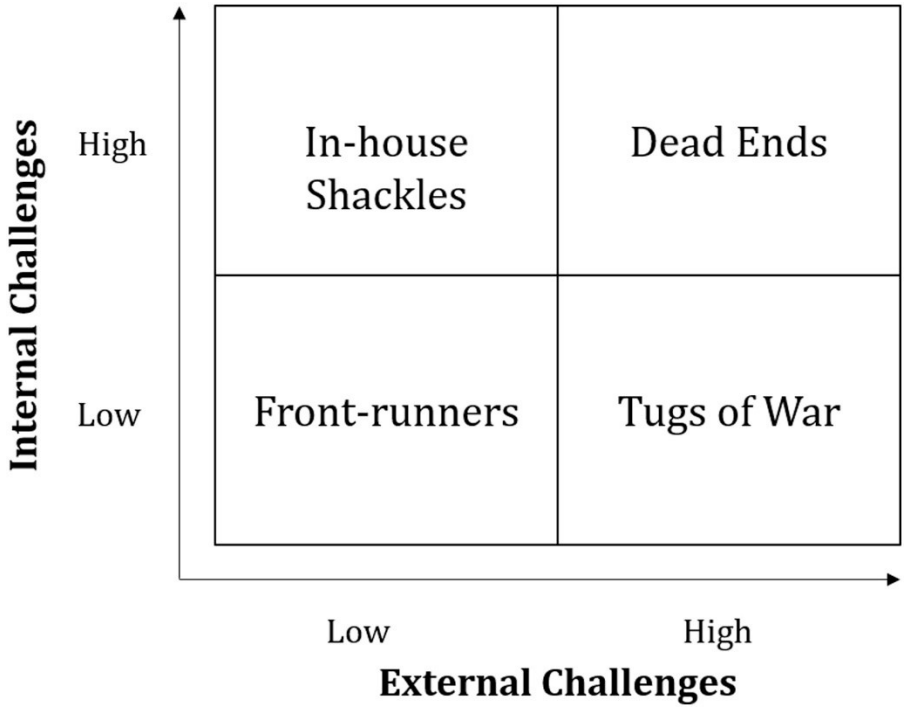
4.4.2 From free to fee (F2F) service, what can be done?

The issue of free services in industrial environments – and the associated drain on enterprises' profitability – is not new, but it has been seldom studied (Ulaga and Michel 2018, Witell and Lofgren 2013). There are no detailed estimates of how much profit industrial enterprises lose by giving free services, yet free services have grown in almost every B2B sector (Macdonald, Kleinaltenkamp, and Wilson 2016; Ulaga and Michel 2018; Witell and Lofgren 2013). As a small and medium-sized enterprise (SME), ESSEBI faces a common challenge in offering free data analysis to its customers while some companies like ABB offer the same service for a fee. For instance, ABB's Asset Optimization helps customers optimize the performance of their robots, components, and software by providing regular reports and proactive recommendations to prevent downtime and improve performance. This service is an optional add-on to ABB's Preventive Care or Express Care service agreements and is included in the ABB Extended Care service agreement. Although it may not be fair to compare ESSEBI with a company like ABB, as they have different motives, value propositions, and company competencies, it's not a sustainable business model for ESSEBI to continually offer this service for free without receiving any compensation. Hence, it's crucial for ESSEBI to educate their customers about the benefits of paying for their services, especially if they have been accustomed to receiving it for free.

The first step of transforming from free-to-fee service is to deeply assess what services that the company is providing for free and what are the challenges when they turn them into the fee version. According (Mustak et al., 2021), there are 2 types of free services that we need to distinguish: "seemingly free" services and "truly free" services. "Seemingly free" services are provided by the supplier to pursue a hidden goal, for example, to increase sales, to defend a higher price or to secure a larger share of wallet. In contrast, "truly free" services are provided without any expectation of monetary compensation or other forms of documented benefit in

return. When the authors exclude “seemingly free” services and engage internal/ external challenges to identify the route of transforming the F2F, there are 4 types of free industrial services available:

Figure 29: Typology of free industrial services (Mustak et al., 2021)



- Front-runners: These are free services that face relatively low internal and external challenges in transforming to fee-for-service. They are typically services that improve operational processes, reduce risks, and are customized to the customer's needs. They require little effort from sales personnel, are easy to identify and communicate the value to customers and face low resistance due to a lack of competition.
- Tugs of War: These are free services that face relatively low internal challenges but high external challenges in transforming to fee-for-service. These services are typically ad-hoc and independent of product-related sales transactions, and suppliers struggle to obtain information about the benefits and value created by these services. These services require a better alignment of organizational dimensions to address challenges that reside outside the firm's boundaries.
- In-house Schackles: These are the services that could potentially be charged for, but face internal barriers within the supplier organization, such as resistance from established product sales personnel, a goods-centric mindset, and outdated internal systems. These services are often tied to the supplier's installed base, such as training

and education programs, and face challenges related to the incentive structure and mindset within the organization.

- Dead Ends: These services face both internal and external challenges to being transformed into paid services. These services have the lowest potential for successful transformation and face a high degree of hurdles, including the difficulty of putting a price tag on standard after-sales support services provided by the customer service center. The article argues that transforming these services into paid services will be considered impractical by both internal personnel and customers.

If we look at the description of each free service above, we can see that providing data for process improvement falls into the easiest type “front runner” when it has low challenge both from internal and externally. Therefore, the possible ways to upgrade this service to the fee version for customers:

- Build a case study portfolio:

  Building a case study portfolio involves showcasing real-life examples of how the data report has helped customers achieve process improvement and achieve their desired outcomes. This can be achieved by conducting detailed analyses of customer processes, collecting data and feedback from customers, and presenting the results in a compelling and easy-to-understand format. For example, ABB stated that their Asset Optimization service involving regularly assessing a robot's overall health and performance can result in a reduction of up to 25% in incidents and a 60% faster resolution time for any issues that arise. By providing quantitative and qualitative evidence from the existing customers of ESSEBI, the organization can demonstrate the value of the service to potential customers and help them understand why it is worth paying for.

- Split the data into basic insights and in-depth insights:

  The idea of splitting the data into basic and in-depth insights is a way to monetize the data analysis service by offering customers different levels of information at different price points. The basic insights would be provided for free and would give customers an overview of key performance indicators such as downtime or energy consumption. These basic insights would be enough to give customers a general understanding of their performance, but not enough to make informed decisions about process improvement.

  The in-depth insights, on the other hand, would provide more details and comparisons, such as downtime compared to other companies (as ESSEBI work with various

customers in the same or different industry) and have a or energy consumption broken down by each month. These in-depth insights would be more valuable to customers as they would provide more outlook that would enable customers to make informed decisions about process improvement. By offering these premium insights for a fee, the organization would be able to generate revenue from its data analysis service, while also providing customers with the information they need to make better business decisions.

- Pay per KPI:

  With a similar approach compared to the basic insights and in-depth insights discuss above, model, companies are charged only for the KPIs they are interested in tracking and measuring. This approach is beneficial because not all companies may have the same priorities or focus on the same parameters during their decision-making process. Some of the commonly used KPIs in a robotic system include:

- Downtime: It refers to the amount of time the system is not operational.
- Production rate: The number of units produced per unit of time.
- Quality rate: The percentage of units produced that meet the quality specifications.
- Equipment utilization: The percentage of time the equipment is in use.
- Maintenance frequency: The frequency of maintenance activities needed to keep the system operational.
- Maintenance cost: The cost of maintenance activities, including labor and materials.
- Mean Time Between Failures (MTBF): The average amount of time between system failures.
- Mean Time To Repair (MTTR): The average amount of time necessary to repair a system after a breakdown.
- Energy consumption: The amount of energy used by the system.
- Error rate: The rate at which errors occur in the system.
- Lead time: The time taken to produce a unit from the time the order is received.

By offering a flexible pricing model that allows customers to choose the KPIs that are most relevant to their needs, the data analysis service can cater to the specific requirements of each customer and provide more value for their investment.

- Our new partner is not working for free:

This approached was applied by Soundless Ltd. which is a small automotive supplier that provides soundproofing solutions for vehicles (Witell & Löfgren, 2013). Previously, the

company participated in development projects with OEMs for free and only received payment upon receiving an order. Due to increased resources spent on development projects, the company realized it was giving away its expertise for free and decided to change its business model. To achieve this, Soundless Ltd. partnered with a consultancy firm to extend the value proposition of their service, which helped the company transition from offering their services for free to charging a fee.

The case of Soundless Ltd. demonstrates the potential for a company to transition from offering free services to a fee-based model by partnering with a consultancy firm with greater technical resources and expertise. This approach could be applied to ESSEBI, especially when one of the challenges in SME is to translate data sources into meaningful insights (section 1.2.3.5). By partnering with a company specializing in IoT / AI and data analysis (for example: Field Service Industry Optimization Solutions | PTC), ESSEBI could enhance the value of its data reports by the partner's wealth of expertise in data collection, analysis and presentation. Highlighting the added value brought by the partner, ESSEBI could convince its customers to pay for a more in-depth analysis of the data and real-time monitoring of their operations. This would result in a more sustainable business model for ESSEBI, as it would no longer be giving away its valuable services for free.

In summary, the provision of free services in industrial environments is a common challenge faced by small and medium-sized enterprises (SMEs), which results in a drain on their profitability. There is no clear estimate of the impact, but free services have become widespread in almost every B2B sector. ESSEBI faces a challenge of offering free data analysis services to its customers, while some companies like ABB offer the same service for a fee. A study by Wolfgang Ulaga et al (2021) categorizes free industrial services into 4 types: front-runners, tugs of war, in-house shackles, and dead ends. Data analysis services fall into the "front-runner" category and can be upgraded to a fee-based service by building a case study portfolio, splitting the data into basic and in-depth insights, and offering a premium service.

Conclusion

In conclusion, Industry 4.0 (I4.0) is a significant revolution in the manufacturing sector fueled by technological advances such as robots, automation, and system integration. Integration of robotics and automation systems is essential for I4.0 deployment success. The worldwide robotics and automation solutions market is optimistic, and Italian SMEs have the ability to implement I4.0. There are still obstacles to face throughout the adoption procedure.

The case of ESSEBI Automation highlights their successful adoption of I4.0 through their involvement in the questionnaire. ESSEBI's solutions have both benefits and challenges, and the most requested solutions are automation systems and automation plug-ins. The company's solutions help customers reduce production costs, improve productivity, and customer service, increase customer product rate, and reorganize activities. ESSEBI is positively impacting its customers through their solutions but demonstrating the effects may be difficult.

ESSEBI's implementation of industrial automation solutions through the incorporation of Industry 4.0 presents both benefits and obstacles. Automation systems and plug-ins, which complement the company's in-house component manufacture, are the most desired solutions. Operations, and new product development divisions use the company's solutions. ESSEBI addresses business models, value chains and processes, IT architecture, organization and culture to help industrial customers adopt I4.0. Customers benefit from I4.0 solutions by lowering production costs, enhancing productivity, customer service, product rate, and reorganization. ESSEBI's solutions positively benefit clients, however documenting these effects through its portfolio may be difficult.

The ESSEBI questionnaire shows that the company realizes the value of data consumption and analysis in their business model but is only somewhat mature in using data. The CEO also stated that ESSEBI does not collaborate with partners to get customer insights, rather they analyze client data to provide customized offers. The company uses numerous integrated sales channels, and moderately collaborates with partners on product and service development. Customer-tailored pricing is relatively dynamic. According to the PWC maturity model, ESSEBI is a vertical integrator in digitization, but they need to improve to boost customers digital transformation maturity.

In conclusion, service management is important to ESSEBI Automation's robotic system integrator success. The company provides bespoke services from pre-sale design and prototype to post-sale testing, on-site assistance, and maintenance. Service delivery is managed by the Service Managers and involves numerous departments and managing Staff. According to the

CEO's questionnaire, clients value services that meet their unique needs, and most of potential in services will be post-sale. The CEO evaluated internal stakeholders' impression of service management highly, reflecting a significant focus on quality solution delivery services.

The ESSEBI services survey shows that the company's priorities and customer needs are both aligned and misaligned. As revenue drivers, Sale and After-sale services should be the company's priority. As seen by the CEO's priority and customer demand, the company's emphasis and customers' values are not aligned. To remedy this, the company should re-evaluate its service process, including pre-sale, during-sale, and after-sale stages, to progressively address most important services for resource allocation and consumer demand. Engineers, designers, and service managers are crucial to most services, thus the organization must examine their position in this re-evaluation. This will assist the organization satisfy client demand and maximize ROI in the future.

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Appendix: Questionnaire to the CEO of ESSEBI (2021)

I, Company portfolio offering

The objective of this part is to take a picture of Essebi Automation system integration offering in I4.0: types of implemented automation solutions supported by robotics and all other plug-ins (for objects detection, moulding, gripping / handling, welding accessories), as well as challenges or opportunities in implementing?

1, Where do you implement your automation solutions, in terms of Customers Departments? (Multiple selection)

- ☐ Spare parts/ post sales
- ☐ Marketing/ Sales
- ☐ Logistic and Supply Chain Management
- ☐ Operations
- ☐ Prototyping
- ☐ New Product Development (R&D)

2, What are the most requested robotics / industrial automation solutions? (Multiple selection)

- ☐ Anthropomorphic robots (arms)
- ☐ **Automation solutions (tapes, sledges…)**
- ☐ **Automation plug-ins: objects detection, molding, gripping / handling, welding accessories…**
- ☐ Cobots
- ☐ Others: please specify

  ……

3, In what aspects is your company driving industrial customers towards the adoption of Industry 4.0?

- ☐ Business Models, Product & Service Portfolio
- ☐ Market & Customer Access
- ☐ Value Chains & Processes
- ☐ IT Architecture
- ☐ Compliance, Legal, Risk, Security & Tax
- ☐ Organization & Culture

4, How does your **customer** take advantage of I4.0 solutions? (Multiple selection)

- ☐ Production cost reduction/ internal efficiency
- ☐ Increase in productivity (final quantity is the same, but manufacturing process is improving)
- ☐ Better customer service
- ☐ General increase in turnover
- ☐ Product diversification
- ☐ Entrance in new markets
- ☐ Maintenance in international competitiveness
- ☐ Increase in customer product – rate
- ☐ Environmental sustainability
- ☐ Re-organization activities **Italy (90%)**/ abroad (10%)
- ☐ Others (please specify):

  ……

5, What are the main problems you encounter in your system integration activities, while implementing I4.0 automated solutions supported by robotics?

- ☐ Difficulties in finding qualified professionals, to work on the field (the main problem)
- ☐ Lack of broadband
- ☐ Limited availability for financial resources
- ☐ Implementation timing
- ☐ Lack of internal competencies
- ☐ General IT maturity
- ☐ Business processes maturity
- ☐ Difficulty in identifying the right partner/supplier
- ☐ Others (please specify): Some places don't have the good Internet connection.

Industry 4.0 readiness:

This questionnaire has been adopted from the following the PWC model in measuring I.40 maturity with the following sources: https://i40-self-assessment.pwc.de/i40/landing/

Actual: Please specify here how you would rate the current state of your company based on the annotations of maximum and minimum score on the right-hand side.

Target: Please specify here how you would rate the target state your company aims to achieve within the next 5 years based on the annotations of maximum and minimum score on the right-hand side.

Rating level is from 1 to 5 in which 1 is representing the least advanced maturity level (lowest) and 5 is representing the most advanced maturity level (highest)

Data integration:

	Reality	Target
1, How important is the **usage and analysis of data** (customer data, product or machine generated data) for your business model? Example: 1: Insignificant - No data analytics are leveraged in the business model 5: Crucial - Data is the main value driver of the business model (e.g. data on machine capacity utilization is used to determine the amount of fees)	3 (Some customers are not ready to compare data from machines)	5
2, To which extent do you analyze customer data to increase customer insight (e. g. personalized offers to customers based on their personal situation, preferences, location, credit score; consideration of usage data for design & engineering etc.)? Example: 1: Trivial data usage - Information is kept decentralized and in an unsystematic way by single units and is not analyzed further (e.g. sales orders in excel sheets) 5: Substantial data usage - Extensive data collection at all touch points that is fed into integrated systems to monitor,	Sometimes, the customers want total price. Sometimes, the customers want detailed price list. 2	3 (Expensive to put details in single supplements – machine is too complicated)

review and optimize products, sales and customer experience		

Partner collaboration:

	Reality	Target
3, How intense is your collaboration with partners, suppliers and clients for development of products and services? 1: No Collaboration - Product development is done completely in-house without any exchange of information with partners, suppliers or customers 5: Intense collaboration - Collaborative development of products together with partners is institutionalized in value networks that are transparent for the customers	If the customers want complete integration → 5. Customers who are not interested in complete integration, maybe 2-3. It depends on the demand of customers in the investment, IT architecture.	5
4, How far do you collaborate with partners regarding your approach of accessing customers (exchange of customer insights, coordination of marketing activities etc.)? 1: Not at all - No collaboration with partners in approaching customers (e.g. separate customer databases and no coordination of marketing or sales activities) 5: Unified approach – Customer access approach is completely backed up along with the partner network (e.g. common customer ID with partners and use of partner data)	3 It is not interesting to collaborate with the suppliers.	3

Digital orientation:

	Reality	Target
5, How would you rate the **digital orientation** of your vertical value chain (from product development to production)? Example: 1: No digital orientation at all - No automated exchange of information along the vertical value chain (e.g. manual machine programming based on paper plans) 5: Complete digital orientation – Continuous data flow along the vertical value chain (e.g. direct controlling of machines via CAD models, integration of ERP and MES)	2 (CAD models but not with the automation)	4
6, How advanced is the digital orientation of your **production equipment** (sensors, IoT connection; digital monitoring, control, optimization & automation)? 1: Purely physical factory – Production equipment is entirely cut off from IT systems and no real-time information can be gathered 5: Fully digitized factory – Interconnected production equipment allows for IT-access and information is fed into a virtual representation of the factory	2 Tailored made machine, it's not easy to make it automated	4
7, How would you rate the digital orientation of your horizontal value chain (from customer order over supplier, production and logistic to service)? Example:	2	4

1: No digitization at all – No automated exchange of information along the horizontal value chain (e.g. no connection to supplier's IT) 5: Complete digitization – Continuous data flow along the horizontal value chain (e.g. integration of logistic service providers into internal IT)		

Sale and pricing:

	Reality	Target
8, To which extent do you use multiple integrated sales channels to sell your products to your customers? Example: 1: One channel - Traditional sales force approach (e.g. local sales force) 5: Multi/ Omni-Channel – Integration of various digital and non-digital sales channels (e.g. store, sales force, web-shop, sales platforms etc.)	3 (Depends on the closure of customers, because of the characteristic of special machine. Customer needs collection are in present)	4
9, How dynamic and customer-tailored is your pricing system (consideration of customer's "willingness to pay")? Example: 1: Fixed pricing - Prices for all products and services are fixed (e.g. price catalogues based on traditional market research) 5: Dynamic pricing - Automated systems calculate prices, discounts etc. dynamically in real-time (e.g. individual prices based on customer potential, history, relevance of order etc.)	5	5

II: The role of service management in ESSEBI Automation:

This part will explore in detail the specific activities of service that ESSEBI Automation is implementing as well as the role of "Service Manager" in the context of controlling services in ESSEBI.

Questions:

1, What are the **items in Essebi automation's service portfolio**?

- ☐ Pre-sale: Designing the solution in parallel with customer's demand.
- ☐ Pre-sale: Prototyping.
- ☐ During Sale: Design the machine: mechanical and electrical and software design
- ☐ During-Sale: Running internal workshop.
- ☐ During-Sale: Implementing mechanical and electrical assembly.
- ☐ Post-sale: Onsite – testing, disassembly, re-assembly and startup of automation solutions for customers in Italy and abroad.
- ☐ Post-sale: On-site and remote assistance service.
- ☐ Post-sale: Maintenance service
- ☐ Others: (please specify)

Reference: http://www.essebiautomation.it/en/service/

2, Which are the **roles involved in the service offering** process?

- ☐ CEO
- ☐ Service manager
- ☐ Designer
- ☐ Engineer
- ☐ Sale and marketing executive
- ☐ Accountant
- ☐ Others: (Please specify)

3, Please match the most important person in charge in each process:

	CEO	Service Manager	Designer	Engineer	Sale and marketing executive	Accountant

Example: Customer engagement					X	
Pre-sale: Designing the solution in parallel with customer's demand.	X		X			
Pre-sale: Prototyping.			X	X		
During-Sale: Running internal workshop.	X				X	
During Sale: Design the machine: mechanical and electrical and software design			X			
During-Sale: Implementing mechanical and electrical assembly.			X	X		
Post-sale: Onsite – testing, disassembly, re-assembly and startup of automation solutions for customers in Italy and abroad.		X		X		
Post-sale: On-site and remote assistance service.		X		X		
Post-sale: Maintenance service//		X		X		
Others: (please specify)						

4, Are your portfolio services standardized or customized on customer's request?

☐ Standardized service offers. Example: All customers have the same number of times for technical check per year, receive the same assistance remotely, receive the same warranty time

☐ Customized service offers: Offered services were designed based on customer's need and extra services (which are not in the list) can be added on demand

5, What are the most important services to ESSEBI in terms of resources spending, cost structure and revenue gain? Please rank these services from 1 to 5 with 1 is the least important and 5 is the most important.

Important level can be depended on how many people that company needs to focus on each step, how much money which was spent to ensure this service and whether this kind of service can bring a high revenue to the company.

	1 (Least important)	2 (Little important)	3 (Neutral)	4 (Important)	5 (Very Important)
Pre-sale: Designing the solution in parallel with customer's demand. //		X Don't spend many time to design the machine			
Pre-sale: Prototyping.			X		
During-Sale: Running internal workshop.			X		
During Sale: Design the machine: mechanical and electrical and software design					X
During-Sale: Implementing					X

mechanical and electrical assembly.					
Post-sale: Onsite – testing, disassembly, re-assembly and startup of automation solutions for customers in Italy and abroad.					X
Post-sale: On-site and remote assistance service. .				X	
Post-sale: Maintenance service			X		
Others: (please specify) //					

6, Please rate internal stakeholders' perception of service management:

- ☐ 1: The team knows company service portfolio offering and what kinds of service the company is focusing on
- ☐ 2: The team has a service management strategy to apply while approaching / working with customers
- ☐ 3: The team has service management strategy to apply while approaching / working with customers **intensively**
- ☐ 4: The team **suggest continuous improvement with customer' decision makers to achieve satisfaction through services**

7, What services that you think are frequently requested/ appreciated from customers? **(Please pick only 4 most important factors)**.

- ☐ Pre-sale: Designing the solution in parallel with customer's demand
- ☐ Pre-sale: Prototyping.
- ☐ During-Sale: Running internal workshop.
- ☐ During Sale: Design the machine: mechanical and electrical and software design
- ☐ During-Sale: Implementing mechanical and electrical assembly.

- ☐ Post-sale: Onsite – testing, disassembly, re-assembly and startup of automation solutions for customers in Italy and abroad.
- ☐ Post-sale: On-site and remote assistance service.
- ☐ Post-sale: Maintenance service
- ☐ Others: (please specify)

8, What benefits do you think customers can receive, when using these services from ESSEBI?

- ☐ Increase productivity
- ☐ Increase revenue
- ☐ Have ability to enter to new markets
- ☐ Increase competitive advantages against competitors
- ☐ Having new customers
- ☐ Others (please specify)

9, What benefits that ESSEBI receive when adding these services to the customers?

- ☐ Increase productivity– some customers ask us more than 1 machine by time
- ☐ Increase revenue
- ☐ Have ability to enter to new markets
- ☐ Increase competitive advantages against competitors
- ☐ Having new customers
- ☐ Others (please specify)

10, Does the company have strategic **review** about current services offered? If yes, how frequent is this review?

- ☐ Yes, monthly
- ☐ Yes, quarterly
- ☐ Yes, annually (our process is time consuming for development)
- ☐ No review
- ☐ Others: please specify

11, Who are the stakeholders involved in the **review process** of company service offering strategy:

- ☐ CEO
- ☐ Service manager
- ☐ Designer
- ☐ Engineer
- ☐ Sale and marketing executive
- ☐ Accountant
- ☐ Others: (Please specify)

12, If the company conduct strategic review process mentioned in question 10, does the company have follow up KPI and Actions after that?

- ☐ Yes
- ☐ No

13, If the answer is “Yes” in question 12, are the new KPI and Actions communicated through all of the company?

- ☐ Yes
- ☐ No
- ☐ Others: please specify