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THE ROLE OF TECHNOLOGY IN AN ERA OF DEMOGRAPHIC TRANSITION

The Case of the "Sagami Robotics Special District" in Kanagawa Prefecture, Japan

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A mia zia Emilia,

che purtroppo non ha avuto la (s)fortuna di invecchiare.

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ABSTRACT

"Demographic change" poses some of the most puzzling challenges that the world needs to face in the XXI century. The global ranking shows that Japan figures as the top ageing country, and together with Italy, which comes second, is pioneering a significant demographic shift that will eventually occur in most countries with "matured economies". It is of uttermost importance to discuss how such fundamental economic and social changes are being dealt with. The present research is pivoted by the belief that the role played by technology nowadays makes it a powerful tool to ensure employment, health care, infrastructures, social protection and integration to all ages. However, as technology alone would not suffice, all social actors, from institutions to entrepreneurs to consumers, are called into question. In this regard, the "Sagami Robotics Special District" in Japan provides a brilliant example of public entrepreneurship in the attempt to foster the development of robotic technologies designed to assist an ageing population. Being fully supported by the central Government and coordinated by Kanagawa Prefecture, it will be explored as a baseline of analysis that may yield some important considerations for the Italian context as well.

I. INTRODUCTION

1.1 Background and context

1.1.1 An ageing world

The world is growing old. The topics of "population ageing" and "demographic crisis" are constantly hitting the headlines in most Western countries. But what exactly is *population ageing* and why would it eventually cause a *crisis*? The definition provided by the United Nations (UN, 2015) indicates "population ageing" as the "increasing share of older persons in the population". Data leaves little room for imagination. The US Census Bureau (He, Goodkind & Kowal, 2015) warns that between 2012 and 2050 the world will witness a considerable increase in people aged 65 and over, from 562 million people to 1.6 billion. Indeed, while the total figure will not change significantly, the share of the population represented by the elderly cohort will rise from 8% to 16.7%.

However, such data is rather generalised, and the phenomenon is not occurring on the same scale everywhere. Indeed, besides the general trend, substantial differences emerge across regions, mainly due to different degrees of economic and industrial development[1]. Among the demographic patterns represented in *Figure 1*, Europe, North America, Oceania and Japan, constitute the areas that are well further along in the demographic transition. A decreased fertility and an increased longevity are the primary reasons: women are giving birth to fewer babies, whilst people can now live longer lives than in previous times thanks to the progress in medicine and technology, raising the median age. As a result, the elderly population of the so-called 'matured economies' has already exceeded at least 14% of the total (and is expected to do so in the next three decades).

[1] According to the Demographic Transition Model (DTM), a country's population cycles through five stages as the economic profile of the country progresses over time. Within the model, birth rates and death rates are both high in stage 1, both low in stage 5, indicating that the life expectancy increases and fewer children are being born as the economic stability of the country becomes stronger (Grover, 2014).

On the other hand, Asia and South America are still at an early stage in the 'ageing process' but, given the size of their populations, will produce an incredibly high number of senior citizens in the upcoming years. It is estimated that China alone will account for around 350 million people aged over 65 by 2030, more than the whole populations of Japan and Egypt together. Lastly, unlike all other regions, Africa is the only area that can still rely on a relevant young cohort and is expected to do so for the foreseeable future.

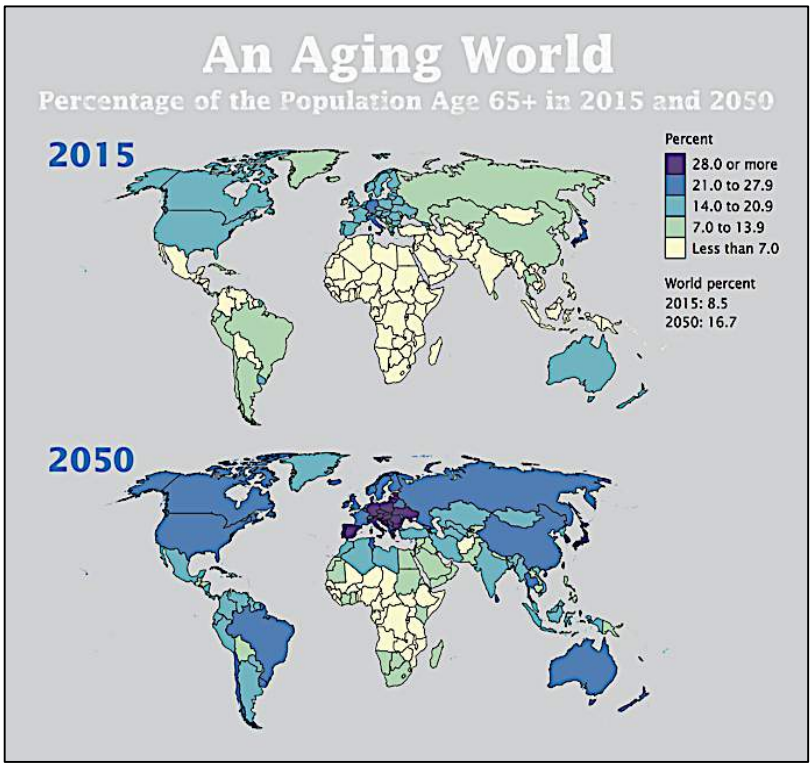

Figure 1: The world's population in 2015 and in 2050

(Source: US Census Bureau)

"Population ageing" poses some of the most puzzling questions that the country needs to face in the XXI century. What kind of issues does an increasingly elderly society bring up? What are the solutions? Unfortunately, the answer to these questions is not straightforward. One of the biggest problems is that the full effects and implications of "population ageing" are still relatively unknown and it is impossible to predict and quantify them exactly (Bloom, 2011). What is certain is that we will witness, and to some extent are already witnessing, a significant change in almost any aspects of society, from the family structure to the labour market, to the demand for different goods and services, to mention but a few examples.

It is therefore essential to formulate a strategy to respond to such fundamental economic and social changes. As the population ages, innovative policies and adequate services targeted specifically to older individuals are necessary in order to ensure a sustainable development at all levels of society. Ensuring employment, healthcare, housing, infrastructure, social protection and integration to all ages is key to achieving a comprehensive and diffused social well-being, accessible to everyone.

1.1.2 Italy & Japan: ground for comparison

It is clear that population ageing is affecting most countries worldwide. If we dig further into the data of the single countries, Japan figures as the top ageing country in the world, followed by Italy, which comes second in the global ranking *(Table 1)*. Japan's hectic pace of ageing is not comparable to any of its European counterparts. Walter Ruffinoni, CEO of NTT Data Italy, has highlighted that, even though they are the top two countries, Japan is actually twenty years ahead of Italy in the ageing process (conference held at the Italian Innovation Day in Tokyo on 30th May 2018).

COUNTRIES WITH THE HIGHEST SHARES OF 65+ POPULATION IN 2015	
Japan	27%
Italy	23%
Finland	21%
Germany	21%
Portugal	21%
Bulgaria	20%
Greece	20%
Latvia	20%
Sweden	20%

Table 1: The "oldest" countries in the world.
(Source: The World Bank)

In 2017, the National Institute of Population and Social Security Research of Japan has announced that the cohort aged 65 and over is predicted to account for 38.4% of the total by 2065 (Otake, 2017). Meanwhile, people aged over 65 represented the 23% of the Italian population in 2015, a percentage that is predicted to rise steadily in the upcoming years reaching the 34% by 2045 (ISTAT, 2017).

Given the size and the impact of the ageing phenomenon in Japan, it is wise to start discussing the demographic issue by looking at it as the forerunner in the ageing process. Japan is certainly a pioneer in the debate and has been dealing with demographic-related problems, such as economic and social shifts, for over a decade now. It can undoubtedly serve as a useful baseline of analysis, as it may yield important implications for all the so-called 'developed economies' in the world, which are experiencing similar demographic patterns, first and foremost Italy.

Indeed, similar demographic patterns do translate into common challenges. The financial and social burden imposed by the ageing and shrinking population of Italy and Japan is significant. An increasingly smaller workforce will have to sustain and provide for an increasingly bigger cohort of elderly people, who mostly belong to the "baby boom" generation, namely the large cohort of children born after the World War II. This leads to a double consideration.

On one hand, the pension system is experiencing an unprecedented crisis, as it difficultly keeps the pace with the size of retirees. On top of everything, the retirement period becomes particularly long in countries that have some of the highest life-expectancy rates in the world, with Japan ranking first with a total life expectancy average of 84.2, as well as the highest number of centenaries in the world (WHO data, 2016). McCurry (2008) highlights that Japan has a concentration of centenaries at 28 for every 100,000 people (with a peak of 61 in Okinawa Prefecture), compared to 10 every 100,000 in the US.

On the other hand, the significant number of baby boomers growing old requires a huge investment of resources in terms of money and people in the provision of constant and adequate assistance and treatment. Japan public spending on Long-Term Care (LTC), registered at 1.2% of GDP in 2010, is predicted to reach even the 4.4% of GDP in 2050, according to the 2011 OECD

projection. LTC workers[2] have more than doubled since 2001 but they are still fewer than most OECD countries, shedding light on an alarming shortage.

1.1.3 Different roads to a shared future

When a country is gripped by demographic ageing and shrinking, it finds itself at a crossroads. Either it tries to stop the trend, or it makes effort in the opposite direction, by adapting to the new environment and identifying the elements that may ultimately yield positive change. Given that human beings are naturally driven towards maintaining the *status quo* and instinctively fear change, governments tend to choose the first option, as was the case of Japan and Italy when they were pressed by such choice in the first stance. The different policies that they have pursued so far can be grouped according to their scope.

Primarily, initiatives have been taken in the hope to (1) increase the birth rate, appealing to families and encouraging more births. In Italy, the Government launched the "Fertility Day" on September 22 in 2016 in the hope to encourage childbearing. However, the campaign was perceived negatively by the public opinion because of its blunt marketing means, while the journalist Roberto Saviano pointed at the official slogans as "sexist, ageist, and anachronistic"[3]. As a result, the campaign sparked an outcry in the country because lacking sensitivity on such a delicate theme and did not sort any effect on fertility rates. Similar efforts are being made by Japan too: the "Abenomics" policies have set very ambitious goals on raising birth rates but no significant change has been recorded yet. Indeed, it is somewhat utopic to trust that such policies would be able to reach the desired outcome, as they do not address the real reasons behind low fertility rates (often related to an adverse labour market or poor employment conditions). Furthermore, natural demographic trends are unlikely reversible, or at least possibly changeable in the very long term.

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[2] Long-term care workers are defined as "paid staff, typically nurses and personal carers, providing care and/or assistance to people limited in their daily activities at home or in institutions, excluding hospitals" (OECD, 2017).

[3] The slogan in question claims "Beauty has no age... Fertility does."

Secondly, the willingness to (2) raise labour participation rates has led to fierce debates on the possibility of increasing the eligibility age for retirement, which is under constant review both in Italy and in Japan. Similar policies may bring the troubled pension system some relief in the short term but represent just a temporary solution to the problem, let alone that they are often a matter of controversy in the public opinion. In the hope to enlarge its workforce, Japan is also moving to increase female and foreign workers, but the results achieved are still disappointing, hence not relevant enough to make a change on the macro level.

Notwithstanding, the agendas of the two countries, albeit similar at a first glance, do actually have substantial differences. Whilst Italy seems sluggish in creating innovative ways for tackling its demographic woes, Japan is making efforts to transform the change that is occurring in society into the trigger that may unravel new opportunities. In this regard, it is possible to identify three main initiatives, yet still in the very early stages: (1) the rise of the "silver market", (2) the active engagement of senior citizens in society, and (3) the development of the robotics industry.

1. The rise of the "silver market"

Japanese firms have soon realised that an ageing population translates in ageing consumers. Many companies have succeeded in benefitting from the changing marketplace, rather than succumbing to it, by seizing new business opportunities in the attractive market constituted by the over 65. In some cases, they have targeted elderly consumers with new products and services; in some others, they have re-adapted existing ones to the current needs and requests.

An example is provided by Fujitsu and NTT Docomo Inc., respectively an IT company and a mobile phone operator, who jointly launched the first "Raku-Raku phone" in 2001, an "elderly-friendly" phone designed for senior people who usually have limited visual or auditory ability. Newer models of the phone, as well as a "Raku-Raku notebook PC", have been released each year since then. The interface of the waterproof and dustproof devices is much more intuitive than the "standard" versions: the keyboard buttons and the text size are enlarged for better viewing, while the caller's voice is easier to hear. Other special features span from a smile detector built-in camera (that trips the shutter automatically

when it detects that the subjects are smiling) to a one-touch access button for the Internet browsing.

Fujitsu and NTT Docomo Inc. demonstrated to be able to deploy *dynamic capabilities* – as "the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" (Teece, Pisano & Shuen, 1997) – to achieve a superior business performance. Teece emphasises dynamic capabilities as what allows firms to gain a competitive advantage over time in an ever-changing market (2009, 2014) and formulates the "sensing-seizing-transforming" framework (2007).

In other words, dynamic capabilities are the firms' the ability to *sense* opportunities, *seize* them, and *reconfigure* resources (according to environmental changes) to maintain the competitive advantage. In producing the "Raku-Raku Phone", Fujitsu and NTT Docomo Inc. have managed to: (1) *sense* the market opportunity offered by a large cohort of senior users in need for more intuitive devices; (2) *seize* such opportunity by launching a phone with many special features, designed exactly to tackle the specific needs of changing customers; (3) *transform* the initial product by constantly releasing updated and better versions, accordingly to the market's direction and changes.

In Italy, companies systematically engaged in the "silver market" occupy a very marginal position: most products targeted at senior consumers are imported from abroad.

2. The active engagement of senior citizens in society

As Japan is gripped by a decreasing productive population and an increasing senior cohort, it is noteworthy that there are attempts to solve the problem by reversing the mainstream mentality, whereby the young generation has to support the elderly one. *Kato Sangyo Co.*, a small Japanese manufacturing firm located in Gifu Prefecture, has managed to do this through the diversification of its workforce, and demonstrated that senior citizens, especially in societies with long life expectations, can (and want to) still actively contribute to the workforce.

When the firm was pressured by financial hardship, it adopted a reverse strategy designed to increase profits through the increment of internal operations, rather than cutting costs with lay-off policies. When a survey revealed that a significant percentage of

over 65s was still willing to participate in the workforce, but with a rare chance of employment, *Kato Sangyo* kicked off the "Weekend Operated by Elderly" (WOE) programme by hiring employees, aged between 60 and 79 years, to work on Saturdays and Sundays. The WOE model differs from other senior employment cases as it does not regard senior people as a cheap and simple workforce. Since the new employees were given significant responsibilities and the same tasks as their younger colleagues, they became strongly involved and motivated from the beginning, and became the vital players for the success and competitive advantage of the company (Kato et al., 2010).

As a result, the company increased its sales by 30%, being able to respond to the customers' needs almost 365 days a year. It gained an excellent reputation in the local community as well as across the country for representing a firm model that is simultaneously profitable for the company and sustainable for the society from a CSR (Corporate Social Responsibility) point of view. It is no doubt true that a similar initiative can bring several benefits, from an increase in the national productivity to a decrease in the overall burden on the pension system.

Although some big Italian companies offer flexible working hours for those aged 55+ to encourage people to work longer, the only efforts in this direction are aimed at making the elderly work longer (by raising the retirement age), rather than creating an environment that makes them willing to work longer.

3. The development of the robotics industry

As already mentioned, the provision of elderly care is one of the greatest challenges of the century for ageing societies worldwide. Data shows that the number of employees in the elderly care sector is not likely to keep the pace with the increase in the population aged over 65 years. Italy, who can rely on a massive immigration of foreigners employed in the sector, is actually coping with staggering figures of illegal workers (especially from Eastern Europe) who stay in the country without a regular residence permit and thus contribute to expanding the size of black labour.

In the case of Japan, the shortage of LTC workers is not even partially filled by foreign workers. It is widely known that Japan has historically registered scarce immigration

figures, with foreigners as low as 2.8% of the population (against 9.2% in Italy). Therefore, it is moving towards innovative solutions in the attempt to cope with the alarming shortage in the supply of caregivers. Foster (2018) reports that the Japanese government has been funding elder care robots to compensate a projected shortfall of 380,000 specialised workers by 2025.

Historically regarded as one of the most robot-friendly countries in the world, it has become a global hub for robotics technologies, pioneering the development of robots for elderly care purposes since the late 1990s (Ogawa, 2005). Along with the lack of caregivers, the need to allow the elderly more autonomy and independence in any aspect of everyday life, including the accomplishment of the easiest tasks, is driving Japan towards the development of the robotics industry.

1.2 Research focus and justification of topic choice

Among the three measures described in the previous paragraph, the research will focus on the latest, namely the development of the robotics industry in Japan. In particular, special attention will be drawn on the rise and evolution of the Sagami Robotics Special District in Kanagawa Prefecture, which is a crucial cluster, if not the hub, of the robotics industry in the country. The topic will be dealt with from an institutional and social viewpoint.

The interest in this perspective has risen from the desire to understand the role played by each social actor (institutions, firms, consumers, etc.) in the formation of robotics clusters, precisely the Sagami District, whose evolution is still ongoing, hence relatively unexplored and in call for further research. It is widely acknowledged that the development of robotics technologies implies multifaceted considerations that may affect the country on different levels, spanning from the mere economic sphere to more intricate social implications. Thus, there is an urgent need to investigate in depth a matter that is so relevant for the future of Japan, as well as all the other ageing countries, first and foremost Italy. How can the world manage the demographic change and embrace the

opportunities concealed by shifting demographics? Can the case of Japan be inspirational in this sense?

The choice to pivot the discussion on this topic is due to the researcher's belief that it is quintessential for a society that is changing its demographic profile to age sustainably. Since the more 'traditional' ways of tackling the demographic problems (i.e. increasing fertility rates or expanding the workforce) have been proven inefficient and are unlikely to attain results, ageing societies should head towards alternative and innovative strategies. It is not just about surviving to change, it is rather a matter of adapting to change while unlocking its inherent potential. Ambidexterity[4] and dynamic capabilities are the keys to sense, seize, and rearrange the opportunities that lie underneath the troubled surface of the ageing phenomenon. If we succeed in deploying these capabilities to foster innovation and technological progress, people would be guaranteed a better life-quality, despite the shifting demographics. This approach can certainly bring several benefits.

First of all, the development of the robotics industry can sustain the productivity of the country, threatened by the ageing of the workforce, by nurturing a new industrial sector that is likely to thrive enormously. Secondly, robotic devices are a powerful tool to achieve universal standards of *accessibility* that can ensure all citizens, regardless of their age, the same life-quality. "Accessibility" takes place at different levels: we need to guarantee senior citizens physical access to public spaces, as well as access to services, social and recreative activities, access to products that respond their needs, let alone access to education, employment, social integration.

The concept lies at the core of age-friendly communities, in everything "from buildings and homes to the configurability and usability of products and services," – as specified by Malcolm Fisk, a Senior Research Fellow at Leicester's De Montfort University in the United Kingdom, who is active in a number of projects aimed at challenging ageism – "Universal design criteria must apply and must be more embedded in standards." It is thanks to "universal design criteria" that technology acquires the potential to address the complexity of human needs as the population ages, turning into

[4] "Organizational ambidexterity" is often described as a balance between "exploitation" and "exploration". An ambidextrous organization should be capable of exploiting its existing competencies for today's business, while also exploring new opportunities for coping with tomorrow's changing demand (Nieto-Rodriguez, 2014).

"accessible technology". Keohane and Campbell emphasise that "accessible technology, when designed right, has the potential to be the most positive impact on an ageing person's quality of life" (2017). As Laura Carstensen, Director of the Stanford Center on Longevity suggests, "the challenge is converting a world built by and for the young into a world that supports and engages a population that lives 100 years and beyond", alluding to the need to develop holistic solutions focused on healthy living, financial stability, and social engagement (Campbell and Keohane, 2017).

Such claims lead to conclude that the hallmark of "age-friendly" cannot and should not suffice to describe what we wish for the society of the future. It is high time we approached the demographic challenge with a more comprehensive and universal view: the elderly should not be stigmatised as a compartmentalised group of people who is a burden on the whole society because of its special needs and requirements. Conversely, we need to label the "age-friendly" feature as *one* goal, not *the* goal. If we include the "age-friendly" objective within a broader mission, *the* goal is then impersonated by the building of a "human-friendly" society. By "human-friendly" society I indicate a social environment that aims at satisfying the needs of all categories of people (the young and the elderly, men and women, abled and disabled, etc.) and provide everyone with the same support and opportunities, hence a more comfortable life.

Therefore, it is of uttermost importance to investigate the topic in order to understand what are the elements that can facilitate or hinder the thrive of the robotics industry, hence how the different social actors relate to its development and what is their role in the process.

1.3 Research objectives and research questions

The overall aim of the research is to frame a model or at least some useful guidelines for the shaping of a "human-friendly" society during demographic-transition phases. In particular, individual research objectives (RO) have been identified to facilitate the achievement of the overall aim. Each objective is related to a research question (RQ). Specifically:

(1) RO: Investigate the rise and development of the Sagami Robotics Special District.
RQ: *What are the elements that permitted the successful formation of the Sagami Cluster?*

(2) RO: Explore the implications aroused by the development of the robotics industry.
RQ: *According to the Sagami case, what are the main challenges in the development of robotic devices designed for the elderly?*

(3) RO: Understand the practical advantages brought by the implementation of robotics technologies in an ageing society.
RQ: *How is the robotics industry contributing to the shaping of a "human-friendly" society in Japan?*

(4) RO: Discuss the applicability of the Sagami model in Italy.
RQ: *To what extent is the model of public entrepreneurship represented by the Sagami Cluster transferable to the Italian context?*

The discussion of the research findings will lead to the formulation of possible answers to the research questions. Ultimately, conclusions will be drawn meeting the dissertation's scope.

II. LITERATURE REVIEW

The review of the literature chronologically precedes the identification of the research questions and objectives, even if these have already been stated to facilitate a smoother reading. Although a research project can be originally motivated by all sorts of reasons, including simple personal interest, the literature review is crucial to establish the purpose and significance of the research and to relate it to previous studies conducted in the same field of investigation.

The researcher has soon realised the challenge of focusing such a broad area of interest: the core topic – the development of robotics technologies in demographic transition phases with a focus on the rise of the Sagami Robotics Special District – actually encompasses several themes. The individual analysis of these subjects is, therefore, a good starting point to understand the overall topic systematically and thoroughly.

For this purpose, the literature review has been articulated into a few sections that correspond to the "micro-themes" touched by the "macro-topic" of the research project, specifically: gerontechnology, industrial clustering, private and public entrepreneurship, institutional economics. Each section unfolds with a critical review of the works produced by authors who contribute to the development of the debate by adopting different viewpoints or drawing diverging conclusions on the same subject matter. Possible links in terms of content are highlighted without neglecting the chronological succession of the researches, in order to capture the evolution of the discussion over time.

Furthermore, the literature review of the current paper aims to be both "topical" and "theoretical". This means it is not only pertinent to the matter of the research; it also legitimises the theoretical frameworks which constitute the ground for the analysis of the information. Indeed, it is through the application of theories to phenomena that a researcher can manage to avoid falling in a naïve discussion of the findings with no conceptual underpinnings.

On the other hand, Petticrew and Roberts (2006) warn researchers that an overreliance on the existing literature may stifle the exploration of uncharted territories, especially in field studies. Thus, it is important to let the literature review guide the research, not dominate it.

2.1 Gerontechnology

Gerontechnology – "the study of technology and ageing with the aim of improving the functioning of the elderly in daily life" (Bouma, 1992) – becomes an independent discipline object of study in quite recent times. Suffice to say that the first journal on the topic (the "International Journal of Technology and Aging") appeared in 1988 and the first congress was held in Eindhoven in 1991.

As soon as most Western countries began to be pressed by daunting prospects about the size of the elderly population, several authors popularised the combined study of gerontology and technology as the key to overcome many of the current and future challenges: senior citizens are more likely to have access to a better life-quality if their needs are studied within the technological society in which they live (Bouma et al., 2007). It is widely known that elder people have different physical and cognitive capabilities, hence a number of issues must be considered when designing for them.

The field of "Human Factors and Ergonomics"[5] is of great help in this regard. Czaja et al. (2009) discuss the application of Human Factors techniques to the optimal design of technologies, hence the application of scientific knowledge to tackle specific users' capabilities and limitations. Their book calls for a better match between users' capabilities and systems' demands – that is to say the requirements imposed by systems like hardware or software interfaces. Salvendy (2012) notes that the inclusion of human-oriented design principles and tools into the production system is extremely advantageous for the manufacturers themselves too, who can thus better satisfy the market demand.

Being the field of gerontechnology a combination of gerontology and technology, both disciplines bring different dimensions that intertwine with each other shaping a new "matrix framework" (Bouma et al., 2007). Such a framework can be considered the exploration territory of gerontechnology and is depicted in the figure below *(Fig. 2)*.

[5] The field of "Human Factors and Ergonomics" consists of the application of psychological and physiological principles to the design of products, processes, and systems. The objective of this discipline is to achieve the best level of safety and efficiency in the interactions between users and environments or systems (Czaja et al., 2009).

		Technology					
		Chemistry Biochemistry	**Architecture Building**	**Information Communication**	**Mechatronics Robotics**	**Ergonomics Design**	**Business management**
Gerontology	**Physiology Nutrition**	Preventive nutrition	Experimental houses Healthy indoor environment	Telecare	Biorobotics Resource sharing (man-vehicle)	Individual differences User participation Inclusive design Standardisation	Care management innovation
	Psychology Social psychology		Experimental houses Domotics	Situated learning Temporal discount & benefits Technology acceptance Persuasive technology Domotics Navigation tools		Individual differences User participation Inclusive design Standardisation	Technology acceptance Persuasive technology Targeted marketing
	Sociology Demography			Technology generation (protocols)	Technology generation (protocols)	Technology generation (user interface)	Targeted marketing
	Medicine Rehabilitation	Preventive drugs Perceptual implants (materials)	Healthy indoor environment	Perceptual implants (signal processing) Modelling restrictions Telecare	Biorobotics Resource sharing (man-vehicle)	Self medication Telecare	Care management innovation

Figure 2: Cross-fertilization matrix of gerontechnology.

The four rows indicate the main discipline groups of ageing processes (gerontology); the six columns the main discipline groups of innovative technology. The matrix cells contain a selection of concepts, insights, and methodology that are relevant to gerontechnology. (Source: Bouma et al., 2007, p. 11)

It is, therefore, not difficult to capture the inherent complexity of the topic, given that several interrelated fields are deeply entangled. Among them, the following section examines the literature regarding the use of Robotics for senior users, a theme that is particularly relevant in light of the research focus.

2.1.1 The use of Artificial Intelligence for an ageing society

The first relevant studies on the implementation of robots for care purposes appeared at the end of the last century. A branch of literature focuses on the physical assistance they could provide as caregivers. Lacey and Dawson-Howe (1998) shed light on how elderly people affected by sight impairments may benefit from robotics aid in daily life, for instance by those devices that function as a sort of "smart walkers". Dubowsky et al. (2000) expand the potential of robots from "sight assistants" to "mobility assistants", developing a system called PAMM (Personal Aid for Mobility and

Monitoring), intended to assist the users both as a physical support and as a device that tracks his or her needs.

The research conducted by E. Libin constitutes a step forward in the ways robots may be used as caregivers. By conceiving the term "robotherapy" (2002), she suggests that robots should not be implemented only as passive physical assistants. They have great potential also as therapeutic tools with whom the patients could interact actively (2003). Later, A. Libin and E. Libin highlight robotics sciences are shifting from a "mechano-centric" to a "human-centric" orientation: the relationship between humans and robots now underpins a psychological, rather than technological, dimension (2005).

At this stage, the literature starts splitting into two main trends: those who further investigate the potential of robots as psychological therapeutic tools, and those who stress the ethical issues that may arise from the development of "human-centric" robots. On the one hand, several studies are conducted to assess the effectiveness of pet-shaped robots in the treatment of dementia. Tamura et al. (2004) pioneer this field of study, demonstrating considerable improvements in mental conditions of Japanese elderly patients affected by severe dementia.

Shibata, who states the effectiveness of interactive robots for psychological enrichment in 2004, dominates this research field from the mid-2000s with a relevant number of papers. The works published in 2007, 2008 and 2011 in conjunction with Wada are the most pertaining ones to this research. The two researchers demonstrate, through the analysis of the social and psychological effects, the positive response of Japanese elderly patients to the interaction with the "seal robot" PARO. The researches undertaken by Shibata and many successive studies – such as the ones carried out by Martin et al. (2013) – show a positivist approach: a number of hypotheses are usually tested, and the effects of robot-patient interactions are verified numerically.

Meanwhile, another branch of literature, led by A. Sharkey and N. Sharkey, focuses on the ethical issues that could arise from the interaction between robots and humans. They assert the importance of the values at stake, such as loss of privacy, loss of personal liberty and infantilization (2008), expanding the work of R. Sparrow and L. Sparrow (2006), who argued that robots are unable to fulfil social and emotional needs. A. Sharkey eventually conceives the term "eldercare factory", to describe the automation process that the eldercare is going through (2011).

Their study is the springboard for further ethical concerns related to human-robots. Petersen (2007) adopts a more philosophical approach, claiming the potential servitude of robots. Borenstein and Pearson (2010) warn about the possible change in human relationships if care recipients start preferring robots rather than caregivers. This hypothesis is examined more in depth by Vallor (2011), who presents a scenario where caregivers' moral values lose their content because of the impact of robots.

2.2 Industrial clustering

The literature on industrial clustering is extremely vast. Only in the period that goes from 2000 to 2015, more than 1,344 research papers have been produced (García-Lillo et al., 2017). A good strategy to deal extensively – regardless of any time frames – with a literature that goes much further than the XXI century, is to dwell on the most cited authors and to identify similar perspectives or patterns of analysis.

A renowned precursor of cluster theory is to be found in Alfred Marshall, who starts growing interest in understanding how and why firms agglomerate in districts. In the "Principles of Economics" (1890) he sheds light on the reasons why firms may be steered towards agglomerations – opportunities to find the workforce more easily (labour market pooling), to share knowledge (technological spillover) and specific inputs (common infrastructures, suppliers, service providers).

Relevant studies in the field of industrial clustering shall not bypass the work of Harvard Business School's professor Michael Porter. In "The Competitive Advantage of Nations" (1990) he argues that nations can accrue considerable competitive advantage thanks to industrial clusters active globally. He then analyses the interactions between the firms, the government and the market, landing the well-known "Porter Diamond" framework (1998), which depicts how competitive advantage is achieved by industries through the interaction of four components: factor conditions, demand conditions, related and supporting industries, and firm strategy, structure, and rivalry.

His definition of industrial agglomerations – "A cluster is a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities

and complementarities. The geographic scope of a cluster can range from a single city or state to a country or even a network of neighbouring countries." (Porter, 1998) – anticipates the extensive research on geographic economy undertaken by Krugman (1991). Making the US "Manufacturing Belt" the baseline of analysis, he provides a comprehensive theory of geographic agglomerations, explaining the reasons and the elements (first and foremost increasing returns) that enhance industrial clustering, as well as the derived advantages.

Whilst most literature agrees that geographical proximity generates economic growth, relatively little attention has been drawn on identifying ways to enhance the stability of a cluster and solutions to cope with collapsing clusters. Accordingly, academics have started to apply theories of industrial agglomeration to concrete districts, such as the Third Italy (Murray, 1987; Paniccia, 1998), the Dutch flower cluster (Tavoletti and te Velde, 2008; Porter et al., 2011), Detroit's automobile industry (Klepper, 2010), California's semiconductors Silicon Valley (Arthur, 1990; Saxenian, 1990, 1991, 1994a; Kenney, 2000) and Boston's microcomputers Route 128 (Kenney and Von Burg, 1999), as well as the "new Silicon Valleys" like the ones in Bangalore and Israel (Bresnahan and Gambardella, 2004).

In particular, Silicon Valley has been one of the most studied clusters ever in the literature – partly due to its success and partly to it being a pioneer in high-tech clusters. The work of Annalee Saxenian is imperative in this regard. Not only she traces thoroughly the rise and formation of the Silicon Valley; she also analyses in depth the reasons why it managed to thrive, in contrast to similar clusters (i.e. Route 128), that despite an initial phase of prosperity, experienced a long and relentless decline.

Silicon Valley had a decentralized structure based on relationships of horizontal coordination and regional networks, whereas Route 128 was characterized by a vertical and hierarchical structure of rather independent firms, that was not ideal in the long term (Saxenian, 1994a). Of course, there are several factors differentiating the two clusters. Langlois and Robertson (1995) stress the importance of technological trajectories: since semiconductors are a critical part of computers, Silicon Valley won on Route 128 as the value of a PC shifted to its single components.

The destiny of industrial districts is not determined by their internal structure solely. It is also crucial to keep in mind that they are embedded in a myriad of inter-organisational networks, whose profile may be decisive. Florida and Kenney (1988a) focus on the entrepreneurial dimension, while

Kenney and Von Burg (1999) emphasise the presence of research centres and universities in the same geographical area.

Lastly, it is noteworthy that most authors acknowledge the role of institutions in enhancing the growth of industrial agglomerations. Florida and Kenney (1988b) outline institutions as the "social structure of innovation", pointing out their potential in disclosing innovation from firms. Kenney and Von Burg (1999) assert that a cluster itself is insufficient to make the regional economy prosper: they rather propose a "double economy" model, where "Economy 1" is represented by the cluster's firms and "Economy 2" by the institutions that facilitate them. Saxenian claims: "Far from being isolated from what's outside them, companies are embedded in a social and institutional setting – an industrial system – that shapes, and is shaped by, their strategies and structures" (1994b).

2.3 Private and public entrepreneurship

The formation of the Sagami Robotics Special District – guided by Kanagawa Prefecture (see chapter 4.1) – inevitably calls into question the importance of understanding the concept of "public entrepreneurship". As one ventures in the literature on public entrepreneurship, he/she soon realises that the concept is much debated among scholars and the path leading to its full conceptualisation is still uphill.

The concept of "entrepreneurship" has been assigned a variety of definitions over the years. Some have seen it as the transformation of an idea into a concrete business action (Collins and Moore, 1964), others as the "creation of a new organization" (Gartner, 1985), others as an "opportunity" (Shane and Venkatamaran, 2000; Stevenson, 1997; Baron and Shane, 2007). However, it is also possible to identify a red thread running through the many definitions of entrepreneurship: the perspective remains unchanged, as entrepreneurship is usually associated with the private sector.

Public entrepreneurship's definitions are much more confined. Ramamurti (1986) asserts that public sector entrepreneurship "is performed by individuals who undertake purposeful activity to initiate, maintain or aggrandize one or more public sector organizations", while Morris and Jones (1999) that it "is the process of creating value for citizens by bringing together unique combinations

of public and/or private resources to exploit social opportunities". Whatever the definition is, it seems that the literature tends to consider public sector entrepreneurship a much more difficult process than the private one.

A significant contribution to a more dynamic view of entrepreneurship is given by Foss et al. (2008), who depart from the static view of individual entrepreneurship. They elaborate the "subjectivist theory of team entrepreneurship", proposing a more fluid view of entrepreneurship as a "creative team act". Their theory, tapping into the "subjectivist" tradition – best represented by the Austrian school of Menger (1871), Hayek (1948) and Mises (1949) – and into Penrose's resource-based view of the firm (1959), encompasses two important elements: the "subjectivist" dimension and the "team" dimension. On one hand, in accordance with the subjectivist tradition, they acknowledge the importance of individual differences: different preferences, knowledge and expectations are seen as a source of creativity and innovation; on the other hand, they recognise that individuals are embedded in a dense network of social relationships. Therefore, entrepreneurship becomes a "creative team act" where "heterogeneous mental models at the team level produce a collective output that is superior to individual entrepreneurship" (Foss et al., 2008).

Embracing a different view of entrepreneurs – as teams, not single individuals – is quintessential to reduce the gap in the literature between private and public entrepreneurship. Ostrom (1965, 1990) emphasises that the two domains of private and public entrepreneurship – despite conceptually discrete – actually co-evolve. As it is argued by Klein et al. (2010), public and private entrepreneurs are very akin in the way they operate: the organisational and governance problems of the former are closely related to the more general problems faced by entrepreneurial teams in the private sector. Nevertheless, differences do exist (Forster et al., 1996): public entrepreneurs may not be profit-driven as financial incentives are lower (Ramamurti, 1986) – the profitability goal may be included though, making the process even more complex (Kearney, Hisrich & Roche, 2009) – or may have reduced autonomy and flexibility in the decision-making process (Rainey et al., 1976; Rainey, 2009).

Therefore, one may conclude that although differences in private and public entrepreneurship lead in different ways of managing innovation, risk-taking and proactivity (Kearney et al., 2009), public and private interests cannot be understood if they are conceived separately, hence an alignment of public and private interests is apt (Mahoney et al., 2009).

2.4 Institutional Economics

Among the many social actors called into question by the current research, institutions shall receive particular attention. Indeed, most literature of the XX century is imbued with the discourse on institutions.

2.4.1 New Institutional Economics (NIE)

The study of institutions becomes systematic with the rise of the "New Institutional Economics" (NIE), a term coined by Oliver E. Williamson in 1975 to underline the fracture with the "Old Institutional Economics" (OIE), which constituted the mainstream current of thought until the first half of the last century. It is usually claimed that while the latter (mainly represented by Thorstein B. Veblen[6], John R. Commons[7] and Wesley C. Mitchell) is based on the rejection of the Neo-classical Economics, the former adopts certain stances – like the methodological individualism, according to which individuals should be taken as given – that can be considered residual assumptions deriving from the Enlightenment.

However, drawing a clear line between the "old" and the "new" institutionalism is rather challenging, given that the authors traditionally ascribed to the NIE actually form a large and varied group of thinkers often supporting diverging ideas. Nor is the chronological succession of the papers matching a consistent and uniform evolution of the debate: different strands of thought often emerge simultaneously. For instance, as noted by Hodgson (1998), the work of some NIE's authors, such as Nelson and Winter (1982), shares with the OIE the rejection of the individual "taken for granted", favouring a more evolutionary theory where the individual is both "a producer and a product of socio-economic conditions". Thus, as Richter (2005) suggests, it is wise to conclude that the only

[6] Veblen defined institutions as "settled habits of thought that are common to the generality of man" (1919).
[7] Commons defined institutions as "collective action in control, liberation and expansion of individual action" (1931).

unquestionable trait of the NIE is identifiable in a renovated interest in institutions, that for the first time become legitimate objects of economic analysis. The "new" institutionalism acknowledges that "institutions matter" and are key to understand economic theory, being them the framework in which economic activities are embedded.

Ronald H. Coase – the father of the NIE – opens the debate exactly by criticising the work of Veblen as "empirical evidence without theory" (1937), asserting that while the OIE *describes* institutions, the NIE *analyses* them. Having said all this, Coase's contribution goes further beyond a mere criticism of previous studies. He introduces the two central concepts of the NIE: "transactions costs[8] " and "property rights"[9]. The former, in particular, occupies a special position in his work. Firms – he claims in "The Nature of the Firm" (1937) – exist to coordinate resources, while economising on transaction costs, achieving a level of efficiency that is not reachable by individuals. The boundaries of the firm are, therefore, determined by the nature and the extent of transaction costs. In addition, Coase claims that people do not trade "commodities" but "rights" – rights to the use of resources (1959). The concept is further explained in "The Problem of Social Cost" (1960): when transaction costs are high, as they usually are, property rights are critical.

After Coase, Oliver E. Williamson and Douglass C. North became the major representatives of the NIE, both re-confirming the explanatory role previously attributed to transaction costs by Coase. Nevertheless, their interpretation of institutions is somewhat conflicting, and they end up fathering different strands of thought.

On one hand, Williamson starts from Coase's theory on transaction costs and re-elaborates it more systematically into the "Transaction Costs Economics" (TCE) theory. Assuming that the human

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[8] According to the definition provided by the OECD Glossary of Industrial Organisation Economics and Competition Law, "transaction costs" are the costs that emerge during production and market exchange, including the costs of "discovering market prices" and the costs of "writing and enforcing contracts" (Khemani and Shapiro, 1993).

[9] The discussion on property rights is largely developed by Armen A. Alchian, who argues: "Many of the constraints on the use of what we call private property involves the force of etiquette and social ostracism [⋯] A property right for me means some protection against other people's choosing against my will one of the uses of resources, said to be «mine»" (1965).

mind is far from being perfectly rational, he adds the trait of bounded rationality[10] to human behaviour. Given the limited human cognition and the potentially opportunistic behaviour of individuals, institutions are expressly designed to reduce transaction costs and, in competitive markets, those that fail to do so would not survive (1981).

On the other hand, North theory is based on a "visible-hand" approach to institutions, seen as the exogenous rules of the game.

> Institutions are the rules of the game in a society, or, more formally, are the humanly devised constraints that shape human interaction... In the jargon of the economists, institutions define and limit the set of choices of individuals.
>
> (North, 1990)

North makes a clear distinction between the rules of the game (institutions) and the players of the game (organisations), who can eventually become rule-makers if existing rules generate the need for new rules. These rules can be informal (social norms, moral codes, etc.) or formal (regulations, contracts, etc.) and in this case should be enforceable (or "implementable") in society – as stressed by Hurwicz (1996). The notion of "enforceability" inevitably cast doubt on the validity of an exogenous view of institutions and rather invokes an endogenous view of "self-enforcing" institutions.

2.4.2 The cognitive dimension of institutions

The "visible-hand" approach – pivoted by transaction costs and by a rule-of-the-game view of institutions – is soon flanked by two important positions: (1) an equilibrium-of the-game view of institutions, and (2) the New Economic Sociology (NES).

[10] Bounded rationality is intended as a "behaviour that is intendedly rational, but only limitedly so" (Simon, 1957).

1. Equilibrium-of the-game view of institutions

The discourse on institutions as game-equilibrium was pioneered by Andrew Schotter (1981) but it was Avner Greif and Masahiko Aoki who became its primary proponents, the latter fathering the field of Comparative Institutional Analysis (CIA). Aoki asserts that the analysis of institutions difficultly leads to a right or wrong definition. It rather "depends on the purpose of the analysis" (2001).

The concept of "Nash equilibrium", derived from game theory, plays an important role in Aoki's work: in game theory, the equilibrium is reached when each player's strategy is optimal given the strategies of all other players. In other words, expectations about the behaviour of competitors acquire a great importance and in a status of equilibrium, "no actor has an incentive to deviate from his present plan of action as long as the other actors do not do so" (Richter, 2005).

Aoki (2001) solves the issue of enforceability by endogenizing it. He applies the game theoretical model to the economic process and proposes a view of institutions as the equilibrium outcome of the game, whose rules are endogenously generated and become self-enforcing through the strategic interactions of the players. The strategy is, therefore, seen as a "choice set".

> Suppose that all the players, including the enforcer of the rules, respond with the best action choices given their respective information regarding possible states [...]. If and only if agents' action plans and beliefs become mutually consistent and repeatedly implementable, then (salient features of) those plans may be regarded as a sustainable (enforceable) rule of the game, and thus as an institution. [...] In order for all the players' action choices to become mutually consistent and sustainable (thus in equilibrium), each player need not know the details of the other players' intentions and choices.
>
> (Aoki, 2007)

In other words, Aoki conceptualises institutions as "self-sustaining systems of shared beliefs about a salient way in which the game is repeatedly played" (2001). The equilibrium can be converted into an objective reality, hence a substantive institution, when all players agree on its linguistic or symbolic representation. Nevertheless, institutions need to be constantly re-confirmed by the agents of the game in order to be

sustainable and viable, leading to a duality of institutions in their being endogenously created and exogenously re-confirmed through objective representations.

> Agents' strategic choices made on the basis of shared beliefs jointly reproduce the equilibrium state, which in turn reconfirms its summary representation. Thus, the institution becomes self-sustaining and information compressed. [...] In this way, although endogenously created, an institution becomes objectified.
>
> (Aoki, 2001)

The process is depicted in the figure below *(Fig. 3).*

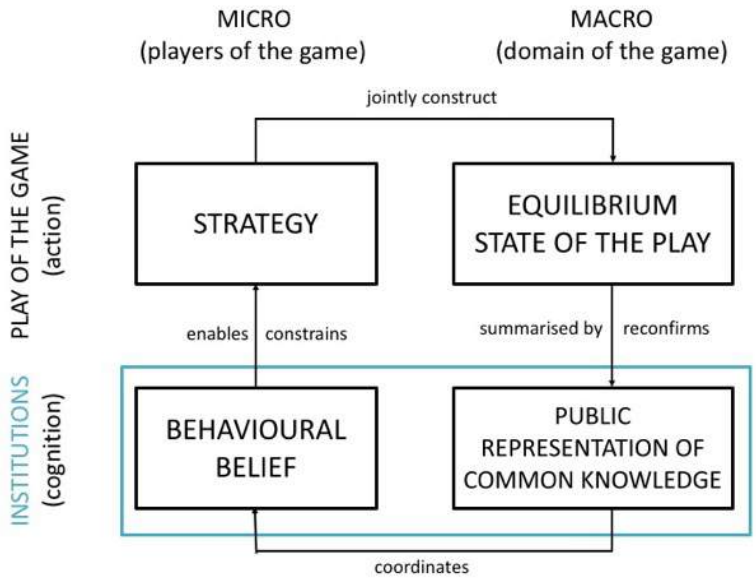

Figure 3: Aoki's game theoretical model
(Aoki, 2001).

Aoki points out that the Nash equilibrium alone, being a static concept, does not explain institutional change. The figure above is not to be intended as a static circular process, but is rather fluid, as institutions are dynamic and do change. Environmental and internal changes may cast doubt on the "shared beliefs" and the players' strategies may be steered towards new choices (Aoki, 2011). However, the rise of a new institution shall not be intended as a simple shift from an equilibrium state to another; instead, it is a process of "revision, refinement, and inducement of mutual consistency of such models incorporating a (common) representation system (Aoki, 2007).

Lastly, it is noteworthy that although an institution may seem to rise from a particular state of equilibrium of the game, Aoki points out that multiple equilibria are possible[11] (2007). It is exactly in their conceptualization of "equilibrium status" that Aoki and Greif's theories depart. In contrast, Greif elaborates the idea of a "subgame perfect equilibrium", as an established equilibrium derived from all players having a strategy for any possible future scenario of the game (1989, 1994)[12].

2. New Economic Sociology (NES)

The increasing interest in institutions pushed economists to intrude in a field of study that traditionally belongs to sociologists, who soon stood up. In particular, Mark Granovetter's work is built upon the concept of "social embeddedness". Reversing the mainstream among economists, who often consider individuals alone, he emphasises that economic activity is just a part of social action. The individual as conceived by Granovetter is deeply embedded in a network of personal relationships that constitute the social structure in which individuals act – "agents [...] generate trust and discourage malfeasance by being embedded in concrete personal relations and structures (networks)" (1985).

2.4.3 Evolutionary economics

It is noteworthy that a dynamic view of institutions, originally introduced by Veblen and greatly developed by Aoki's CIA, has enlarged the domain of "evolutionary theories", that were typically concerned with firms and technology rather than social and public institutions (Van den Bergh and Stagl, 2003). The Schumpeterian view of innovation as the driving force of economic progress

[11] The salient equilibrium can then be explained in terms of "focal point" (Schelling, 1980).

[12] This is best exemplified by the case of the merchant guild. Let's suppose that a merchants' guild trades in a city unless the ruler cheats on any of them. Considering that in this case, the traders would organize a boycott, the ruler decides to cheat on any merchants if a boycott is announced (Greif, Milgrom, & Weingast, 1994). The authors demonstrate that such strategy represents an equilibrium status, but it is obvious that a boycott does not occur in the normal circumstances in which the game is played. It rather belongs to all the possible states of the play envisaged by the players.

(Schumpeter, 1942) has influenced most literature in this regard, monopolizing the attention towards technological innovation and how firms engage to achieve it.

Nelson and Winter, whose "An evolutionary theory of economic change" (1982) is by many considered the benchmark of Evolutionary Economics, borrow from Darwinism the concept of "evolution", expanding it from a mere "natural selection" into a broader meaning of "economic dynamism". Their argument is in sharp contrast with orthodox theories on relatively static economic processes, where firms adjust optimally to market conditions. Agreeing with Schumpeter (1934) about "competition" as a process that inevitably leads to winners and losers (rather than just seeing it a feature of the market), they identify "routines" as the "genes" of organisations. In other words, Nelson and Winter explain a firm's "capabilities and choices" in terms of routines[13], that need to be revised constantly in order to let the firm survive in the competitive environment. Thus, in their evolutionary view of economics, they suggest a dynamic perspective that rejects the social optimum and that investigates what "an economic system 'ought' to be doing" (1982). They also hint that institutions evolve in similar ways as firms, following an evolutionary pattern as well (Nelson and Winter, 1982, Chapter 16).

Indeed, as it is highlighted by Archibugi (2017), the study of technology cannot neglect the social dimension in which it is imbued. Aoki himself points out that innovation *a la* Schumpeter – intended as "carrying out new combinations" (Schumpeter, 1934) – triggers bundling (2007). The analysis of how social and economic transformations are linked to each other is, therefore, necessary.

Nelson resolves the apparent dichotomy of technology and institutions by theorizing the co-evolution of technology and institutions. He stresses the importance of the social aspect of any economic activity, determined by two fundamental features that complement each other: "physical technologies" and "social technologies" (Nelson and Sampat, 2001). While the former can be seen as the procedure of an economic activity, the latter represents the way in which the economic activity is organized among the social actors. In his view, institutions become the structures and forces that "support and hold in place social technologies" (Nelson, 2007).

[13] Capabilities as routines are first theorized by Winter - "an organizational capability is a high-level routine" (2003).

2.5 Final considerations

The review of the literature shows a tendency to deal with these themes separately. Whether the focus is on the implications of gerontechnology, on industrial clustering, on the significance of entrepreneurship, or on the scope of institutions, academics typically concentrate on one single aspect which pivots of the research.

I certainly acknowledge that narrowing down the research field is often crucial to carry out a thorough and detailed investigation on a certain topic. However, it is equally important to analyse a topic by taking into account the research framework in which it is embedded. Technology does not exist *per se* but is embedded in a complex framework where different actors interact incessantly, and interrelated disciplines complement each other. A comprehensive perspective could, therefore, reveal aspects that unilateral viewpoints hardly disclose.

Nevertheless, such a perspective has occupied mostly marginal positions in the studies conducted so far. How do robotics technologies, industrial clusters, and institutions integrate and complement each other? Can humans and robots co-evolve through the mediating role of institutions? What is the contribution of entrepreneurship? What is at stake for the society as a whole? How do national differences affect the process?

The current research aims at filling the gap by exploring the interrelation of these topics at their intersection through the original case study of the Sagami Robotics Special District.

III. METHODOLOGY

Once the contents touched by the research have been critically related to previous studies, it is crucial to elaborate a suitable methodology in order to answer the research questions as thoroughly as possible. The justification of the methodology chosen is allegedly one of the most important parts of a research, as it ensures the reader of the validity and reliability of the findings.

The first step in this direction consists of the statement and justification of the research approach *(section 3.1)*. The choice of a research approach involves philosophical assumptions *(section 3.2)* and will be the benchmark for the planning of the research design *(section 3.3)* and the research methods[14] *(sections 3.4 and 3.5)*, namely the data collection and data analysis methods.

3.1 Research approach

I have carefully examined all the options available before making methodological decisions and analysed extensively the literature on research methods in management. As highlighted by Newman & Benz (1998), qualitative and quantitative approaches do not represent a source of dichotomy. They should be viewed as different ends on a continuum, rather than discrete entities. For this reason, it is more careful to address a study as "*tending* to be more qualitative than quantitative or vice versa".

Qualitative research can be defined as the "approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem" (Creswell, 1994). Since the research questions and objectives focus on social actors (rather than on the external environment, for example), it has been concluded that the current research tends to be qualitative. Indeed, the process of research has involved emerging questions, data collected in the participant's setting, and an inductive style (from particulars to general themes), as it is typically the case of qualitative studies.

[14] "Methodology" and "methods" are two distinct terms and should not be confused. The former is "the rationale for the research approach, and the lens through which the research occurs" (Brookshier, 2018); the latter is simply a research tool.

Secondly, it is generally assumed that conducting research among institutions and organisations, hence people rather than objects, advocates a subjectivist thinking (Gill and Johnson, 2010). The researcher privileges the importance of rendering the complexity of a situation. Since the meaning of the data is framed through the researcher's individual interpretation, the ontological[15] view of reality tends to be relatively subjective, not existing *per se* but tethered to the perspective of the research (Bryman, 2016). Nonetheless, this does not imply that findings are not credible or reliable but warns the reader that other viewpoints are possible about the same topic, thus the findings of the present paper do not have the pretension of providing a comprehensive and complete discussion that includes all the multiple possible perspectives and implications.

The broad research approach involves the intersection of the philosophical worldview it brings to the study, the research design that is related to this worldview, and the specific methods and procedures that translate the approach into practice (Creswell, 1998).

[15] "Ontology" pertains assumptions about the nature of reality, hence what it is and how it is organised (Bryman, 2016).

3.2 Research philosophy

The philosophical view, which encompasses both ontology and epistemology[16], remains most times hidden behind the research (Slife and Williams, 1995). Nonetheless, it is of paramount importance to inform the readers by making it explicit. Doing so, the researcher can also gain a deeper awareness of the philosophical orientation that shaped his/her own research approach and through which the study is being carried out.

Although different research philosophies are often framed as distinct categories, the current study is far from underpinning solely one set of beliefs. Assumptions belonging to different philosophical views are taken into account. As it is claimed by pragmatism, mere ideological premises should not be the most important factors (Saunders, Lewis & Thornhill, 2009). I agree that practical reasons, more than theoretical assumptions, should be the primary determinants of the methodological choices.

Given that the purpose is not to analyse robots scientifically but to investigate in depth the Sagami Robotics Special District and its impact on the social structure, as well as drawing lessons that can be useful for other countries and yield some general recommendations, it is of uttermost importance to adopt the point of view of social actors. The focus on the social actors, instead of the robots themselves, may lead to the adoption of an interpretivist perception of knowledge.

This choice might appear a breakpoint with most literature in the robotics field, which usually adopted a positivist or quantitative attitude based exclusively on relationships of causality between phenomena. However, the main weakness of the positivist approach lies in a lack of flexibility, hence in the inability of assessing the topic by taking into consideration several aspects.

On the other hand, neither an exclusively interpretivist philosophy could be suitable, as it is strongly influenced by the individuals' perceptions of reality and focus on their uniqueness[17]. The present research requires an emphasis both on social actors (institutions, firms, patients, etc.), as well as on the external context. Organisations should not be conceptualised and explained

[16] "Epistemology" relates to assumptions about the nature of knowledge, hence the best ways to obtain knowledge. what is considered acceptable knowledge (Bryman, 2016).

[17] Weber relates to this concept in terms of "Verstehen", the assumption that human behaviour's interpretation depends on the social actors and on the social context (Gill & Johnson, 2010).

deterministically, as they do not follow iterative behavioural patterns that can be labelled *a priori* (Outhwaite, 1986); at the same time, the excessive study of their peculiarities would not be functional for the scope of this paper. This need justifies the rejection of both a merely positivist and a merely interpretivist worldview. Instead, the paradigm of interpretation underpinned the research is mainly ascribed to constructivism[18] combined with interpretivism.

As exemplified by Creswell (1998), social constructivism believes that individuals interpret their experiences subjectively, giving objects a wide variety of meanings. Since these meanings are diversified, their heterogeneity drives the researcher to look for the complexity of views rather than labelling them with a few categories or ideas. The goal of the research is to rely as much as possible on the participants' views, who forge the meanings of the situation being studied by answering to broad, open-ended questions.

Crotty (1998) underlines the importance of the engagement with the world in the interpretation process: the subjective meanings are not simply entailed by individuals but are formed through the interaction with others (hence social constructivism) and through the historical and cultural norms and settings of the context in which they operate. Constructivist researchers aim at interpreting the meanings others have about a specific situation, whilst recognising that their own backgrounds shape their interpretation. Rather than starting with a theory (as in positivism), they generate or inductively develop a theory or pattern of meaning. In light of all this, social constructivism is typically seen as a qualitative approach.

Lastly, critical realism calls for attention too. Constructivist perspectives often view reality as entirely constructed through and within human knowledge. In contrast, critical realism claims that "ontology (i.e. what is real, the nature of reality) is not reducible to epistemology (i.e. our knowledge of reality)" (Fletcher, 2017). The world is treated as theory-laden, but not theory-determined. Critical realism claims that even though we can all try to interpret the outside world, some knowledge can be

[18] Social constructivism goes back to Karl Mannheim ("Ideology and Utopia: An introduction to the sociology of knowledge", 1936), who fathered the "sociology of knowledge". He focused on the analysis of the relationship between human thought and the context in which it arises, arguing that human thought arises and operates in a specific social setting, by which it is shaped unconsciously (Coombs, 1966). Later studies are represented by Berger and Luckmann's "The Social Construction of Reality" (1967), Lincoln and Guba's "Naturalistic Inquiry" (1985), Denzin and Lincoln (2011), Mertens (2010, 2012), and Crotty (1998).

closer to reality than other knowledge in terms of theories (Danermark, Ekstrom & Jakobsen, 2002). The theories that help us get closer to reality and identify causal mechanisms driving social events, activities, or phenomena, are selected and formed using the rational judgment of these social events (Archer et al., 1998). The ability to engage in explanation and causal analysis (rather than engaging in a thick empirical description of a given context) makes it useful to consider the implications of critical realism for analyzing social problems and suggesting solutions for social change.

3.3 Research design

Another major element in the shaping of the methodology is the procedure of inquiry that the investigator chooses to pursue. The present paper is formulated in the form of a single case study[19]. Case studies are typically used in qualitative researches, especially in the field of social sciences.

Among the jungle of definitions that have been produced in the literature so far, Simons (2009) asserts that "A case study is an in-depth exploration from multiple perspectives of the complexity and uniqueness of a particular project, policy, institution, program or system in a 'real life'". The research questions and objectives, rather than just the author's view of the relationship between knowledge and the process by which it is produced, have been the major drivers for the choice of this strategy.

Robert K. Yin (1994), an undiscussed author in the literature on case studies, advocates the use of case studies as a suitable strategy when the researcher:

- tries to answer mainly "how" and "why" questions;
- has little or no control of the events;
- the phenomenon is occurring contemporarily in a real-life context.

Given that the present research falls into all of these categories, the strategy adopted is justified profusely. Furthermore, Yin emphasises that case studies are suitable for studying complex social

[19] Evidence is collected through documents and interviews. The collection of the data will be further explained later in the next section (3.4)

phenomena, as the focus is on a contemporary situation within its real-life context and whose boundary with its context is not clearly evident (2009).

A common criticism against case studies is the objection that it is difficult to generalize findings from an individual case (Tellis, 1997). However, as Starman argues (2013), inference is based on analytical induction (analytic generalization) and not on statistical induction (enumeration). While the latter stresses only quantitative parameters, the former is interested in structural or functional connectivity, thus in the relationships – emerged from a single case – among individuals and circumstances (Starman, 2013). Therefore, as validated by the holistic[20] approach, even a single case can yield important theoretical implications and expose relevant connections that could allow generalisations.

Secondly, concrete knowledge is often privileged against practical case knowledge produced by case studies. In contrast, Flyvbjerg observes: "Concrete case knowledge is more valuable for social sciences than the vain search for predictive theories and universals." (2006; 2011)

Lastly, considering that the case of Japan will be used to draw potential implications for Italy, the "source-target model" will be applied, where the source is Japan and the target is Italy. This framework of thinking is justified also in terms of "analogical reasoning" (Gavetti, Levinthal & Rivkin, 2005).

3.4 Research methods (I): data collection

Taking into account the nature of the topic and the approach, philosophy and strategy adopted, the most appropriate method is believed to include the collection of both primary and secondary data. Although it may seem an unconventional choice, there is evidence that argues its potential and supports this strategy in certain cases. Simons (2009) justifies the choice of multiple research methods when framing a case study. In addition, a meaningful contribution to a field that is still significantly unexplored is believed to rely best on data from different sources (Smith, 2014). Backing

[20] Holism is the study of complexity in terms of the whole, which is more important than its individual parts. Holism is the opposite of individualism, but they often occur in pairs – in macro and micro perspectives of observing social reality (Starman, 2013).

up original findings with the researches carried out by others eschews a blind and potentially naïve interpretation of the outcomes.

Meanwhile, the awareness that studies on the Sagami Cluster are still at the very early stage, leads to the necessity of relying also on primary data, compensating the scarce secondary data on this field. The use of different methods would eventually address each other's weaknesses, bridge the findings with a critical eye, and bear meaningful outcomes. The following sections will describe more in details the reasons for the choice of both primary and secondary data.

3.4.1 Collection of primary data through interviews

The first[21], the second[22], and a part of the fourth research question[23] have been answered by collecting primary data. This choice was partially driven by the lack of specific literature about the topic, due to the fact that the evolution of the Sagami Cluster is still ongoing. Furthermore, the willingness to collect answers rich in details resulted in the decision of conducting unstructured, in-depth interviews. Open-ended questions are more likely to encourage confessions or to reveal certain attitudes, maybe not even conceived by the researcher (Grummit, 1980). Furthermore, since it is somehow similar to a "conversation", interviewees may feel much more at ease and express their beliefs freely (Burgess, 1988). Besides, the main advantage of gathering primary information consists of the specificity of their purpose, designed precisely to answer the set of questions formulated by the researcher, not by others (Denscombe, 2007).

The choice of interviews, rather than questionnaires, is also explained by the conviction that people may feel discouraged if asked to write the answer to long, open-ended questions on a sheet of paper, or they may not find the proper words to phrase what they really want to express, while the researcher would not be able to catch their emotions and feelings in depth. During interviews, the

[21] RQ1: "What are the elements that permitted the successful formation of the Sagami Cluster?"

[22] RQ2: "According to the Sagami case, what are the main challenges in the development of robotic devices designed for the elderly?"

[23] RQ4: "To what extent is the model of public entrepreneurship represented by the Sagami Cluster transferable into the Italian context?"

researcher can take notes of relevant paralinguistic information that would otherwise be forgotten and underestimated. In the case of professionals, these may not feel at ease in discussing on a piece of paper a sensitive subject related to their own job, that could involve multifaceted considerations of ethical, moral, social and psychological nature.

Conversely, interviews enable to capture the body language or any other significant paralinguistic information that is, deliberately or not, provided by the respondents. Moreover, they allow the researcher to give a self-introduction in person, building the ground for a more intimate debate where the respondents would feel more willing to share opinions. Questionnaires, especially in the form of self-administered ones on online platforms, inhibit the respondents from engaging in extensive and thorough discussions with a person they have never met or talked to face-to-face (Bryman, 2016).

I have personally conducted the interviews in Japan over a period of time of ten months; the interviewees are personnel from a number of institutions engaged in the Sagami Cluster. This choice was suggested by the possibility that the viewpoint of people working in different institutions may differ. The interviews were conducted with professionals from the Industrial Promotion Division of Kanagawa Prefecture, from the Kanagawa Institute of Industrial Science and Technology (KISTEC), from the Kanagawa Rehabilitation Robot Clinic (KRRC), and from a couple of Italian start-ups that are developing robotic devices targeted at elderly users.

The decision of conducting unstructured interviews condones a relatively small sample of respondents (a total of eight interviewees), which is justified also by the rejection of a quantitative approach, that would otherwise call for the analysis of big samples of data in order to generalise findings. However, it would be neither feasible nor plausible to interview a large number of people for the research in question. It is important to keep in mind that its purpose is not to generalise, to find trends or patterns on large-scale samples, but to understand thoroughly the information told by the interviewees. To achieve this, it is fundamental to allow each respondent sufficient time and attention. Meanwhile, it is desirable to hear the opinion of professionals belonging to different institutions, albeit to the same industrial field, as involving a broader range of people and situations may interestingly produce unexpected outcomes.

3.4.2 Evidence from the literature

Once assessed the evidence offered by primary data, the third[24] and a part of the fourth[25] research question will be answered with evidence from the literature.

Mordoch et al. (2013) warn about the recurring problem of identifying overconfidently which projects are part of the same study and which are the original primary studies. Moreover, conflicts of interest may be suspected, since a deeper investigation into some of the authors' background can unveil their engagement in collaborative projects with the developers of the robots. Such a difficulty can be partially overcome by collecting secondary data only from reliable sources and that are relevant to answering the question. In the current project, the focus will be drawn on those studies, published primarily in business journals, that allow sufficient relevance to the analysis of the process, before judging possible effects.

As already stated, being the object of the research quite unexplored, the available sources of information were often represented only by pamphlets and handouts released by the Prefecture itself. For this reason, the researcher ought to be aware that such documents might be affected by potential biases due to their scope, which is informative as well as promotional, since aimed at raising awareness and creating a consensus on the development of robotics technologies.

This concern can be seen also as the inherent characteristic of any secondary data, which are originally produced for a purpose that is different from the one they are used by third parties at a later time (Denscombe, 2007). Nevertheless, as it is argued by Saunders et al. (2009), they still enable a relevant "re-contextualisation" of information for other purposes.

[24] RQ3: "How is the robotics industry contributing to the shaping of a "human-friendly" society in Japan?".

[25] RQ4: "To what extent is the model of public entrepreneurship represented by the Sagami Cluster transferable to the Italian context?".

3.5 Research methods (II): data analysis

It is proper to acknowledge that one of the major drawbacks of collecting data with a mainly qualitative approach, is the potential overwhelming quantity and heterogeneity of the information obtained. It is essential to plan the analysis of such data carefully, designing a practical project in advance, in order to study them in an organised way (Miles, 1979).

A functional and powerful recording is the first step to becoming confident at handling the data. The primary data were registered by what Creswell calls an "interview protocol" (2014). While the interviews are being audio-recorded, it is useful to take some notes in case the recording device stops working or the tape gets lost. Interviews are unique events, hence hard to repeat, while the interviewees may not be available a second time.

The option of video recording the interviews was dismissed due to its potential influence on the interviewees' behaviours. The interviews were audio-recorded only, following a verbal agreement granted by the interviewees to the researcher, who, according to transparency policies, should provide them with a copy of the record, if required. The interviewer should try to make the participants feel at ease and relaxed, facilitating a conversation on a more intimate level. The use of the native language of the interviewees would help achieve this goal.

As soon as possible, the researcher listened to the recordings and, consulting the notes, transcribed the interviews. At this stage, making sure that non-verbal communications are included is fundamental, as reminded by the "Thick Description" formulated by Geertz (1973).

The last step, which is the translation of the transcript from Japanese into English, needs not only a proficient language competency but also cultural sensitivity. May (2011) observes that concepts, more than words, are transmitted and it is the translator's responsibility to convey them as accurately as possible. Furthermore, as the interviewer is the same person as the translator, the eventuality of inconsistencies between the data collection and the data analysis is largely reduced.

IV. RESEARCH FINDINGS AND DISCUSSION

The forth chapter contains the research findings and the relative discussion. It is divided into two sections.

The former contains a detailed analysis of the Sagami Robotics Special District, in the form of a case study. The aim is to depict its formation from an historical perspective as well as all the multiple features of its evolution. Since the process is still ongoing, the research also tries to shed light on future scenarios, despite the difficulty of predicting what turn it will take.

The latter part investigates the features of the social, economic and institutional environment in the Italian context, hence whether the Sagami model is potentially replicable, even partially, in other circumstances. Finally, the reasons why it would be proper to consider a potential applicability of the model elsewhere will be justified.

4.1 RESULTS

The Sagami Robotics Special District

（さがみロボット産業特区）

The following sections present quite a few terms in Japanese. Given that they are based on the information obtained through interviews and handouts released by Kanagawa Prefecture, the researcher has found it proper to indicate the original terms used in Japanese as well, in order to avoid any inaccuracy due to the inherent difficulty of the translation.

4.1.1 Historical background

The beginning of what later became the Sagami Cluster goes back to July 2005, when the "Kanagawa bio-medical special zone" （かながわバイオ医療産業特区）was created as part of the

governmental plan[26] intended to identify "special zones for structural reforms" (構造改革特区), that could have thrived benefitting from advantageous conditions such as the ease of regulations.

When the power shifted from the Liberal to the Democratic Party in 2009, the political line around this matter remained unchanged and rather strengthened in the same direction. The Government granted the prefecture additional special allowances, moving beyond the mere, yet fundamental, ease of regulations, and providing a more comprehensive support in terms of tax and financial aid.

It indicated as "Comprehensive special zones" (総合特区) the areas with a high probability of carrying out pioneering efforts to form the clusters of industries and functions that would serve as the engines of Japan's economic growth. Such areas were meant to respond two main objectives: (1) to bolster the international competitiveness of Japan (国際競争力の強化) and (2) to revitalize peripheric regions (地域の活性化).

1. *Bolstering the international competitiveness of Japan*

   The first clause was embodied by the eastern part of Kanagawa Prefecture, which officially started the "Life Innovation in Keihin Coastal Areas" project (京浜臨海部ライフイノベーション) in December 2010, as part of the "Comprehensive Special Zones for International Competitiveness Development" (国際戦略総合特区). The goals of the Keihin coastal area are stated as the "development and manufacturing of innovative pharmaceuticals and medical equipment by global companies that can respond to the new era of individualization and preventive medicine and creation of health-related industries".

   In other words, it aims at fuelling the economic growth of Japan while also contributing to the solution of international issues, such as the reduction of health-care costs and the improvement of the quality of life.

[26] At that time the cabinet was held by the LDP (Liberal Democratic Party, or Jimintō), with Junichiro Koizumi as Prime Minister (2001-2006).

2. Revitalizing peripheric regions

On the other hand, the commitment to creating "Comprehensive Special Zones for Regional Revitalisation"（地域活性化総合特区）led to the formation of the "Sagami Robotics Industry Special Zone"（さがみロボット産業特区）in the central part of Kanagawa Prefecture in February 2012.

In fact, the region was formerly an automobile industrial area, that thrived throughout the 70s and the 80s but experienced a long decaying phase when the majority of the big firms located there started to move the production of automobile components elsewhere, mainly to South-East Asia.

Pressured by the need to nurture new businesses, the prefecture envisaged the pre-existent agglomeration of manufacturing industries as the breeding ground for the development of the robotics industry. Thus, it can be said that the Sagami Cluster *(Fig. 4)* is the result of its own past, rather than kick-started by a specific occasion.

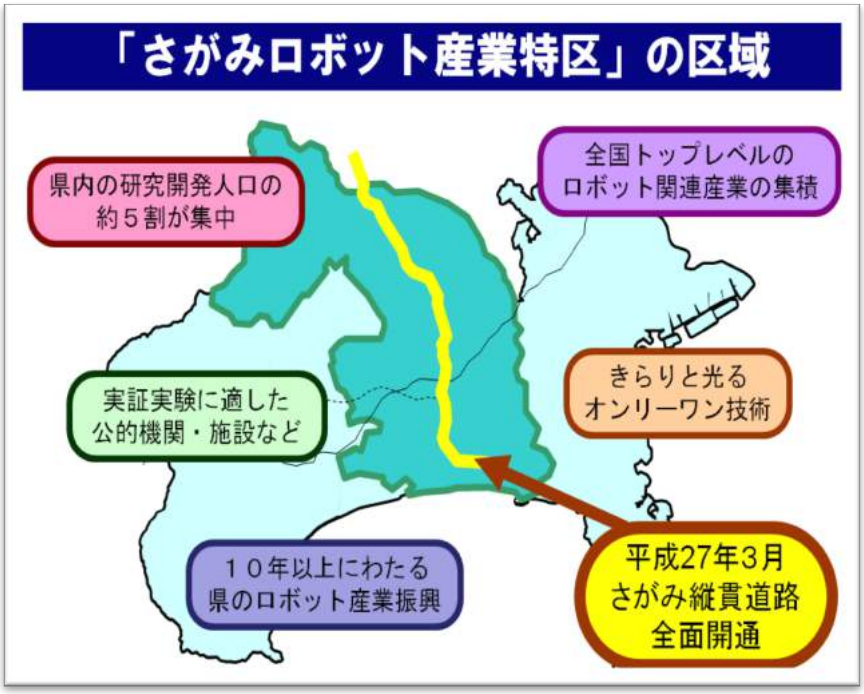

Figure 4 : The Sagami Cluster.

The Sagami Robotics Special District occupies the central part of Kanagawa Prefecture – marked in darker green – and is crossed from north to south by the "Sagami Highway" – vertical, yellow line.

4.1.2 The Sagami Cluster ... in theory

The executive power switched again to the LDP in December 2012, and the Sagami Cluster was re-confirmed as part of the "Plan of economic growth through the creation of pre-symptomatic and cutting-edge medical-related industries"
（未病産業と最先端医療関連産業の創出による経済成長プラン）. In March of the following year, the Prime Minister Shinzo Abe officially granted it the full support of the Government for an initial period five years (2013-2017), that was eventually extended in 2018 for another five-years term.

The Sagami Cluster *(Fig. 5),* despite named after Sagamihara, actually corresponds to the area of twelve municipalities: Hiratsuka, Fujisawa, Chigasaki, Atsugi, Yamato, Isehara, Ebina, Zama, Ayase, Samukawa, Aikawa, and, of course, Sagamihara. It was clear that adequate infrastructure was the fundamental precondition for an industrial agglomeration that covers such a large territory. The commitment to linking the region internally with an appropriate road transportation system was soon put into practice with the construction of a highway that crosses the region longitudinally from north to south. It was completed in March 2014 and was a key presence to foster the development of the cluster from a logistical point of view.

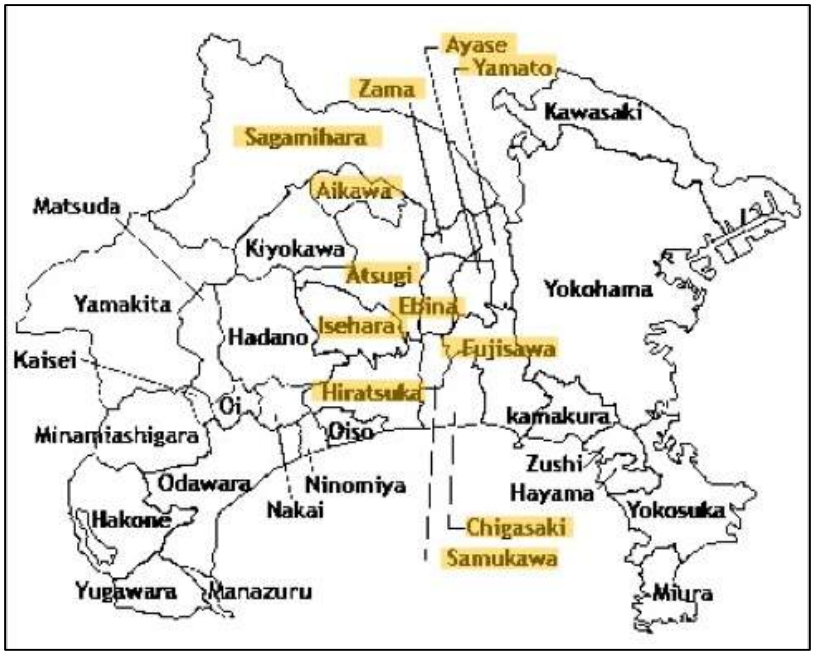

Figure 5: Map of Kanagawa Prefecture.
(The cities marked in yellow correspond to the Sagami Cluster)

The objective of the Sagami Robotics Special District is stated as the "realisation of regional safety and security through the practical application of *life-supporting robots*"（生活支援ロボットの実用化を通じた地域の安全・安心の実現）. "Life-supporting robots"（生活支援ロボット）become therefore the means by which the Sagami Cluster would achieve its objective. This type of robot differs fundamentally from the "industrial robots"（産業用ロボット）and is also called "service robots"（サービスロボット）.

According to the International Federation of Robotics, a "service robot" is a robot that operates semi or fully autonomously to perform services, excluding manufacturing operations, useful to the well-being of humans. Since the robots developed in the Sagami Cluster are meant to cope with either the increasing needs of an ageing society or with natural disasters, they can be grouped as follows:

1. Nursing and medical robots（介護・医療ロボット）;
2. Life-assistance robots targeted at elderly users（高齢者等への生活支援ロボット）[27];
3. Disaster-response robots（災害対応ロボット）.

The internal organisation of the cluster is described by the illustration below *(Fig. 6)*, which shows the extremely large concentration of companies, research centres, organisations, and institutions belonging to the Sagami Robotics Special District.

[27] The current research narrows down on these first two types. Some practical examples of robots developed in the Sagami area will be provided in Section 4.1.4.

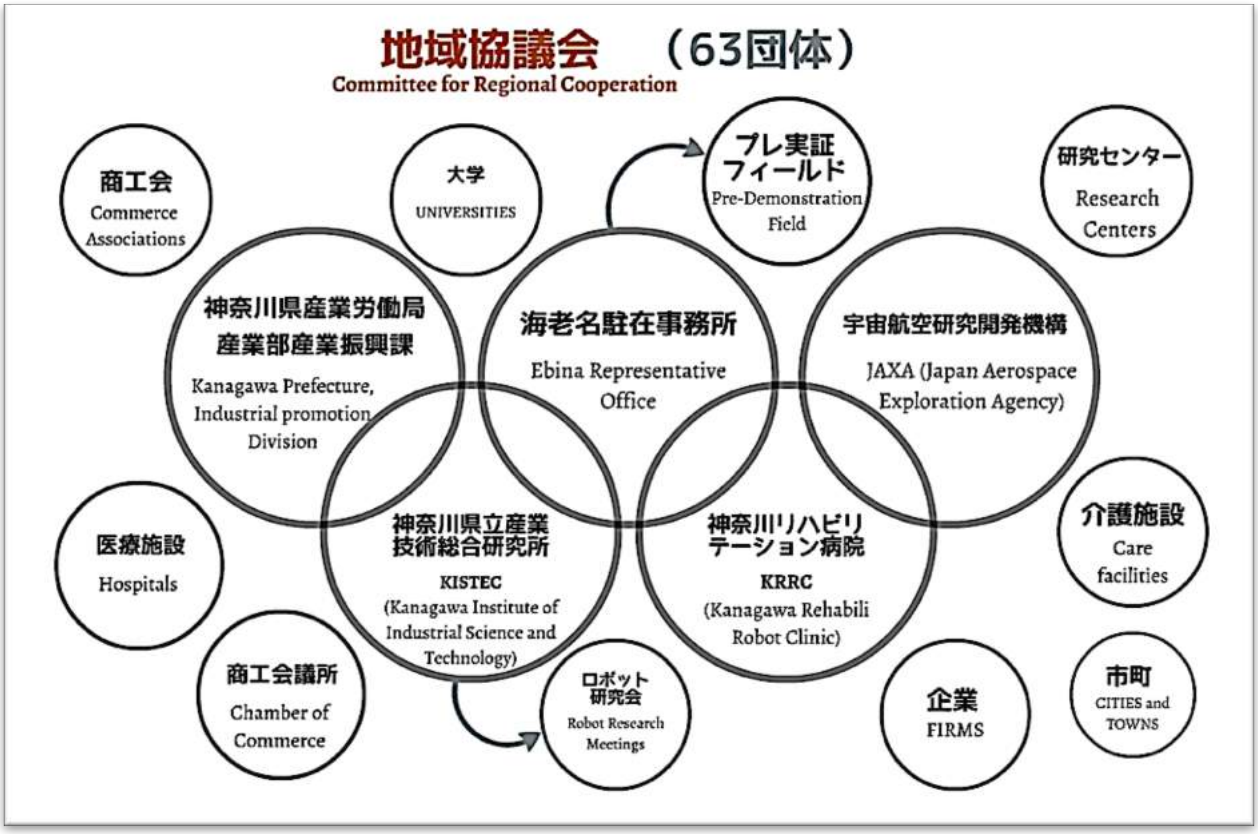

Figure 6: Internal organisation of the Sagami Cluster.

As one may notice, the cluster does not present a pyramidal structure that would involve a vertical decision-making process guided by governmental institutions. As widely explained previously, the "Industrial Promotion Division" of Kanagawa Prefecture has played a crucial role in enhancing the rise of the Sagami Cluster. This notwithstanding, it maintains a role of coordination primarily, and voluntarily does not take the lead of the cluster itself, in order to allow the formation of horizontal relationships among organisations, hence a dynamic and competitive environment. It rather offers support for choices in the development phase, advising companies on a variety of aspects both at the research and pre-development level and during the realization of the project as well.

Doing so, the prefecture avoids favouring one company over the others, while each member of the cluster can enjoy a considerable degree of autonomy and independency contributing not only to its own growth, but to the development of the cluster as well. To guarantee that individual members operate not only for their personal profit, but also for the advantage of the district as a whole, the *Committee for Regional Cooperation* (地域協議会) regularly holds meetings to discuss the current and future direction of the district. These meetings can be set up by any of the 63 members –

including firms, economic associations, universities, research centers, hospitals, care facilities, etc. – when it deems is necessary.

On the other hand, the *Kanagawa Institute of Industrial Science and Technology* (KISTEC) functions as a contact point among different members of the clusters. It can be seen as a platform（場）where they can exchange information and knowledge during "seminars" or "research study groups" about robots（ロボット研究会）. These may occur spontaneously or might be facilitated and organized by the prefecture – case in which they assume the characteristics of R&D meetings - especially when small-medium enterprises are trying to reach out to bigger ones.

Companies, research centres, and universities all contribute to the development of new projects on robots. Even the *Japan Aerospace Exploration Agency* (JAXA) is deeply involved in the Sagami District, handling the realisation of robotic systems related to the aerospace field, such as drones. Universities can enter the Sagami District as members of the Committee for Regional Cooperation, and include Tokai University, Keio University (Shonan-Fujisawa campus), Kitasato University, the Kanagawa Institute of Technology, and the Shonan Institute of Technology.

The *Ebina Representative Office*（海老名駐在事務所）is a sub-organisation of Kanagawa Prefecture, and supports the projects that have already been developed sufficiently by companies, performing a bridging function between firms and users, and focussing on the testing and commercialization of the products, allegedly the most challenging tasks. In fact, since even big firms can hardly find opportunities to test their products before launching them in the market, the Ebina Representative Office plays a crucial role in creating this kind of opportunities and let developers carry out verification tests without being hindered by major financial, legal or logistical obstacles. For instance, it administers the use of the "Pre-Demonstration Field", a crucial place for firms to test the robots (this will be described more thoroughly in the next chapter). It can also organise trial tests and "Robot Experience" events in hospitals and care facilities.

4.1.3 ... And in practice

It is clear that the successful implementation of life-assistance robots must be rooted in a well-orchestrated, strong and joint effort, so that all the different tasks are distributed to the most suitable performer in terms of skills and resources. The Sagami Cluster has adopted a clear and concrete strategy that can be exemplified in three core stages *(Fig.7):*

1. Research & Development （研究開発）;
2. Testing（実証実験）;
3. Diffusion & Education（普及・啓発）.

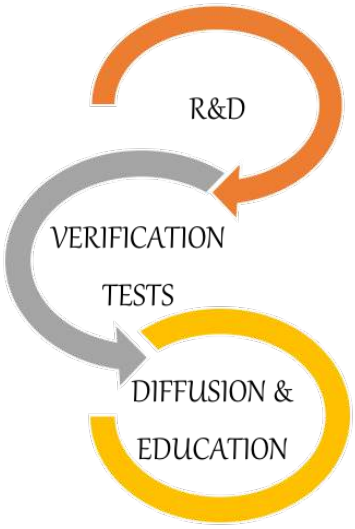

Figure 7: The process required to develop a robot.

1. RESEARCH AND DEVELOPMENT

First of all, firms should examine carefully both their internal and external environment. Doing so, they can understand what the needs of the market are, as well as whether there is scope to enter the industry, and how the organization can contribute to fulfilling such needs. The development phase is equally important: designers should constantly bear in mind that

there is always room for improvement, welcoming ongoing changes and refraining from being fixed on the project as they originally conceived it. In this regard, it is crucial that developers from different organisations have the chance to confront each other, while constantly being projected towards the final users, aiming at devising a product that can be accepted and used easily by the society.

The phase of Research and Development is practically carried out by companies but supported and coordinated by Kanagawa Prefecture and by the Kanagawa Institute of Industrial Science and Technology (KISTEC). As a first step towards the realisation of the robotics product, firms can participate in "Seminars" (or "Research Study Groups") about robots（ロボット研究会）. These gatherings are held in the form of joint research among members and can be extremely useful both for companies still in the process of considering joining the Sagami Cluster and for companies already in the process of product development.

During these workshops, the former can gather information on the current needs of the market, which should be investigated very thoroughly. Since "life-assistance robots", which constitute the thrust of the Sagami District, mainly target elderly people, a special attention to their characteristics and demands is required. Once these have been sufficiently explored, the firm can either receive advise on the planning level in case it decides to develop a new robotics technology or understand whether it can enter the market with its product. It is interesting that it is not necessary that a firm develops from scratch a new robot to enter the cluster. There is a myriad of small and medium enterprises who could possibly join the Sagami District as they manufacture technological parts and components that could be used for robots produced by other companies belonging to the cluster.

On the other hand, companies already developing robotics projects, may rely on the "Research Study Groups" for different reasons. Some may be seeking for consulting services to improve the "usability" and "acceptability" of their robotics product by users, others may be willing to be put in contact with other members of the cluster in order to exchange technological know-how.

Another form of cooperation among organisations of the cluster is constituted by the "Open Innovation" initiative（神奈川版オープンイノベーション）. The project is a form of joint research and development, where different organisations, from firms to universities, can

combine their resources in the R&D phase. They can also rely on the support of experts and professionals, who perform a role of coordination and help them find the optimal match. This arrangement is particularly useful when trying to commercialise quickly "life-assistance robots", whose implementation is being sought as soon as possible.

A practical example of "Open Innovation" is represented by the construction of the "Volcanic Activity Monitoring Drone", commercialised in December 2016. Since the volcanic activity of the Owakudani valley, near Hakone (Kanagawa Prefecture), had increased notably in recent years, it became unsafe to get closer to collect data on the site, due to the extremely high volcanic alert. Thus, it was necessary to monitor the situation with new technologies. The need was soon filled by a robotic device fathered by the joint R&D of three different companies *(Fig. 8)*.

Figure 8: The "Volcanic Activity Monitoring Drone".

The device is basically made of an aerial robot carrying a ground robot and sampling equipment to inspect the surroundings, measure volcanic gases, and gather relevant information to predict eruptions, landslides and similar incidents. *Japan Circuit* (株式会社日本サーキット) coordinated the general planning and mounting of the fuselage[28]; *Okino Industries LTD* (オキノ工業株式会社) supplied the single components of the fuselage; *Art 1* (アート１) devised the surfaces of the robots, treated with special materials

[28] The *fuselage* is the main body of an aircraft.

and techniques that make them contemporarily anti-rust, anti-deformation and Sulphur-resistant. This example is particularly significant as it provides an episode of bigger companies (*Japan Circuit* and *Okino Industries LTD*) that rely on a smaller firm (*Art 1*) for its skills in a specific field - in this case surface painting, sheet metalworking and molding - that apparently may not seem relevant for the development of robotics technologies. It clearly demonstrates that the Sagami Cluster does pull together a variety of organisations operating in a wide range of different fields.

Furthermore, firms can also receive comprehensive support during the design phase of their robots. Committed to helping manufacturers deliver the best appealing products, Kanagawa Prefecture offers services such as collaborations with design professionals, collaborations with other firms, trial production support with 3D printers, intellectual property rights, etc.

Finally, it creates opportunities of cooperation not only between firms, but also between firms and consumers. When users directly express their need for a specific type of robots, the prefecture gets moving to encourage new robot-development projects. It usually reaches out to potentially suitable robot makers, or holds special meetings – called "matching-support forums" （マッチング支援のフォーラム） to present the new challenge to companies in the form of a public recruitment event. In these cases, it may also provide financial aid.

2. VERIFICATION TESTS

The development stage of robots is followed by a long phase of verification tests. Service robots have a deeper degree of interaction with users, hence involve a deeper degree of risk, a long experimental phase is required afterwards. New technologies need to undergo a series of trial tests when they are at a prototype stage, meaning when they are almost completely developed but still not in the condition for being sold in the market. The robot has to be perfect in order to avoid harmful incidents that would end up hurting the user and damaging the company. It is therefore necessary to create opportunities and provide environments where these experiments can take place without restrictions imposed by regulations.

Moreover, it is also important for companies to conduct trial tests open to the public, so that they can contemporarily experiment with real users, as well as raise public awareness and attention on the theme of robots.

Nevertheless, since the cost of hiring facilities to carry out these experiments is usually extremely high, the aid of Kanagawa Prefecture becomes vital. Its support does not translate merely into financial coverage of the costs. Instead, it creates itself the opportunities for testing through the provision of "testing-facilities" or the organization of "testing-events", accessible for any organisation with no discrimination of sort. Thus, it can be affirmed that the prefecture maintains a rather neutral position and performs a coordination function bridging together users and firms, rather than granting concessions to one side over the other in a condescending way.

A significant case of testing-facility supplied by Kanagawa Prefecture is exemplified by the conversion of a former high school campus (whose closure was due to the scarce number of students enrolled) into the "Pre-Demonstration Field" （プレ実証フィールド） located in the city of Sagamihara. The facility features all the ideal characteristics that this kind of infrastructure should have. Not only it is located in a strategic and easy-to-reach position (just outside the Sagami Highway); it is also completely free of charge and firms can apply to use it even for long periods of time.

Covering a wide area which includes one main building, several other buildings, a gymnasium, a running ground, two tennis courts, a volleyball court, and a pool *(Fig.9),* it allows the reproduction of different settings and conditions, hosting a variety of tests on robots since the end of 2013. For instance, the sports ground is used to pilot the self-driving machines, while the high ceiling of the gymnasium makes it suitable to fly drones (in addition, drones' testing can take place outside too, thanks to a protective net installed between two buildings that prevents drones from deviating from the designated area).

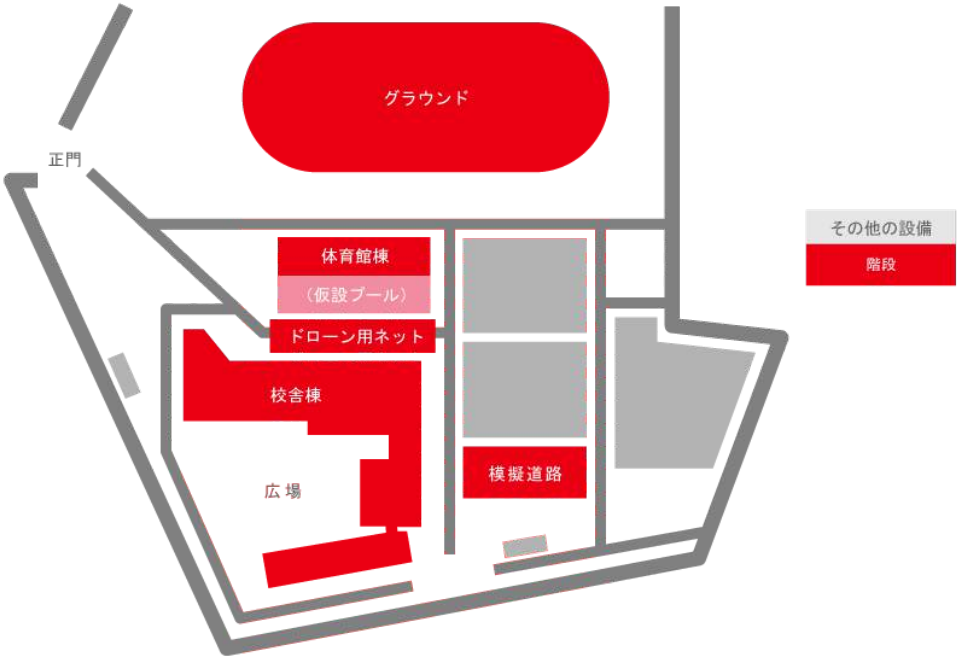

Figure 9: Map of the Pre-Demonstration Field.

It is noteworthy that the facilities for testing are not limited solely to designated infrastructures such as the 'Pre-Demonstration Field". Thanks to special agreements with a number of hospitals, care facilities, and rehabilitation centres, firms can carry on trial tests at these sites with real patients, who in turn enjoy the privilege of interacting with cutting-edge technologies.

Furthermore, Kanagawa Prefecture guarantees operational support at all levels, including the testing phase, to 23 selected "Priority Projects"（重点プロジェクト）. Indeed, some projects can be chosen and receive preferential treatment if they comply with special requirements:

1. "a robot whose experimentation can attract the attention of the population at an early stage"（「早期に県民の目に触れる形で実証実験可能なもの」）, or
2. "a robot that can impact the everyday life of the population"（「県民生活にインパクトを与えられるもの」）, or
3. "a robot that has a high public reputation and/or can exert a great influence externally（「知名度が高く、対外的な発言力に優れたもの」）.

Nevertheless, the “Priority Projects” represent only a part of the experiments that are being pushed forward by the prefecture. The willingness to support any company at the “experimental level” is confirmed by the establishment of the “Open Recruitment Campaign”（公募型「ロボット実証実験支援事業」）. The initiative is essentially a nationwide call in which companies from all over the country can participate by presenting their robotics products. The chosen projects (13 in total) obtain assistance at various levels, from financial aid to partly cover the costs of experiments, to the procurement of testing venues and opportunities to receive advise on potential adjustments from the testers, as well as support concerning safety measures and ethics reviews.

Lastly, the prefecture is continuously carrying on negotiations with the central Government to obtain ease of regulations in order to facilitate verification tests and accelerate the implementation of robots in the society.

3. DIFFUSION AND EDUCATION

Once the robot has been developed and tested accurately, the last step, and allegedly also the most difficult, is represented by the promotion of robots in order to boost the sales and enhance their commercialization and diffusion in society. This stage is extremely delicate, and a failed diffusion of robots in the society may result in a lack of awareness of their importance in public opinion. The whole effort would then be wasted: investing huge resources in developing, testing and launching robotic devices that nobody would eventually purchase, is nothing but a lack of rationale.

Even the population of Japan, which is one of the most robot-friendly countries in the world, still seems reluctant to accept the presence of robots in everyday life and to rely on them for daily tasks and activities. For this reason, institutions need to raise public awareness of robots, of their crucial importance and of the role they are already playing in our society, so that people can understand how they can take advantage of them.

For instance, there was a lot of resistance from the local population against the proposal of converting the Sagamihara High School campus (that either way was in disarray) into an area destined to robot testing, later named "Pre-Demonstration Field". It took Kanagawa Prefecture no less than three years before managing to persuade the citizens and obtain the official permission to use the territory, accepting to assume itself all the related responsibilities and maintenance costs. Therefore, it soon became clear that any effort to advertise robots with promotion activities, must be accompanied by equal efforts to educate people on them.

The "Robot Experience Caravan" （ロボット体験キャラバン）can be considered an excellent strategy in this regard. This initiative takes place in the form of gatherings in which both firms and users participate. Being held periodically in a variety of different places – from hospitals and caring centres, to schools and public events about regional welfare - it aims at creating opportunities for firms and users to get to know each other and mutually benefit from these meetings. The former can promote the robots, and the latter can try to use them in person and understand how they work.

The "Robot Experience Caravan" meetings usually start with an explanatory briefing where the firm can describe the functions of the robot and how to use it correctly, followed by a Q&A session. Afterwards, the participants can test the robot themselves: this is a unique chance for citizens to experience a product that they have never used before and that may meet their needs. Finally, they fill in a questionnaire where they evaluate the robot and the experience they have had. This survey is of uttermost importance for developers to understand who the potential buyers of the product are and whether it should make changes according to the testers requests.

Another similar initiative promoted by the prefecture is the "Tester system of life-assistance robots"（生活支援ロボットのモニター制度）.Users and patients can apply to "borrow" a trial version of the robot for free, and use it for a fixed period of time, usually one month. This is undoubtedly a great chance for firms to introduce their products in the market and start advertising them. As in the "Robot Experience Caravan", users evaluate their experience and answer a final survey, that will be particularly useful for the developers to understand what it the future direction they should take. Both the "Robot Experience Caravan" and the "Tester system of life-assistance robots" can be used by anyone, even by those

companies whose projects have not been chosen officially by the district through the “Open Recruitment Campaign” or among the “Priority Projects”.

In addition, financial aid is offered to robots already commercialised thanks to the “Robot Introduction Support Subsidy” Programme（ロボット導入支援補助金）, covering up to one third of the total cost of the robot.

Finally, the prefecture has created an anime series called “Robot Town Sagami 2028” *(Fig.10)*, where the main character is inspired by Astro Boy, known in Japan as Tetsuwan Atom（鉄腕アトム）.

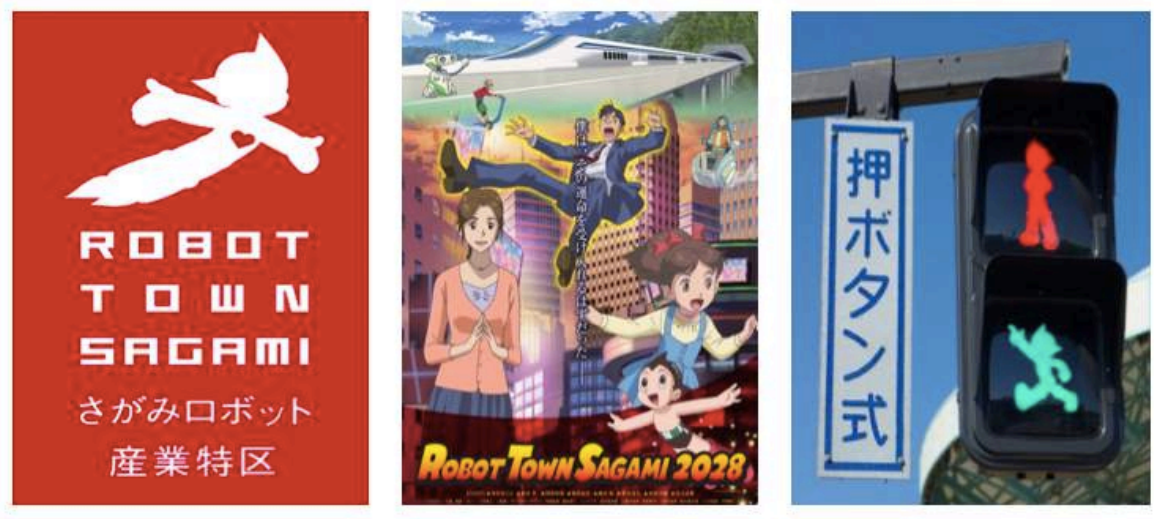

Figure 10: Different ways to popularise robots.
On the left: a commercial of the “Robot Town Sagami” of the future.
In the middle: a poster of the animation featuring Astro Boy.
On the right: a traffic light shaped like the Astro Boy.

The animation, produced jointly by the Sagami Cluster and Tezuka Productions, depicts a community where robots and humans co-exist and co-evolve together in harmony. In other words, through this story Kanagawa Prefecture tries to imagine the society of the future, or at least as it hopes would be by 2028 considering the enormous effort it is making to integrate robots in the society. Trying to increase robots-awareness through channels of communication that belong to the entertainment sphere and that have always had an extraordinary popularity in Japanese society – like animations – is certainly an innovative and promising initiative to build the ground for the penetration and acceptance of robots in society.

4.1.4 Brief insight in life-assistance robots developed in Sagamihara

Too often, popular beliefs and collective imaginary associate “elder care robots” with creepy humanoid robots whose presence is too often perceived as more disturbing than helpful. It is therefore important to clarify what is the exact meaning brought by the term “robots” in a care-assistance context. The exploration of a number of devices developed in the Sagami District will provide some practical examples, shedding light on how “humanoid robots” actually represent only a minimal percentage of the latest creations, which, being declined in myriad forms, can respond to the most varied needs.

Sometimes users who have to rely on robots may feel “inadequate”, hence may instinctively develop a feeling of rejection towards devices that they feel distant and that indirectly recall their disability. In order to foster their commercialisation and let them win people’s minds, the Sagami Cluster has classified the robots according to a very distinctive criteria: their “special power”, or “strength”（チカラ）, each impersonated by a different feature of the character Astro Boy (Tetsuwan Atom). This decision is naturally part of a well-reasoned marketing strategy: Kanagawa Prefecture rejected the use of purely technical descriptions that could jeopardise the real message of robots as friendly and pleasant presences.

Therefore, a couple of robots for each type of “strength” will be presented briefly *(Table 2).*

1 MUSCLE POWER

POWER ASSIST HAND & LEG
（手足のリハビリを支援する
パワーアシストハンド・レッグ）

- Robot aimed at assisting the rehabilitation therapy of hands and feet.
- The device is equipped with little airbags (connected to a pump) that expand or contract in an arcuate shape, according to the movements of the joint.
- It enables the patient to continue the rehabilitation therapy at home and addresses the shortage of therapists in hospitals.

2 EYESIGHT POWER

ELDERLY MONITORING SYSTEM
（赤外光センサーを使用した高齢者見守りシステム）

- Health monitoring system by remote control targeted at elder patients.
- The device monitors the environment thanks to contactless sensors (i.e. infrared lights) and AI.
- It can detect anomalous situations (falls, deterioration of health conditions, etc.) occurring in a room and immediately notifies it to family members or care staff.
- It ensures the safety of patients in the respect of their privacy.

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3 HEARING POWER

ULTRASONIC DIAGNOSTIC ROBOT
（遠隔操作による超音波診断ロボット）

- Pregnancy-status monitoring robot by remote control.
- The device scans the abdomen of a pregnant women through ultrasounds and send the information to a physician.
- It addresses the scarce number of obstetricians (especially in peripheric regions), allowing remote medical check-ups for pregnant women.

4 POWER OF WORD

COMMUNICATION ROBOT
(介護施設における認知症患者を含む高齢者向け
コミュニケーションロボット)

- Humanoid communication robot targeted at elder users including patients affected by dementia.
- The robot, called “PALRO”, can recognise more than 100 faces (associated with the corresponding names), and entertains the user with quiz, games, dance, gymnastics or simple conversation.
- It aims at preventing the need of LTC through conversation and other recreational activities to stimulate the elder’s brain and maintain physical functions.

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5 POWER OF THOUGHT

GYMNASTICS TEACHER ROBOTS
(体操評価付き健康啓発ロボットシステム)

- Gymnastics teacher robot targeted at patients affected by locomotive syndrome.
- The system works thanks to the cooperation of different devices. “PEPPER”, a communication robot, gives instructions on the exercises to be performed; “KINECT”, a sensor robot, detects the performance through a motion camera and communicates the information back to Pepper, who in turn reports the feedback to the user (so he/she can improve it). The robot “NAO” may also be used to give a practical demonstration of the exercises suggested by Pepper.
- It enables patients to perform such rehabilitation therapies in autonomy, without the need of specialised staff.

6 POWER OF FEELING

GUIDANCE ROBOT
(人の行きたい方向を察知し先導する
ガイダンスロボット)

- Guidance robot that supports the movements of visually impaired people (including elderly) in indoor spaces.
- When the user handles the grip and applies a light force in the desired direction, a built-in sensor detects the instructions and the device starts moving.
- It also allows to set a destination and calculate the route. If on the way there is any obstacle, it avoids it or automatically stops.

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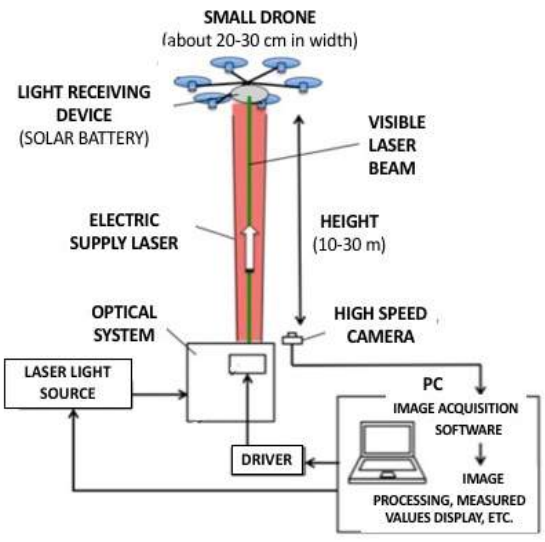
7 POWER OF FLYING



WIRELESS POWER SUPPLY DRONE
(災害現場等で長時間活動する無人飛行
ロボット等への無線給電システム)

- Wireless power supply drone to be used in disaster-hit area.
- The drone can be detected from the ground and charged remotely thanks to the laser it is equipped with.
- Thanks to its small size, it allows to observe the desired objects from a closer distance. The wireless power supply system enables it to fly for long period of times, outflanking the recurring problem of small devices with weaker batteries.

Table 2: Examples of robots developed in the Sagami Cluster.

4.1.5 The future of the Sagami Cluster

As already mentioned, the Sagami Cluster has just entered its second term of existence, which is guaranteed until the end of 2022 (and likely to be renovated again even afterwards). The new five-years term has projected the District towards new horizons. While the first term was focused on the *implementation* of life-assistance robots in healthcare, welfare and calamity response to "*protect* the life of the population"
（保健・福祉面や災害面において、生活支援ロボットの実用化の促進により、県民の「いのち」を守る）, the second term has shifted its attention to the implementation and *diffusion* of life-assistance robots *in every field* to "*brighten* the life of the population"（あらゆる分野において、生活支援ロボットの実用化・普及の促進により、県民の「いのち」を輝かせる）.

The cluster has therefore laid down new objectives, specifically: (1) an extension of the fields for which robots are developed（ロボット活用の対象分野の拡大）and (2) the increase in the visibility of robots in society（ロボットの「見える化」の促進）.

1. *Extension of the fields for which robots are developed*

   It has become clear that robots have a great potential in a myriad of different fields and should be leveraged to tackle even problems other than those linked to an ageing society and natural disasters. Thus, the pool of projects under development has increased significantly and the concept of "life-assistance robots" is acquiring a broader meaning, going further beyond the three categories of nursing-medical robots, robots targeted at elderly users and disaster-response robots. In particular, the second period is encouraging the development of:

   I. *Robots aimed at supporting a shrinking population*

      As widely explained in the introductory section of the current research, countries like Japan and Italy do not face just the ageing phenomenon. Indeed, their populations are experiencing an unprecedented shrinkage that will inevitably affect many fields and lead to the rise of a series of needs to be fulfilled, mainly due to a lack of workforce.

II. Robots aimed at guaranteeing public safety and security

Considering that Japan will host the Olympic and Paralympic Games in 2020, it is urged by the need to comply excellently counter-terrorism and crime-prevention measures in big public events. The Government should invest resources not only to deal with emergencies once they happened (like in the case of natural disasters, which cannot be predicted easily), but should also develop technologies that can help prevent them from occurring.

The new types of robots under development are summarised in the next page *(Table 3)*.

2. Increase in the visibility of robots in society

The second term of the Sagami Cluster sheds light on the necessity to promote robots with more emphasis. However, this prospects more than a few challenges. The diffusion of robots in society, as well as the public awareness on them, does remain a controversial topic and institutions are still far from having achieved their objectives in this regard.

A major matter for the upcoming five years is the debate around the monetary cost of robots, that, being usually considerably high, undoubtedly has a deterrent effect on people considering purchasing one. Lowering the price of robots may seem the most straightforward solution to increase the market demand. Nonetheless, the development and production of such devices is extremely demanding in terms of economic investments, and since companies often struggle to cover their costs, cannot lower the prices under a certain level.

Thus, it is clear that if people do not gain awareness of the utility and necessity of robots in their lives and do not commit to using them, the circle keeps turning like a snake biting its tail: companies do not lower the price unless the market demand increases, while the market demand does not increase unless the cost is lowered.

APPLICABILITY	NEEDS	EXAMPLES OF ROBOTS	
AGRICULTURE, FORESTRY, FISHERIES	Ageing and/or lack of people in charge of measures for the control of birds and wild animals in Agriculture, Forestry and Fisheries.	 *Birds and wild animals repelling drone*	 *Harvesting robot*
INFRASTRUCTURES, FACILITIES	➨ Large- scale renewal of existing infrastructures; ➨ Ageing and/or lack of workers.	 *Sewer inspecting robot*	 *Waist-assistant muscle suit*
TRANSPORTATIONS, DISTRIBUTION	➨ Lack of drivers; ➨ Increase in people with reduced autonomy in the daily grocery shopping.	 *Delivery service with automatic driving vehicles*	 *Automatic delivery service to the elderly homes*
TOURISM, SIGHTSEEING	➨ Responding to the rapid increase in foreigners visiting Japan; ➨ Difficulty in moving with autonomy due to ageing.	 *Guidance robots*	 *Wheelchair robot for movement support*
CRIME & TERRORISM MEASURES	➨ Securing safety when holding big events; ➨ Deterioration of the sense of public order.	 *Patrolling and defense robot*	 *Facial recognition system*

Table 3: Examples of robots under development.

4.2 DISCUSSION

4.2.1 What is behind the success of the Sagami Cluster?

The previous section has shed light on the historical path of the district, on the relevant players and their interactions, as well as on the prospects for the future. Moreover, a practical insight into the characteristics of the devices has provided a concrete example of what is being produced in the cluster, hence how those technologies can be used to fill specific needs.

In spite of the challenges – mainly related to the procurement of testing opportunities and the diffusion and the acceptance of robots – one can prudently bring the Sagami Cluster as a successful case of robotics development enhanced by the ageing of the population. It is appropriate to wrap up the research findings by making explicit some fundamental elements that one can only glimpse from a first reading. Indeed, the clear identification of the factors which have determined the success of the cluster enables to set a benchmark for drawing relevant lessons for Italy.

Specifically, I have identified the following distinctive components as the key drivers of Sagamihara's success: (1) the role played by institutions, (2) the type of relationships established among members, and (3) the culture permeating the cluster.

1. *The role played by institutions*

   The review of the literature has widely informed us that industrial clusters, such as the Silicon Valley, typically have a spontaneous nature: they are normally formed by the spontaneous agglomeration of interconnected firms that would benefit from geographic proximity. For instance, the growth of the Silicon Valley was enhanced greatly by the rise of a myriad of spinoffs founded by highly-skilled employees who leveraged the know-how acquired in the "parent" company and started a new business.

   Klepper (2010) notices that both the Silicon Valley and Detroit's automobiles cluster could benefit from one big firm[29] that generated a relevant number of spinoffs and acted

[29] The leading firms were Fairchild Semiconductor in the Silicon Valley and Olds Motor Works in Detroit's automobile cluster.

as leaders, especially in the first phases. In the beginning, the number of entrants was relatively low, and the clusters began to surge, spontaneously, only once spinoffs started to multiply.

The nature of the Sagami Cluster is totally different. As described in Section 4.1, it did not arise spontaneously from the natural aggregation of firms spawning spinoffs over time. The lack of big firms in the region, which can lure smaller companies and spark an industrial agglomeration as it happened in Silicon Valley or Detroit, was supplied by the entrepreneurial initiative of the public sector. For this reason, the Sagami Robotics Special District can be seen as an inspiring example of public entrepreneurship, which is rarely found in traditional patterns of clusters formation.

Institutions undoubtedly played a fundamental role in fostering the growth of the cluster. The central Government initially designated the Sagami Cluster as the key driver for the revitalisation of the region and continues to support the district – regardless of the ruling party – with advantageous policies such as ease of regulations. Furthermore, Kanagawa Prefecture provides support at different levels, especially for the most critical steps, that firms alone would not be able to overcome. As widely described earlier in the paper, it creates opportunities for testing the robots under trial, undertakes activities to popularise them in the society and educates the population on what is being produced in the Sagami Cluster, constantly contributing to its growth.

Therefore, institutions engaged in the district can be considered as a sort of "entrepreneurial teams": they constantly carry out innovation-driven initiatives, fuelling the economic growth of the cluster, hence of the country. In other words, they ignite that Schumpeterian "creative destruction" (Schumpeter, 1942) which is fundamental to nurture a changing society.

2. The type of relationships established among members

As described in previous chapters, the internal structure of the Sagami Cluster is quite complex. It is not limited to the inclusion of firms and relevant institutions. Instead, it consists of a myriad of different organisations, which are thus embedded in a dense network with whom they constantly interact.

Moreover, the relationships among members generally have a horizontal nature, allowing a significant degree of cooperation. For instance, the "research seminars on robots" (ロボット研究会), held by KISTEC, set an inspiring example on the sharing of such an important resource like technological knowledge.

Lastly, as already pointed out, the coordinating role performed by Kanagawa Prefecture and its sub-organisations guarantees the preservation and sustainability of the economic activities within the cluster. As noted by many authoritative sources in the literature (Saxenian, 1994a; Kenney and Von Burg, 1999), a major issue – often responsible of clusters' decline – is represented by the difficulty in maintaining the *status quo*. In the Sagami Cluster roles are well defined and distributed among members, avoiding confusion or unwanted behaviours such as prevarication or obstruction.

3. The mission permeating the cluster

It is noteworthy that the main purpose of the Sagami Cluster is rather generalized and inclusive of a broader concept, namely the "protection of the life of the population" (県民の「いのち」を守る).

It was not designed solely for tackling the issues brought up by an ageing society and rather placed within a broader framework of action. Doing so, demographic problems are not isolated, but recognised as part of a higher, more comprehensive mission: developing robotics technologies for a wide variety of purposes and users, in order to enable the whole society benefit from them. It is important to avoid the stigmatisation of elderly citizens as a "distinct group with special requirements" weighing on society. If they sense some kind of "discrimination", they are likely to instinctively develop a rejection towards robots because they may associate them with their physical and cognitive impairments. The diffusion and acceptability of robots are at stake.

The Sagami Cluster is empowered with the major responsibility of sustaining the growth and the well-being of a population who is experiencing a demographic shift. It confirms the conviction, expressed in the introduction of the current research, that it is high time we went beyond the idea of "elderly-friendly society" and embraced a more comprehensive "human-friendly" concept. It acknowledges that responding to the needs

of an ageing society is a vital step, exactly like tackling natural disasters, to ensure the population a better and safer life-quality. Not only senior citizens, but the society as a whole would benefit from such policies.

4.2.2 Implications for Italy

In light of the analysis of the research findings, it is no doubt true that the Sagami case leads by example in many respects. The model proposed depicts how Japan is coping with the future challenges risen by its ageing society with an innovative strategy, driven towards the creation of a "human-friendly" society through the development of robotics technologies. Italy can undoubtedly draw some meaningful lessons from the case of the Sagami District.

Nonetheless, practical implications are far from being straightforward and one shall be careful in drawing conclusions or even formulating guidelines for the application of the Sagami model elsewhere, for instance in Italy. A number of questions remain unanswered. Does Italy have those crucial elements, labelled as the key drivers of the rise and growth of the Sagami Cluster? If not, how can they be acquired? In any case, is it proper to replicate them or should Italy consider other solutions? Grappling with the conundrum is not an easy task. The critical re-assessment of the research findings through the lens of theoretical frameworks can help find the answers to such puzzling questions.

The literature informs us that the replication of the Silicon Valley model around the world turned into failure, most times (Kenney and Von Burg, 1999). This is because diversity matters. Governments and entrepreneurs are not likely to achieve success if they just identify and copy the key features of a given cluster. Since the new environment probably has different characteristics, the peculiarities of the context must be taken into account. Framing it from Aoki's perspective, different players involve a different structure of the game (2011).

Thus, it is important to acknowledge the global relevance of the example set by the Sagami cluster whilst adapting model components or model behaviours to the local context. The joint analysis of the Italian context with an insight in some guidelines suggested by the literature has led to the formulation of the following recommendations.

1. *Build on Strengths*

Any cluster has a source of competitive advantage that fuels its growth. When the Silicon Valley boomed, it could rely on decades of accumulated expertise on semiconductors, as well as on the presence of some giant leading companies in the sector that were magnets for new firms. The Sagami Cluster relied on a former automobile industrial area combined with a powerful mission and the coordination of the Prefecture.

Italy needs to identify its source of competitive advantage and exploit it too. It means that it does not necessarily need to reproduce the model adopted in Sagamihara. For instance, the typical apathy of Italian institutions makes initiatives of public entrepreneurship unlikely to be implemented easily. Even if the Italian Government decided to build a robotics cluster from scratch, it would not be able to guarantee its success. Engels (2015) reports that most cluster failures occur when Governments purposely start a new industrial agglomeration with the vertical implementation of policies and reforms.

The importance of leveraging local capabilities leads to the possibility for Italy to exploit its ability to gain economic strength from internal cohesion and deeply embedded social ties, confirmed by the well-known "Third Italy"[30] – one of the most studied districts in the literature on industrial clustering.

2. *Entrepreneurship is the Engine of Innovation, Networks are the Fuel*

Kenney and von Burg (1999) remind us that both Silicon Valley and Boston's Route 128 had their key figures: the former enjoyed the presence of Frederick Terman from Stanford University, the latter of the visionaries who created and managed the ARD (American Research & Development).

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[30] The term "Third Italy" was first coined by Arnaldo Bagnasco (1977), to indicate the North-Eastern and Central regions of Italy, characterised by the presence of small, crafts-based industrial districts (e.g. knitwear in Emilia, textiles in Tuscany, footwear in Civitanova Marche, toys in Canneto sull'Oglio in Lombardy, wooden furniture in Sacile in Friuli, etc.). The term distinguishes these geographical areas from the poorly developed South and the North-West – focused on the heavy industry with the triangle formed by Turin, Genoa and Milan. (Bianchini, 1991)

Given the lack of a solid basis to foster public initiatives, private entrepreneurship becomes even more important in the Italian context. Firms and start-ups are urged to find the courage to disrupt stability and become the drivers of innovation. In Italy, business efforts in this direction still remain isolated. For instance, “WeCARE” and “HeartWatch” are two examples of Italian-born startups that have produced robotics devices for the remote monitoring of health parameters, the latter declaring that it is quite hard to receive considerable institutional support, or to partner with big firms.

However, as argued by Engels (2015), it is highly desirable to pursue a mutual collaboration between startups and bigger firms in order to enhance entrepreneurship at multiple levels. Thanks to such partnerships, startups can gain access to resources, and enterprises can be inspired by innovative business models and enrich the core production with secondary products and services.

Furthermore, it is crucial to keep fostering innovation by building a solid framework of social networks, including a variety of different organisations from firms to institutions to universities and research centres. Part of the success of the Sagami Cluster lies in its horizontal structure whereby the organisations are all oriented towards the same mission, under the crucial coordinating role of Kanagawa Prefecture. In contrast, Boston’s Route 128 declined as a result of the excessively independent profile of its members (Saxenian, 1994a). Building and maintaining stable relationships enable to acquire resources, scout talents, facilitate exchanges of information. Innovation requires flexibility, dynamicity, fluidity, hence a broad and inclusive environment where all social actors can interact rapidly and easily.

Lastly, as pointed out by Buciuni and Pisano (2015), “clusters cannot be insular". They need to be internally focused but externally driven towards global markets, hence needs to be receptive to external inputs and transform continuously according to market changes.

3. Institutions are Crucial

The Sagami Cluster has demonstrated that the support of institutions occurs on different levels. A crucial aid is provided by Kanagawa Prefecture: it performs a bridging

function and provides resources in the creation of testing opportunities, as well as in the commercialization of robots.

As we have seen previously, the process required to develop robotics technologies is quite complex. Although the lack of public entrepreneurship may be supplied by private initiatives, the Sagami case teaches us that some fundamental steps – especially the testing and diffusion phase – cannot neglect the institutional support.

In Italy, opportunities for testing robotic devices under development are almost inexistent. Developers have to bear huge costs to obtain certificates and hire facilities. Even public hospitals charge firms if they wish to test their new products on patients, and the Government does not provide any financial coverage. Such an adverse environment is far from facilitating the development of robotics technologies. Institutions should actively contribute to the mission of building a human-friendly society, even by starting from little and gradual steps (such as enacting an ease of regulations).

V. CONCLUSIONS

The last chapter of the dissertation brings together all the aspects that have emerged previously, linking them into a holistic conclusion representing my interpretation of the topic. Eventually, the final sections mention the contributions of the present research to the existing literature, they acknowledge its intrinsic limitations, and offer suggestions for further investigation on the subject.

5.1 Final considerations

The research focused on Japan's strategy to cope with the demographic challenge through the systematic development of robotics technologies. The Sagami Robotics Special District was analysed to shed light on a topic that is still unexplored in the existing literature, partly due to the young age of the cluster itself: it is still in early stages of development; thus, it does not feature the typical interest shown by academia towards more matured industrial districts.

The research produced original findings: an attentive analysis and interpretation through the lens of appropriate theoretical frameworks, have allowed meeting the research objectives set at the beginning of the paper. All the research questions have been answered. The rise and formation of the Sagami Cluster were explored in detail, and the key drivers of its growth have been identified (RQ1). Current and future challenges are acknowledged (RQ2), whilst the study of the Sagami Cluster's projects has allowed understanding what the practical advantages brought by the products under development are, and in which sense the district is achieving its mission while creating added-value for the whole society (RQ3). Eventually, attention was drawn on the elaboration of some interesting implications for a country, like Italy, which is experiencing similar demographic woes (RQ4).

The die has not yet been cast, though. There is one clue that remains unanswered. At this point, critical readers may question the validity itself of the analogy between the Japanese and the Italian context. Why should Italy, after all, develop the robotics industry? Does the country really need an Italian-born agglomeration of technological knowledge? Would it not be easier to directly import the products from countries historically more apt to develop robotics technologies?

Although some scepticism is understandable, it is important to acknowledge that robots really represent the technological revolution of the XXI century and will, eventually, become more integrated into our society. We had better prepare for the revolution. New technologies are often niche products in the beginning (e.g. automobiles) but are quite likely to become part of the society at later stages, marking incredible turning points in people's everyday lives.

It is true that Japan has a culture more prone to accept robots compared to other nations, hence the ground for their development might be more fertile. However, it is also true that the implementation of such technologies does not end in the development and production phase. As demonstrated throughout the paper, the process is rather complex. The development of robotics technologies involves two fundamental domains that complement each other: economy and society.

All social actors are required to contribute actively in the process. We need to foster entrepreneurial behaviours, seek institutional support and change people's mindset at any costs: only with a comprehensive and well-orchestrated strategy, we may achieve the diffusion and acceptance of robots in the society, hence a superior co-evolution of humans and robots oriented towards the shaping of a "human-friendly" society.

Such considerations remind us that technology is the means, not the end: humans must remain the central actors. It is not an external force and shall not dominate society. Since it arises exactly from social interests, it can contribute to sustain and shape relationships among social actors. The development of robotics technologies is not proposed by the current research as the magic wand to solve the huge demographic problems that most countries are facing. Notwithstanding, it has the potential to shape social interactions and help us build a society where everyone can fulfil his/her needs and have access to the same opportunities.

Yuko Harayama – Executive Member of the Council for Science, Technology and Innovation (CSTI) of the Japanese Cabinet Office – creates the concept of "Society 5.0"[31]. For the future of Japan (and of the world), she envisages a "super smart society" where "various needs are finely differentiated and met [...] and in which all the people can receive high-quality services and live a

[31] Harayama (2017) provides the following definitions of "society". Society 1.0 is the hunting society, Society 2.0 the agrarian society, Society 3.0 the industrial society, Society 4.0 the information society and Society 5.0 the super smart society.

comfortable, vigorous life" (Fukuyama and Harayama, 2017). Exactly because we live in an era when anyone can act as a game changer, society as a whole – not just experts and professionals – is called to participate in the process of igniting innovation. Existing constraints and obstacles shall be removed, and the ambitious goal of shaping a "human-friendly" and "human-centered"[32] society shall be pursued at all levels.

5.2 Contributions

The value of the research primarily lies in the contribution it brings to the existing literature and to a topic that is of vital importance in the future agenda of Governments. The study of the Sagami Cluster is undertaken through the use of original data sources and underpins a wide range of theoretical frameworks that typically belong to different domains of study.

Not only a rare and inspiring example of public entrepreneurship in cluster formation is provided by the investigation of the Sagami District. The analysis of the case study also adopts an original perspective: it deals with the demographic challenge as part of a broader and more comprehensive strategy for the future of the country. Lastly, the careful assessment of the research findings has generated the formulation of critically reasoned conclusions, drawing some important considerations for the Italian context as well.

[32] The concept of "human-centered" is conceived by Harayama together with the concept of "Society 5.0" (Fukuyama and Harayama, 2017).

5.3 Limitations and recommendations for further research

The present research is not immune from some intrinsic pitfalls and limitations, that ultimately lead to the suggestion to expand the topic with further research.

First of all, since the Sagami Cluster is still under development, all related implications are not clear yet, hence the full extension of the topic is hardly identifiable at present. Furthermore, the limited number of case studies analysed may constrain the findings. Further research in similar clusters is required. For instance, the Japanese Government is trying to foster robotics industrial agglomerations also in Chiba and in Fukushima Prefectures. These districts are still in the very early stages of formation and lack of adequate academic interest, which is desirable in order to track the development of the areas over time.

In addition, the development of robotics technologies is and will be a very controversial theme. As suggested earlier, social actors should prevent technology from dominating society. However, an extensive development of robotics technologies may trigger several drawbacks. Among these, I have identified the potential overreliance on robots as one of the most critical factors.

Further research into these aspects is, therefore, crucial to gain a deeper knowledge on the topic, as well as more awareness of every possible outcome and implication.

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