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Japan and ICT: an analysis of the core strategies and their implementation

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Sommario

論文の概要

本論文は、日本における情報通信技術の状況、日本におけるデジタル・イノベーションを実現するために政府が行った主要な政策、日本の高齢化社会とこの分野の技術に内在する経済的機会に対するこの分野の重要性について考察することを意図している。

この論文の3つの章を通して、著者の目標は、日本社会におけるこれらの技術の実装に対する主要な障害の概要を提供することです。 これらの政策の背後にある政治的プロセス、前世紀以来この地域で強力な存在感を示しているにもかかわらず、なぜこれらの技術の使用が不足しているのか、そしてこれらの技術インフラストラクチャと日本人との関係を分析します。そうすることにより、日本におけるデジタル革命の阻害要因として、主に2つの特徴を定義しています。1つ目は、政府機関同士の連携が取れていないことです。2つ目は、国民のデジタル代表の欠如と、「マイナンバー」制度の達成度の低さである。

第1章の主な目的は、ICTというテーマを、その歴史的な起源と関連性の両面から読者に紹介することである。さらに、2000年代の最初の数年間、ICT政策の発展が必要とされた政治的枠組みについての分析が示されている。本章では、ICT分野の関連性を強調し、その関連性について歴史的な文献をいくつか紹介します。これは、日本における最新のICTインフラと、世界最高レベルのブロードバンドネットワークのカバー率を紹介するためである。その後、ICT統合政策に焦点を当て、日本におけるその進化を検証した。現代日本におけるこれらの側面の影響を明らかにすることを目的として、2000年代初頭から提案されている主な国家戦略を分析した。その結果、国家戦略は日本を現代の高度情報通信インフラに導くことに成功したものの、ICTがもたらす機会を最大限に活用することができず、民間および公的機関によるICTの導入が不安定になったことを明らかにしました。

第2章では、日本のICT技術の経済的量と、このセクターが提供しなければならない主な機会に焦点を当てています。 この章では主に、ICT投資の欠如と「失われた10年」における全要素生産性への投資の欠如に焦点を当てています。 この観察は、ICTに固有の可能性のある機会を紹介し、将来の5GおよびIoT技術の使用により、日本に影響を与える人口の高齢化に直面する可能にするために行われました。本章で分析した重要な点は、ICT資本と高齢労働者の間の補完効果である。日本の産業界において、高齢者が低学歴である場合、高齢化は労働生産性にプラスの効果をもたらすようである。したがって、日本における低学歴の高齢者の増加は、労働生産性を向上させ、日本経済への将来の投資において考慮されるべき有用な資産となり得る。以上より、本章では、高齢化社会への急激な人口移動が必ずしも経済的な脅威ではないこと

を証明した。
本論文の最終章である第3章では、日本が政府のデジタル化を推進し、民間企業のデジタル変革を実現するための主要戦略である 「マイナンバー 」を紹介する。この「マイナンバーカード」と「デジタル庁」の設立に伴い、政府は、日本のICTの大きな問題の1つである、異なる政府機関間の交換と情報交換を組織しようとしています。「デジタル庁」は最終的に、異なる政府機関間の情報交換を規制する際の指揮塔の必要性に対処します。「マイナンバー」は、初めて中華民国居留を作成する外国人を含む、日本国内のすべての居住者に発行される固有の12桁の番号です。 「マイナンバー」制度の導入により、政府が過剰な数の書類を審査する必要がなくなったため、行政手続きがスムーズになりました。また、現代日本社会で「マイナンバーカード」の普及率が低い理由の一つである、個人番号カードの情報量に対する誤解についても解説しています。この章「マイナンバーカード」が最も信頼性が高く、安全な身分証明書であることを証明する主要な技術について説明します。

Introduction

This thesis has the intent to examine the state of the Information and Communication Technology in Japan, the main policy the government undertook to implement digital innovation in the country and importance of this sector, both for Japanese ageing society that for the economic opportunities intrinsic of this category of technology.

The main goal of the first chapter is to introduce the theme of ICT to the reader, both in regard to its historical origins and ramification. The main feature that characterizes modern Japanese society's use of ICTs are also analysed in this part. To this end, one of the main sources of information used was the peerless work of Yoshio Arai and its article "History of the development of telecommunications infrastructure in Japan", through which the author was able to delineate a clear and comprehensive track of evolution of this infrastructure in the country. Furthermore, an analysis of the political framework through which the evolution of the ICT policy had to develop in the first years of the 2000s is presented. This, in order to make the reader comprehend some of the key feature that outline the government shortcoming regarding this subject, most notably the shortage of a tower of command which would cohordinatinate the interaction between different government bodies. Two of the main texts that have helped in the realization of this chapter are the one of Noriko Igari "How to successfully promote ICT usage: A comparative analysis of Denmark and Japan" and the one of Masahiro Kawai "The Evolving Power of the Core Executive: A Case Study of Japan's ICT Regulation after the 1980s". These two texts were used as complementary agents, the joint use of these and other key texts contributed a lot to the realization of this chapter, their clearance and meticulous approach facilitated the understanding of key accomplishments and missteps on behalf of the

government.

The second chapter focuses on the economic volume of the ICT technology in Japan and the main opportunities this sector has to offer. Taking this into consideration, the chapter aims at providing a clear summary of the current state and ramification of this technology in modern Japan, analysing its shortcomings in an historical framework, mainly focusing on the lack of ICT investments and of investment towards Total Factor Productivity in the "lost decade". This observation was made in order to introduce possible opportunities inherent to the ICT, and the future 5G and IoT usage it enables, the key one being the possibility to capitalize on a new kind of threat that many advanced and developing economies are facing: population ageing. This research was made possible through the works of many literatures' representative, most prominently the ones of Fukao Kyoji "Explaining Japan's Unproductive Two Decades" and the one realized in collaboration with Ikeuchi Kenta, YoungGak Kim, and Gyeog Ug Kwon "Why was Japan left behind in the ICT revolution?", and with the use of core government documents such as the "White Paper on Information and Telecommunications" published yearly by Japan's Ministry of Internal Affairs and Communications.

The third and final chapter of the dissertation consists of an analysis of a propaganda strategy enforced by the government: the "My Number" initiative. Starting with the creation of the Digital Agency last September, which finally addresses the need for a "tower of command" which could organize the interaction and information exchange between different government agencies, the chapter introduces the main strategy through which Japan aims to push for the digitalization of the government and to bring forth the digital transformation of the private sector. This was made possible

through various transcript of the Diet session in which the so-called “Number Law” was introduced, and various interview of some core agents behind its promulgation: former Prime Minister of Japan Yoshihide Suga and the “father of the internet” in Japan, Murai Jun. In this chapter, a brief overview of the “My Number” initiative will be provided, analysing both the “My Number Card” and “Myna Portal”. In addition, the political debate behind the enactment of the 'number law' will be analysed, what the major concerns of the political class were at the time and how these were resolved by the Japanese government. To this end, a core text that has enabled this examination is “Anonymisation and encryption technology to protect the privacy of personal data” by the hands of Koichi Ito, Jun Kogure, Takeshi Shimoyama and Hiroshi Tsuda. These authors not only provide a clear account of the evolution of the political framework behind the "My Number" initiative, but they also address the public misconception about the amount of information stored inside the "My Number Card," which is one of the main reasons for its low penetration rate in modern Japanese society despite being one of the most reliable and secure identification devices.

Chapter 1: ICT history in Japan and the main agent in its regulation

Japan is internationally esteemed as one of the world's most technologically advanced nations, with a state-of-the-art electronic industry. The Country has earned its fame as one of the most dominant nations regarding scientific research, with prominence in fields such as technology, robotics, and AI investment in later years. Not only that, but along with the revenues from the software sector alone, which accounted for sales of more than 15 trillion Japanese yen as of 2018, the data processing and the information service sector generated revenues of more than seven trillion yen [1]. Despite these statistics and the country's reputation, both the public sector and certain areas of the economy have been perceived as relatively lethargic when it comes to the adoption of digital technologies, in particular regarding the field of Information and Communications Technology (ICT). ICT is sometimes misinterpreted and mixed with term IT (Information Technology). IT is just one, maybe more important, part of ICT, the second one being Telecommunications. It is not just one of the most important innovation "creators" but also a cause of cultural, economic, political and educational changes and it is defined by OECD as:

> "combination of manufacturing and service industries, whose products electronically capture, transmit or display data and information. The production (goods and services) of a candidate industry must primarily be intended to fulfil or enable the function of information processing and communication by electronic means, including transmission and display[2]".

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[1] 総務省, Ministry of Internal Affairs and Communications "Information and Communications in Japan 2021", available online at: https://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/whitepaper/2021/pdf/chapter-4.pdf

[2] Information available at: https://www.oecd.org/digital/ieconomy/2771153.pdf

The Network Readiness Index[3] (NRI) is an international index published by the World Economic Forum, whose objective is to provide a detailed analysis of the digital skills of the various nations by analysing, through what is defined as the NRI framework, the factors, policies, and institutions that allow a country to fully rely on ICT in order to lead to inclusive, sustainable and competitive growth of the nation itself. Albeit Japan has had support facilities with very high-speed broadband network, e.g. Fiber-To-The-Home/Building (FTTH/B) connection since 2003, the truth is that Japan is still struggling with various issues regarding the efficient implementation of digital and technological services to the general public, which leads it to occupy a "mere" twelfth place in the NRI ranking.

The aim of this first chapter is to give a clear and organised review of the ICT infrastructure history in the Country, of the main actors that have helped shape the history of this industry, of the ratio behind the lack of efficiency of some policies during the last two decades, what ICT integration policies have been proposed during the years and some aspect which have led to their deficiency. Concurrently, reference will be made to *e-government* policies understood as "the utilization of ICTs to make government more accountable, responsive and equitable"[4].

In order to provide a clear summary and help understand some of the peculiarities of ICT in modern Japan, the first section will provide a detailed history of the construction of ICT in the country. In the course of this section, we will highlight some of the fundamental steps that led to the current technological infrastructure and how these helped the growth of the business and information trade in some prominent cities such as Tokyo, Nagoya and

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[3] Information available at: https://networkreadinessindex.org/country/japan/

[4] Takao Y., "Democratic Renewal by "Digital" Local Government in Japan", *Pacific Affairs, Summer, Vol. 77, No. 2 (Summer, 2004), pp. 237-262*, 2004.

Osaka. The domestic telecommunications network that takes full advantage of Japan's geographical conformation and the joint use of two communication routes, expanding one towards the east and the other towards the west, will help the construction of a strong ICT apparatus both in the national and international spheres. With the passage of the decades, a major configuration change corresponding to the expansion of Internet use can be found in the international telecommunications infrastructure rather than the national one, the reason being that the domestic one inherited the strong geographical configuration of national telegraph networks. Japan's national telecommunications networks were built and operated by an essentially monopolistic firm which has evolved with time and remains a key agent in ICT regulation to this day. The fundamental structure of Japan's telecommunications infrastructure has remained considerably unchanged since the early period of Japanese telecommunications.

1.1 ICT implementation history (ICT実装の歴史)

As stated before, Japan beneficiates from its very high-speed broadband network to enrich its information environment, but how has Japan managed to construct such a performative telecommunication infrastructure? The start of this process can be traced back to the establishment of the Meiji Government in 1868, when Japan started to modernize its State. Given its insularity, Japan has required long overseas telecommunication routes to access the international telecommunications networks, in order to construct them a great deal of investment have to be made, which usually are accompanied by technological difficulties. In addition, one of the most pressing issues for the Meiji Government was to establish a modern state, which required political and economic relationship with overseas developed countries. This was achieved through the employment of continuously more

advanced technologies such as radio technologies first, satellite communication then and optical fiber nowadays. During the course of centuries, the technology behind the telecommunications process has advanced, and the original telegraph networks and telephone ones has since been greatly enhanced. In particular, it is impossible to discuss the expansion of the internet starting from the 20th century separately from the advancement of telephone and telegraph infrastructure, which is why the goal of this paragraph it's to identify, as a historical process, the development of Japan's telecommunication infrastructure. Given that no telecommunications infrastructure is built from the ground up, but rather upgraded through the introduction of new basic technologies, its modern characteristic can only be understood throughout a comprehensive exam of its construction process in a historical context, from the beginning of the Meiji Era to the implementation of 5G and its ramification in the modern era.

1.1.1 Telegraph and telephone networks in Japan

The Great Northern Telegraph Company, a Danish telegraph company, managed to establish a telecommunications network between Europe and the Far East in 1871, by completing a line of submarine telegraph cable which connected Vladivostok in Russia, Nagasaki in Japan, and Shanghai in China[5]. During this time the Meiji Government hasted to complete domestic telegraph lines and successfully connected Tokyo to Nagasaki via Nagoya and Osaka, in order to attach itself to the Danish company lines. Having completed its local lines, it was now possible for telegraph to be sent from Japan to major Europe cities through the Great Northern lines. In addition, by utilizing a previously built British international network (the so called "All-Red Route") which

[5] Ahvenainen J., *"The Far Eastern Telegraphs: The History of Telegraphic Communications Between the Far East, Europe and America Before the First World War"*, Helsinki, 1981.

connected to Shanghai, it was now possible to establish communications with Indian, European, and Southeast Asian countries as well[6]. It is also during this time that the major economic and political centre of Japan started establishing themselves as one. By looking at the communication records illustrated in the table below, it is possible to distinguish how more than half of the international telegrams in 1892 were transmitted from the Tokyo area, with a great deal of this communications coming from Yokohama, we can also observe how the Osaka area transmitted almost one-third of the international telegrams. Given this data we can determine how the globalization of the Tokyo area, in terms of international communications at least, far preceded the one of other Japanese cities, and how the lack of communications routes across the Pacific Ocean hindered the possibility of communicating with United States and other major Countries in the area[7].

Place of sending and receiving	Number of telegrams	Percentage	Counterpart country	Number of telegrams	Percentage
Tokyo	5 651	6,8	China	29 648	35,7
Yokohama	36 677	44,3	Korea	13 624	16,4
Subtotal	42 328	51,1	India	4 706	5,7
Osaka	10 551	12,7	United Kingdom	12 828	15,5
Kobe	16 918	20,4	France	4 286	5,2
Subtotal	27 469	33,1	Germany	3 290	4,0
Nagasaki	9 434	11,4	Switzerland	1 453	1,8
Others	3 602	4,4	United States	8 843	10,7
Total	82 833	100,0	Others	4 155	5,0
			Total	82 833	100,0

Figure 1 Incoming and outgoing international telegraph traffic in major Japanese cities, 1892[8]

It is in fact not until 1906 that a functioning direct communication route

[6] Headrick D. R., "*The Invisible Weapon: Telecommunications and International Politics*", *New York: Oxford University Press,* New York: Oxford University Press, 1991.
[7] Ohno T., "*The History of International Telecommunications in Japan in the Meiji Era*", Yokohama: Seibunsha, 2012. In Japanese
[8] Yoshio, A., "History of the development of telecommunications infrastructure in Japan", *Japanese Journal of Human Geography, no.72, p.274, 2020*

crossing the Pacific Ocean enabled Japan and the United States to be connected. Even though a first trans-Atlantic submarine telegraph was completed in 1866 the installation of its cable was delayed and it would not be until the connection through two submarine cables in Guam (one American and the other a mainland-connecting Japanese one) that the two countries would have a direct communication route[9]. In parallel with the construction of international telegraph networks Japanese Governement continued to improve and establish domestic ones, requiring the telecommunication networks which connected every region to maintain domestic sovereignity system. Since this networks were connected to the international ones, the possibility of interchanging international telegrams was made available throughout almost all of Japan by the early 20th century.

Communication routes between Japan and the rest of the world highly beneficiated from having two connection centers throughout its mainland: one wich expanded eastward from Tokyo, and one oriented westward via Nagasaki. As we will see later, a new international communication route from Tokyo to the United States seems to have a similar design to contemporary Internet-era routes that use optical undersea cables, making trans-Pacific telegraph cables pioneers for today's international Internet networks[10].

During the first years of the 20th century, Japan started building radiotelegraph stations by developing long-distance radiotelegraph and long-wave technology[11]. Years later, during the 1930s, international telephone

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[9]Headrick D. R., "*The Invisible Weapon: Telecommunications and International Politics*", New York: Oxford University Press, New York: Oxford University Press, 1991.

[10] Arai Y., "Globalization of Japan as "the Far East": From the viewpoint of transportation and telecommunication infrastructures", *Geographical Review of Japan* Ser. A 90(4), pp. 279-299, 2017.

[11] Headrick D. R., "*The Invisible Weapon: Telecommunications and International Politics*", *New York: Oxford University Press*, New York: Oxford University Press, 1991.

services using short-wave radio were launched [12]. These technologies not only helped pave the way for the improvement of domestic telephone networks, but also proved essential to improve and expand long-distance telephone communications. By connecting these long-distance telephone networks to the international radiotelepone stations Japan also managed to provide and improve international telephone services, achievement made possible by relying on radio technologies.

Soon after the end of the Worl War II Japan experienced a rapid economic growth, which consequentily raised the demand for international communications. In order to face this high demand of communications, the deployment of high-capacity submarine communications networks using cable technology was established. In 1964 this project saw its completition with the connection of Tokyo to the United States made possible via the Trans-Pacific Cable 1 (TPC-1). This submarine cable connected to two previously installed cable lines, the Commonwealth Pacific Cable, or COMPAC, and the South East Asian Commonwealth Cable, or SEACOM, which were systems built by the Bristish Commonwealth[13]. So once again, just like in the telegraph age, Japan found itself in a favourable situation being included to two majour international communication networks and thus being able to communicate with both Britain and United States connected countries.

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[12] Ohno, K., "*The Dawn of International Radio Telecommunications in Japan*", Tokyo: Kokusai Denshin Denwa Kabushiki Gaisha, 1976. In Japanese.

[13]Baglehole, K. C. "*A Century of Service: A Brief History of Cable and Wireless Ltd.", 1868–1968*, London: Bournehall Press, 1969.

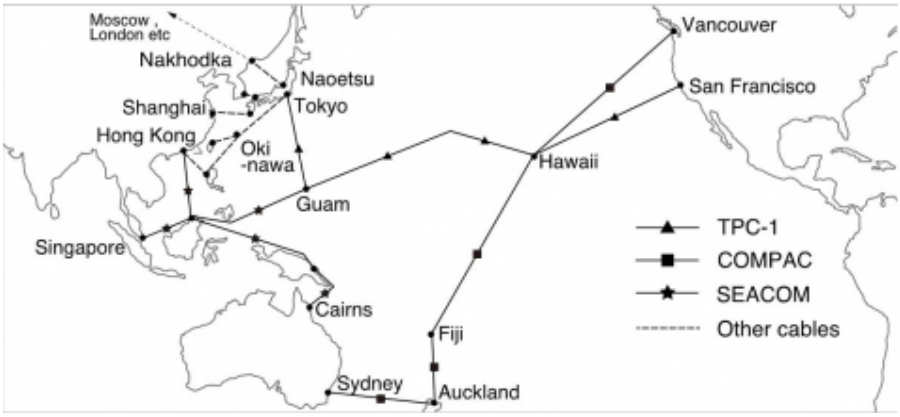

Figure 2 Trans-Pacific and East/Southeast Asian coaxial submarine cables, 1964–1984 (Kishi 2015)

The communication system saw a rapid change throughout the world in the 1960 to the 1970 decade, as seen before, with short wave radiophone lines starting being replaced with coaxial submarine cables [14]. Japan's domestic demand for telecommunications was being supported by high-capacity microwave technology which was developed throughout the country's mainland, and international coaxial submarine cables were connected to this microwave networks.

The 1964 saw the rise of commercial communications services and their reliance on communication satellites [15]. These type of communications were used mainly for tv relays services and international phone ones, and helped considerably to help raise awerness towards Japanese people and its culture, other than grounding their global communications in the Internet age.

The development of optical fiber communication technology during the 1970s resulted in a drastical impact on world's telecommunications technology. We can trace this impact a decade later in the domestic Japanese telecommnications technology, with the expansion of optical fiber technology and digital communications technology, which resulted in a drastical

[14] Kishi T. "*The History of Japan-China Submarine Cables After World War II*", Tokyo: Yoshikawa Kobun Kan, 2015. In Japanese.

reduction of the cost of telecommunication[16] and the installation of the first trans-Pacific optical cable the TPC-3 in 1989.

Another factor of crucial importance is the deregulation in the telecommunications business. Trailbrazer of this phenomen are the United States, following the rapid penetrations of the new telecommunications technologies, in Japan the businesses were liberalized in 1985. The previous monopolistic telecommunications carrier, The Nippon Telegraph and Telephone Public Corporation (Nippon Denshin Denwa Kosha), was broken up and several new private telecommunication carriers were established[17].

1.1.2 Infrastructrure in the internet age

A essential aspect to derive from what has been discussed so far is the fact that the telecommunications infrastracture constructed established the conditions for access to telecommunications services throughout Japan. However, the use of these services were limited for voice telephone calls. The advent of internet changed radically this situation, and in 1990 commercial Internet services were launched and made available to ordinary users. Because the fixed public switched telephone network had been established, dial-up internet access through analog telecommunications lines was possible. Nonetheless, to access advanced Internet services a broadband access is indispensable by reasons of large data transfers required to download software and multimedia content [18]. In chapter 2 we will analyse thoughtfully

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[15] Ueda H., "*The Dawn of Satellite Communications*", Tokyo: Kokusai Denshin Denwa Kabushiki Gaisha, 1973. In Japanese.

[16] Shinohara H., "*An Introduction to Optical Fiber Communications*": Revised edition, Tokyo: Ohmusha, 2006. In Japanese.

[17] Naoe S., "Japan's telecommunications industry: Competition and regulatory reform", *Telecommunications Policy*, 18(8), pp. 651-657, 1994.

[18] Arai Y., Naganuma S., "The geographical digital divide in broadband access and governmental policies in Japan: Three case studies", *NETCOM* 24 (1–2), pp. 7–26, 2010.

the evolution of the technology supporting telecommunications.

1.1.3 Fixed broadband penetration in Japan

The creation of an effective telecommunications infrastracture regarding broadband services in Japan was hindered by a negative attitude towards the investment on behalf of private companies. The technology behind such services, such as cable modem, fiber cable and digital subscriber line (DSL), were developed during the 1990s, however such services were launched in Japan around 1998.

Even though introduction of DSL had proven to heighten the penetration of broadband connections in many developed countries in Japan its development was delayed by a company which substantially held a monopoly on fixed telephone service, the now renamed Nippon Telegraph and Telephone (NTT), which will continue to be a prominent agent in ICT policy and related services throughout the years. In contrast, the Japanese government, anxious to promote broadband services, required NTT to open its telephone lines for DSL services in 2001. DSL services rapidly expanded troughout Japan following this event, and in 2002 surpassed cable modems connections[19].

DSL and cable modem services began to diffuse around the same time in Japan, during the early stage of this diffusion cable television networks were installed in densly populated areas, while its installation was delayed in less populated regions due to its low profitability. Once again the Japanese government had to mediate the situation, driven by the prospect of replacing analog television services with terrestrial digital television broadcasting, and promptly promoted installation of digital cable television throughout all

regions of the Country. Hence, penetration rate of broadband largely grew in the areas where digital cable television networks were installed [20].

The company responsible for the installation of optical fiber cable networks throughout Japan, and which holds almost all domestic wired telecommunications networks, since the early 2000s is the aforementioned NTT [21]. Due to its high costs relatively few subscribers switched from DSL to optical fiber [22]. Nonetheless, throughout the years fiber cable services area have increased tremendously since the middle of the 2000s. The national coverage rate for fiber optic broadband services for households, which exceeded 70 percent in 2013, was 99.1 percent as of the end of March 2020, and services are not available for almost 530 thousand households in Japan [23].

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[19] Arai Y., Naganuma S., Satake Y., "Broadband deployment projects in less-favored areas and the broadband policies of national and local governments in Japan", *Komaba Studies in Human Geography* 20, pp. 14–38, 2012. In Japanese.

[20] Ibidem

[21] Shinohara H., "*An Introduction to Optical Fiber Communications*": Revised edition, Tokyo: Ohmusha, 2006. In Japanese.

[22] Sunada M., Noguchi M., Ohashi H., Okada Y., "Coverage area expansion, customer switching, and household profiles in the Japanese broadband access market", *Information Economics and Policy*, 23(1), pp. 12-23, 2011.

[23] Ministry of Internal Affairs and Communications 2020: https://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/pressrelease/2021/pdf/The_fiber_optic_broadband_service_coverage_rate_in_Japan.pdf (last accessed 21/12/2021)

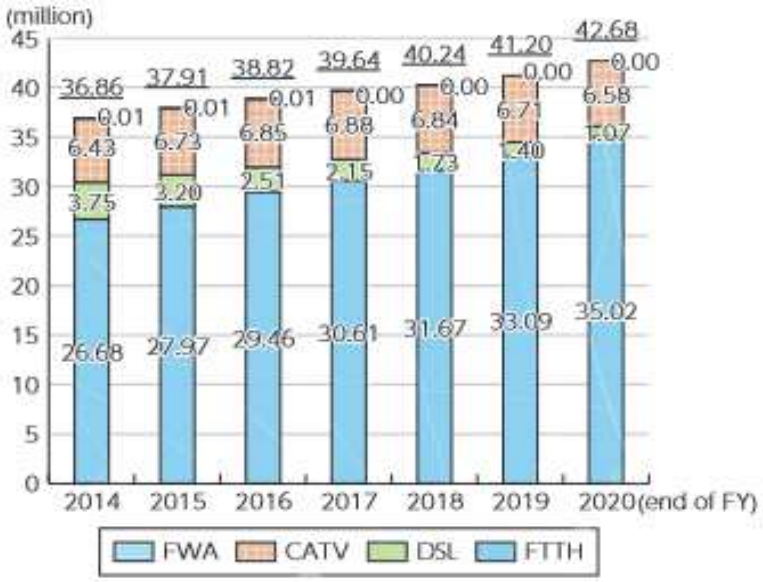


Figure 3 Changes in broadband service subscriptions (key points SOUMU)

1.1.4 Mobile broadband penetration in Japan

There have been five generational changes from the first generation of mobile communication systems, which was established in 1979, to the fifth one which started in the year 2020. Each generational change generated new value, which is the result of the evolution of mobile communications systems. The first mobile phone Internet service was i-Mode, launched in 1999 by a mobile phone subsidiary of NTT called NTT-Docomo, but 1st generation (1G) communications were limited to voice communications. 2nd generation (2G) ones improved on this front and allowed data communications (emails, internet access); i-Mode however used second-generation (2G22) mobile phone technology. This generation marks the growing factor of mobile communications systems, and it enabled this market to establish itself as a parallel infrastructure with fixed-line ones. In fact, the year 1996 marked an inflection point where number of fixed-line telephones subscriptions began to fall, whilst mobile subscriptions soared (this also thanks to reforms in the mobile sector, such as handset sold-out system and the abolishment of fee-

approval system).

As stated before, the first instance of internet access for mobile can be found in the year 1997 during the 2G era and in 2010 this way of accessing the internet would surpass even those accessing from PC. But how was it possible to have such a drastic change in the way of accessing internet, during the span of just 13 years? This can be traced back to the substantial change brought upon by the 3rd generation (3G) generational change. In 2001, services based on third-generation mobile phone technology were released, which improved the communication speed enough to allow relatively large Internet content [24].

With 3G, the growth of mobile phones accelerated, results in the formation of an ecosystem and the emergence of various mobile phone services. This marked the start of the "industrialization of wireless." The majority of 3G devices were SIM-locked and offered in tandem with a mobile carrier subscription, which also operated as a fee collection agent for internet access services. As a result, mobile carriers developed relations with handset manufacturers and content suppliers. The arrival of the iPhone 3G in 2008, also Android by Google the following year (that allowed third parties to develop and deliver smartphone services as apps), completely changed the structure of this ecosystem. Due to the overall existence of platforms, app developers had significantly lower barriers to entry into the mobile market because they only had to provide connectivity with the platform.

[24] Arai Y., "Geolocation technologies and local information in mobile telephony", *NETCOM 20* (1-2), pp. 9-25, 2006.

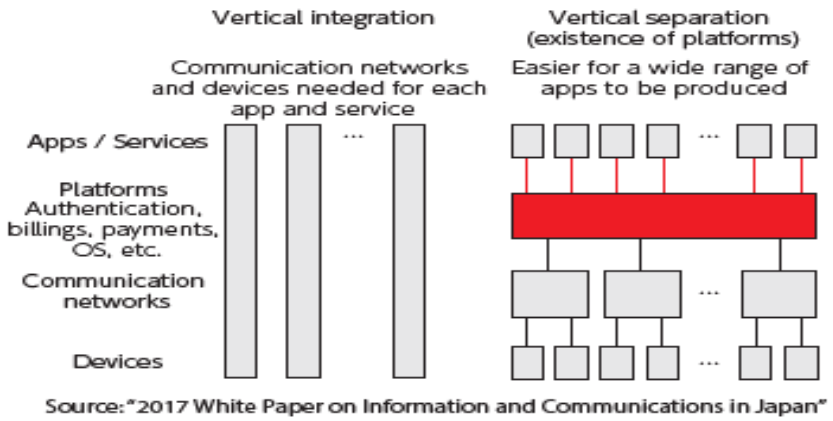


Figure 4 Comparison of vertical integration and separation (2017 White Paper on Information and Communications in Japan)

Smartphone revolutionized the mobile interface and shifted the ecosystem leadership from mobile carriers to digital platformers. And as mobile communications service advanced from 3G to 4th generation (4G), the ecosystems further evolved as an ICT industry with digital platformers at the centre and encompassing mobile carriers, device makers, and other key subjects. Since 2010, 4G compliant mobile phones have been available, employing services such as long-term evolution (LTE) and worldwide interoperability for microwave access (WiMax). These services can provide large volume content for 4G mobile phones, and mobile broadband services became competitive against again fixed broadband services [25]. Finally, 2010 marks the year where mobile subscriptions surpass the fixed-line one, leading to the remarkable result held in Japan as of September 30th, 2019, of 180 million of mobile subscriptions with a population penetration rate of 142 percent.

[25] Nakamura A., "Mobile and fixed broadband access services substitution in Japan considering new broadband features", *Telecommunications Policy*, 39(2), pp. 140-154, 2015.

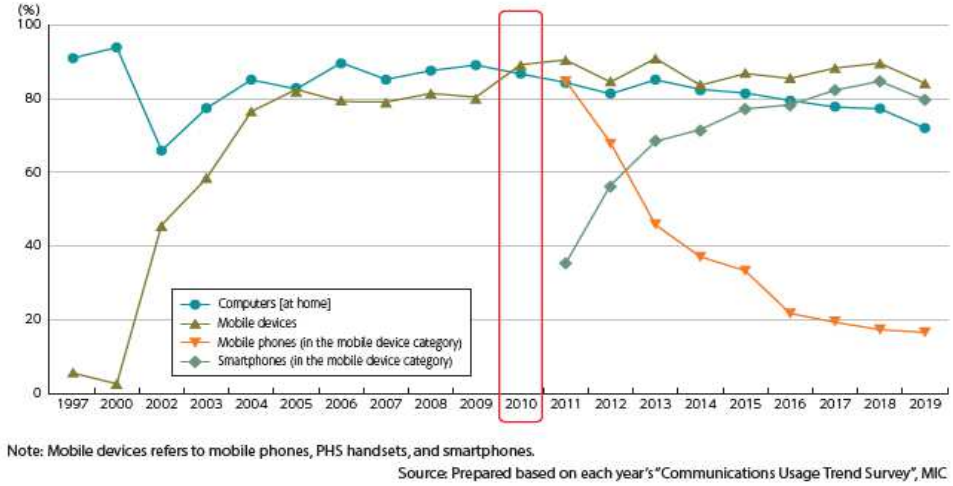


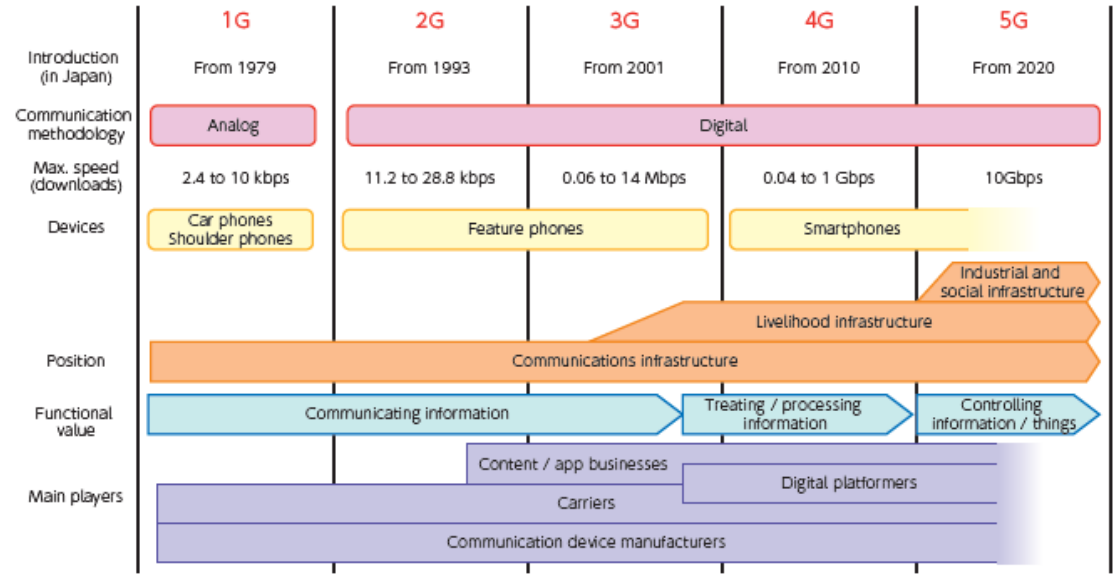
Figure 5 Internet usage rates by device (Ministry of Internal Affairs and Communication)

This led to the development of app that reached behind music, videos, games, and entertainment, and became rooted in users' lives. In this way, mobile communications systems transformed from simple communications infrastructure to infrastructure supporting users' livelihoods, which as we will see is the core of the current Japan Governments' ICT policy. The transformation to the functional value of mobile communication systems, from 1G connections to 3G ones, changed their main purpose into "treating or processing information to add new value" in addition to communicating information, which was the leading objective with 2G connections. At the same time, industries outside the ICT began studies to improve productivity, using smartphones and other wireless technology in earnest for social implementation of wireless technology in combination with cloud, big data, and Internet of Things. The first inklings of "wirless-ization of industry" appeared. 5th generation (5G), featuring ultra-high-speed communications, is a natural extension of mobile wireless technology progression up until 4G, it also possesses new functions such as ultra-low latency communications and multiple simultaneous connections unlike 4G. It is expected to become the ICT infrastructure for the IoT age when everything around us is connected to

networks.

Furthermore, the implementation of 5G is hoped to have a greater social impact than previous mobile communications technology in terms of making business operations more efficient and generating new ones. On the other hand, although IoT devices and applications are seeing explosive growth in numbers, they have a myriad of use cases and varying communications traits. Especially wireless IoT devices, with power consumption and unique radio-signal properties, and addressing all these needs with a single communication technology is impossible. As different industries and economic sector move ahead with digitalization, it will be important to combine 5G with other tech.

5G use, its implementation and the structural changes to the ICT industry that is expected to be brought about by 5G connected infrastructure will be discussed thoroughly in the following chapter.



Note: In this figure, 3G includes 3.5G and 4G includes 3.9G.

Figure 6 Evolution of mobile communication systems (Ministry of Internal Affairs and Communication)

1.1.5 International telecommunications infrastructure since the launch of Internet services

As a direct consequence of the diffusion of commercial internet services which took place in 1990s Japan experienced an explosive increase in the demand for international communications. Because Japan required overseas telecommunications networks to correlate with its internet use, ultra-high-capacity telecommunications networks with connections to the hub of internet services, the United States, were necessary. As described in previous paragraph, the first optical submarine cable across the Pacific Ocean were laid at the end of 1980. These older generation optical undersea cables were phased out at the end of the 1990s as a new generation of optical communication technology was developed. Once again we can find two areas of expansion for these new generation trans-Pacific fiber cables: some extends westward and form a direct connection between Japan and United States or Canada, such as the PC-1, JUS, Unity and FASTER; others connect Japan with China, Korea or the Southeast Asia and the United States or Europe, such as the SEA-ME WE3 or the APCN2.

Opening year	Abbreviation	Formal name	Capacity	Counterpart country/re-gion	note
1999	SEA-ME WE-3	South-East Asia-Midle East -Western Europe 3)	40Gbps	Korea, China, Southeast Asia	connecting the cables to Europe
2000	PC1	Pacific Crossing 1	160Gbps	United States	Direct connection to the American continent
2001	AJC	Australia-Japan Cable	320Gbps×2	Australia	connecting at Guam
2001	JUS	Japan-US Cable Network	1.28Tbps	United States	Connecting at Hawaii
2001	APCN2	Asian Pacific Cable Network 2	2.56Tbps	Korea, Taiwan, China, Southeast Asia	
2010	Unity	Unity/EAC-Pacific	4.8Tbps	United States	Direct connection to the American continent
2016	FASTER	FASTER	60Tbps	United States	Direct connection to the American continent

Figure 7 Typical optical submarine cables across the Pacific Ocean and to East/Southeast Asia since 1999

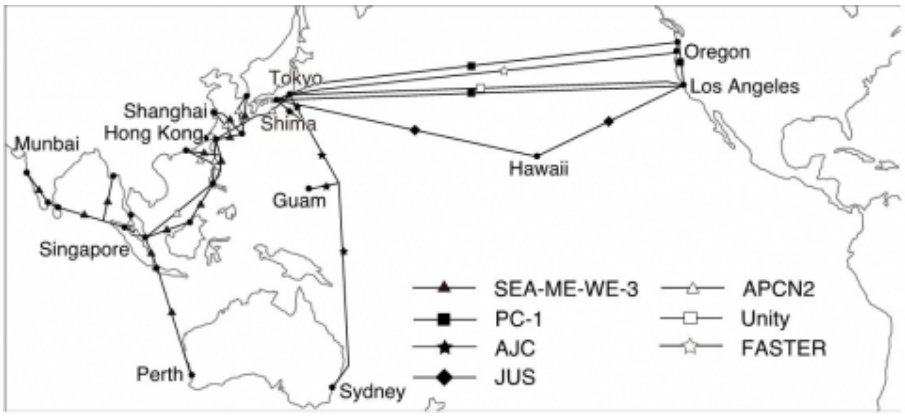


Figure 8 Typical trans-Pacific and East/Southeast Asian optical submarine cables since 1999

1.2. ICT integration policies (ICT導入政策ICT dōnyū seisaku)

One would expect that technologically advanced infrastructure observed in Japan would consequently lead the Country at the vanguard regarding e-government application, but when discussing ICT usage by government, business and individuals, the commonly held view among Japanese literature is that Japan lags behind not only within-government-entity (Within-G) and government-to-government (G-to-G) ICT usage, but also in government-to-business (G-to-B) and government-to-citizen (G-to-C) ICT usage[26]. In the following paragraph we will analyse thoroughly the political and institutional aspects which characterize modern Japan and the reasons that, while still having the world's best infrastructure, characterize Japan's slow adoption of ICT and why it's unable to take advantage of such infrastructure in the field of public services whose purposes is to make government more accountable, responsive, and equitable [27].

State transformation became a significant phenomenon in the first decades of the 21st century, so modern Japan state is considerable diverse from the nineteenth century and 1960s state [28]. We can differentiate between three schools of thought regarding the Japanese state in literature after the 1980s: state centric, pluralist, and rational choice[29], but after the 1990s, the different ideologies mostly agreed that some significant structural changes were emerging in Japan: the bureaucracy was losing its typical approach, policies were moving towards economic development and companies were more willing to take risks. As pointed out by many authors in the literature, the

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[26] Noriko I., "How to successfully promote ICT usage: A comparative analysis of Denmark and Japan", *Telematics and Informatics, Vol. 31, No. 1*, pp. 115-125, 2014.

[27] Ibidem.

[28] Steven K. V., "Japan Remodelled: How Government and Industry are Reforming Japanese Capitalism" New York: Cornell UP, pp.224, 2006.

[29] Masahiro M., "The Evolving Power of the Core Executive: A Case Study of Japan's ICT Regulation after the 1980s", *Pacific Affairs , March 2015, Vol. 88, No.* 1, pp. 27-49, 2015.

complicated process of decision-making in Japan's fiscal policy includes constant negotiation between various ministries, Liberal Democratic Party (LDP, 自由民主党, Jiyū-Minshutō) organisations, local representatives, and local governments. A common point highlighted in the various studies, and by the three school of thought, is the need to negotiate policy implementation with ministries in each sector. The literature also defines the concept of Japan being a 'dual state' in which development-oriented and distribution-oriented sectors coexist. As seen before in the telegraph and telephone history paragraph, with the 1985 telecommunications reform, which liberalised the market and privatised the dominant state-owned enterprise (NTT), ICT experienced a significant disjunction. The telecommunication network industry in Japan "experienced the most significant transformation from monopoly to competition" [30]. This schism shattered old regulatory approaches to the business and shifted the roles of governmental actors. Two factors that profoundly characterised this change are the timing - the 1980s was a period when the neoliberal discourse attracted public attention - and the nature of the industry which has the potential to offer insights into Japan's political economy (the 'dual state' mentioned earlier).

Prompted by the "臨時行政調査会：臨調, (rinji gyōsei chōsakai: Rinchō) or Second Provisional Commission on Administrative Reform" an independent council supported by Prime Minister 中曽根 康弘 Nakasone Yasuhiro (1982-1987), the Telecommunications Regulatory Reform in 1985 brought about a great period of change in Japan's ICT sector. Privatizing the NTT, alongside institutional changes, deeply transformed the structure and core actors of ICT sector and while NTT began concentrating on its business operation, the "MPT, 郵政省(Yūsei-shō) or Ministry of Posts and Telecommunications"

[30] Masahiro M., "The Evolving Power of the Core Executive: A Case Study of Japan's ICT

emerged as the dominant regulator replacing de-facto the NTT role.

The main agents in Japanese ICT regulation can be recognised as: prime ministers, responsible cabinet ministers, political appointees, and key party politicians outside the cabinet [31]. The state, through the MPT used regulation as a new tool that transformed the governance of key sectors from a regime that focused on the provision of services by public organisations to a regime of principal-agent regulation. Three key stages can be highlighted in Japan's ICT regulation: the privatisation of NTT in 1985, its reorganisation in 1999 and the subsequent transformation of the regulatory approach from ex-ante to ex-post that emerged in 1990 and the 2000s [32]. One of the most prominent agents in ICT regulation is a group called "郵政 or Yūsei-zoku": a peculiar kind of " 族議員or zoku giin" who specialize in posts and telecommunications affairs in the LDP. The zoku giin are LDP members of the Diet who specialize in peculiar fields, who often have special knowledge of other interest groups such as firms, and emblematic of a LDP administration instituted practice that bills would not be adopted without ruling parties' internal authorization, which was a crucial step in policy-making process. Hence, Yūsei-zoku role was exercised by promptly examining bills in the LDP Policy Affairs Research Councils (PARC) Communications Division, examining policy issues such as draft bills, and stopping endorsement if necessary [33]. This influence will continue to prove significant until the change in government party in 2009.

Regulation after the 1980s", *Pacific Affairs , March 2015, Vol. 88, No. 1*, pp. 27-49, 2015.

[31] Mitsutoshi I., "Kantei shudõ gata seisaku kettei to Jimintö-Core Executive no shūken ka" [The policy decisions led by the Kantei and the LDP-the centralizing core executive], Leviathan 38: 2006:

[32] The former indicating the concentration of regulation on issues that emerge before firms and the latter focusing on issues that emerge after firms have acted

[33] Muramatsu M., "The 'Enhancement' of the Ministry of Posts and Telecommunications to Meet the Challenge of Telecommunications Innovation". In: Wilks S., Wright M. (eds) *The Promotion and Regulation of Industry in Japan*, Palgrave Macmillan, London, 1991. https://doi.org/10.1007/978-1-349-12218-9_12

Through the use of the PARC and its Communications Division as their key tool to influence policies the Yūsei-zoku, together with elder and senior LDP politicians significantly influenced ICT policy decisions[34].

The period between 1985 and 1999 was dominated by the debate on the NTT breakup, during which we can observe the gradually evolution of the regulatory approach from ex ante to ex post. The crucial components of these regulatory measures are the development of rule for interconnection between telecommunications operator networks and the establishment of the "電気通信紛争解決委員会 (denki tsūshin funsō kaiketsu iinkai) or Telecommunications Dispute Settlement Commission" (TDSC). Although TDSC is located within the ministry is in principle an independent third-party organization, which demonstrates the government's intention to change its mode of ICT regulation. This set of policies aimed at rule making and dispute resolution proved effectively and therefore, broadband services grew exponentially. During LDP/LDP-led coalition governments little to none changes can be found in the decision-making framework with politicians outside the Cabinet, notably Yūsei-zoku, actively opposing attempt at asymmetric regulation. Nonetheless, challenges to this traditional framework emerged: the administrative reform in January 2001 which gave stronger power to the Cabinet Secretariat and establishing the Cabinet Office, also the establishment of the "政務三役or seimu sanyaku"[35] which strengthened the power of individual cabinet ministers within their ministries, thus replacing the previous configuration of the parliamentary team, composed of a cabinet

[34] Masahiro M., "The Evolving Power of the Core Executive: A Case Study of Japan's ICT Regulation after the 1980s", *Pacific Affairs , March 2015, Vol. 88, No. 1*, pp. 27-49, 2015.

[35] Seimu sanyaku (three political officers) is a team of parliamentary senior officials in a ministry composed of a cabinet minister, senior vice-ministers and parliamentary secretaries.

minister and one or two parliamentary vice-ministers[36]. Another key disjuncture in power relations within the core executive happened in 2009 with the government change from the LDP to the Democratic Party of Japan (DPJ) and with the collapsing power of the LDP zoku giin. The fall of the zoku giin predominance in the Japanese Government was prompted, among other reasons, by the 1994 electoral reform[37]: the lower house electoral system changes to the Mixed-Member Majoritarian electoral system (MMM). When the LDP returned to power in 1996 (the first elections under the new system), it had changed its rules regarding PARC membership[38]. Previously, LDP representatives could only belong to two PARC divisions, unless they were part of one or two legislative committees, in which case they were automatically added to the parallel PARC division. The reason for this change was the incentive of the new electoral system. Previously, when a candidate could win in a multi-seat Single Non-Transferable Vote district with only 10-20 percent of the vote, it was important to gain expertise and influence in a niche of the political field and contribute decisively to that electoral victory. But under the MMM system, with only one representative from a local constituency, representatives had to cater to a much larger and more diverse constituency to win the election. While in the new system there are incentives for MMM candidates to specialise less because of the increasing diversity of their smaller constituency, there are incentives for those on the regional party list to specialise more in a larger geographic area[39].

A further complication emerges from the governmental bodies set up to

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[36] Masahiro M., "The Evolving Power of the Core Executive: A Case Study of Japan's ICT Regulation after the 1980s", *Pacific Affairs , March 2015, Vol. 88, No. 1*, pp. 27-49, 2015.

[37] Masahiro M., "The Evolving Power of the Core Executive: A Case Study of Japan's ICT Regulation after the 1980s", *Pacific Affairs , March 2015, Vol. 88, No. 1*, pp. 27-49, 2015.

[38] Ibidem

[39] Pekkanen, R. J., "The Rise and Fall of Japan's LDP: Political Party Organizations as

oversee the functioning of the apparatus itself. The methods of risk assessment and evaluation of the ministries will only be established in 2008 and entrusted to investigative commissions whose only guidelines were to reduce costs in the individual ministries: they acted without any frame of reference to establish a system of collabouration within them. On the 6th of January of 2001 the "高度情報通信ネットワーク社会形成基本法[40] or Basic Law on the Formation of an Advanced Information and Telecommunications Network Society[41]" was enforced which, through its article 14, obliges the Government to compile and publish statistics concerning IT [42]. The Law indicates the intent of the Government to create a framework for systematically collect IT statistics and will culminate with the creation of the so-called "ＩＴ総合戦略本部IT (sōgō senryaku honbu) or Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society, or IT Strategic Headquarters[43]" an inter-ministerial entity located immediately under the "内閣府 (Naikakuhu) or Cabinet of the Ministry", whose aim was to promote the use of ICT among the various institutions. However, lack of budget and authority have prevented this initiative from working properly, as well as undermining the attempt to create solid lines of communication between local and national governmental entities, which has become an increasingly important problem in recent years. To exacerbate this problem, as reported above, there is also the cause of the lack of collabouration between the ministries themselves,

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Historical Institutions" Cornell University / *Cornell University Press*, 2010

[40] Transliteration: Kōdojōhōtsūshin nettowāku shakai keisei kihon-hō

[41] 首相官邸、Prime Minister of Japan and His Cabinet: https://www.kantei.go.jp/jp/singi/it2/hourei/honbun.html, in Japanese

[42] Hiroyuki K., "Official Statistics on ICT in Japan", *International Statistical Review, Vol. 71, No. 1*, pp. 69-82, 2003.

[43] 首相官邸、Prime Minister of Japan and His Cabinet: https://www.kantei.go.jp/jp/singi/it2/index.html

which has led to the decay of the mechanisms for the propagation of ICTs within local administrations. The case that emerged during the so-called "Millennium Project" is emblematic[44]. Despite the fact that the "総務省 (Sōmu shō) or Ministry of Internal Affairs and Communications" had recognised the need for a single IT system to ensure greater fluidity and avoid duplication between the various ministries, various ministries asked the "金融庁 (Zaimu shō) or Ministry of Finance" for funding to build their own IT, in some cases even turning to private companies to complete the sites themselves. Such individuals' initiatives included no way of ensuring that each system would not waste IT funds by duplicating others.

1.2.1 National strategies

We will now analyse the national strategies undertaken by Japan to expand and introduce ICT usage in its territory. A fact worth noting is how in the first decade of the new millennium alone Japan has drafted five national ICT strategies and how the core intention of this policies has shifted away, during the course of the years, from broadband infrastructure to the promotion of ICT usage.

The first of this policy is the "e-Japan Strategy" drafted in 2001 by the afore mentioned IT Strategic Headquarters. Japan government set the goal of having the world's most advanced ICT by 2005 by prioritizing the construction of an ultra-high-speed network infrastructure and competition policies, as analysed in paragraph 1. According to the Organization for Economic Co-operation and Development (OECD), in terms of the use of ICT in government, business and individual environments, Japan lagged far behind other countries. This is a direct consequence of the acknowledged lack

[44] Masahiro M., "The Evolving Power of the Core Executive: A Case Study of Japan's ICT Regulation after the 1980s", *Pacific Affairs , March 2015, Vol. 88, No. 1*, pp. 27-49, 2015.

of political integration of ICT policies not only in terms of the communication aspect within the government itself, but also of the government's poor communication operation with businesses and citizens[45]. As shown in the table below (Table 1), OECD data from 2001, place the Land of the Rising Sun well below other nations in terms of e-government, despite its strong ICT.

Country	*E-gov. index*	*Country*	*E-gov. index*
USA	3.11	Sweden	2.45
Australia	2.60	France	2.33
Singapore	2.58	South Korea	2.30
Canada	2.52	Italy	2.21
UK	2.52	Japan	2.12
Germany	2.46		

Figure 9 E-Government Index of Major OECD Countries, 2001 (UN, Division for Public Economics and Public Administration, 2003[46])

As seen in the paragraph before, Japanese Government had to request NTT to unbundle its ADSL services in 2000 which led to the entry of new carriers including SoftBank and to a severe price reduction during the year 2001[47]. This resulted in a widening offer of broadband services and made possible for Japan to conclude its goal described with the "e-Japan strategy" two years ahead of time, in 2003[48]. As to the promotion of ICT usage, the first government strategy had the ambitious goal of making all administrative procedures available online in order to realize a state-of-the-art electronic government administration. The following strategies, named "e-japan strategy II" in 2003 and "new IT reform strategy" in 2006, clearly shifted the direction of the strategy from the creation of an infrastructure to ICT

[45] Igari N., "How to successfully promote ICT usage: A comparative analysis of Denmark and Japan", *Telematics and Informatics*, Vol. 31, No. 1, pp. 115-125, 2014.

[46] Takao Y., "Democratic Renewal by "Digital" Local Government in Japan", *Pacific Affairs, Summer, Vol. 77, No. 2 (Summer, 2004), pp. 237-262*, 2004.

[47] Ibidem

[48] Igari N., "How to successfully promote ICT usage: A comparative analysis of Denmark and Japan", *Telematics and Informatics*, Vol. 31, No. 1, pp. 115-125, 2014.

utilization, and three focus areas in which slow utilization of ICT had been experienced were specified: e-government, health care, and education. With regard to e-government a separate goal to increase the usage ratio to 50 percent by 2010 was established. However, the proportion of government services available fell from 94 percent in 2007 to 52 percent in 2009 due to the low usage rates and enormous costs of operating and maintaining electronic administrative systems[49]. During 2009 DPJ minister 原口 一博Kazuhiro Haraguchi, made the attempt to promote both FTTH infrastructure and ICT usage through a project named "Path of Light". The government attempted to reach its goal by launching the "ICT policy taskforce for a Global Era", aimed at enhancing the broadband services through competition, service promotion measures including opening ICT networks and restructuring the NTT. This policy was promptly brought to a halt following the minister's departure in 2010, another factor emblematic of the turnover of people in change in ICT policy: in fact, during the 10 years between 2000 and 2010 fifteen different people have become minister in charge of ICT issues, making it difficult to propose and plan consistent strategies and policies[50]. With the advent of the era of the mass circulation of data socially recognised in the introduction of mobile smartphone and with mobile subscriptions surpassing the fixed-line one, Japan's ICT implementation and deployment plans over the past decade had to adapt and can be summarised with the name of the ambitious government plan formulated in 2013: “Declaration to be the World’s Most Advanced Digital Nation“, which has been adjourned yearly ever since being drafted. Since 2014, MIC has hosted meetings of the "Conference on the Promotion of ICT Introduction Throughout Society Leading Up to 2020." The

[49] Ibidem.
[50] Igari N., “How to successfully promote ICT usage: A comparative analysis of Denmark and Japan”, *Telematics and Informatics*, Vol. 31, No. 1, pp. 115-125, 2014.

conference examined how to further advance Japan's ICT, with a focus on national growth beyond the 2020 Olympics, and two of the most important government plans to that end are "The Basic Act on the Advancement of Public and Private Sector Data Utilization," which was promulgated and implemented in December 2016, and the "New IT Policy Principles for the Digital Age," which the IT Strategic Headquarters established in June 2019. The intent of these policies is the establishment of conditions through which Japan will survive and flourish in the international competition digital age and to resolve Japan's challenges through digitalization of all aspect of society. Japan's main intent is the integration of ICT for the life of the citizen with the aim of creating a society where people are enriched by data without having to be aware of the utilization of IT and data [51] .

1.2.2 Social and technological reasons behind unsteady adoption of ICT

A crucial document which can be used to better describe and analyse Japanese's' ICT regulation failure is the "情報通信に関する白書 (Jōhō tsūshin ni kansuru hakusho) or White Paper on Information and Telecommunications[52]" This document has been drafted yearly by Japan's MIC ever since 2001 and it states governments intention and challenges regarding ICT application. One of the reasons that has been recognized as a hindrance is the failure in Japan's digitization process: G-to-B and G-to-C ICT usage is emphasized but there is little to no progress made in reforming internal operations (Within-G) or information systems for back-office coordination (G-to-G). Consequently, the government has faced serious

[51] Ministry of Internal Affairs and Communications 2020: https://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/pressrelease/2021/pdf/The_fiber_optic_broadband_service_coverage_rate_in_Japan.pdf (last accessed 21/12/2021)

[52] A complete archive of all "White Paper on ICT" since 2009, can be found online through the official site of 総務省, Ministry of Internal Affairs and Communications: https://www.soumu.go.jp/menu_news/s-news/index.html, in Japanese

setbacks in being able to provide access to services useful to citizens and business, thus preventing the usage rate from rising. One of the integration main problems resides in the ICT-promoting mechanisms: the IT Strategy Headquarters lacks adequate level of budget and authority, it also mainly consists of agents which are sent from various government agencies and is not able to take sufficient initiatives. Another crucial setback is one which has been emphasized before, and it resides in the inability to build cooperative ties between central government and local governments, with results of ICT integration in the latter proving far more efficient than the national ones in some instances [53] . Another aspect related to this is the resistance from government agencies to mitigate the consequences of the government's vertically structured administrative system and the resulting unattainable creation of "one-stop transition points" for increased convenience in government services. This results in budget being wrongly allocated (each ministry building their own IT network) and hindering the flow of information which could be commonly shared by different agencies, thus not optimally setting up systems and preventing the government to function as a whole[54]. Japan also proved incapable of providing businesses and citizens with clear incentives for digitization. Furthermore, the country's focus on adequately servicing individuals without adequate Internet connection and digital literacy prevents the eradication of paper-based operations in government offices and a coordinated transition towards digitalization[55]. Other factors are the culture of not pursuing mandatory measures on behalf of Japanese governments', there is also the lack of compromises regarding

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[53] Takao Y., "Democratic Renewal by "Digital" Local Government in Japan", *Pacific Affairs, Summer, Vol. 77, No. 2 (Summer, 2004), pp. 237-262*, 2004.
[54] Masahiro M., "The Evolving Power of the Core Executive: A Case Study of Japan's ICT Regulation after the 1980s", *Pacific Affairs , March 2015, Vol. 88, No. 1*, pp. 27-49, 2015.
[55] Ibidem.

ICT-related strategies from the MIC and "経済産業省, Keizai sangyō shō) or Ministry of Economy, Trade and Industry" (METI) officials which leads to a lack of consistency between ICT strategies, with some government agencies showing strong independence and no framework for cooperating toward unified digitization. Another historically recognised problem in the course of ICT integration policies was the lack of a National Personal ID system[56]. Japan has had no unified personal ID system until 2013. which has hindered the reduction of number of ID systems that each agencies had, with some even having different ID systems for different services within the same agency and as stated by the literature "Lacking the unified ID of this type is one of the strongest disadvantages in terms of supporting advanced ICT usage for social convenience and efficiency". A first attempt of introducing a taxpayer identification number system was considered in 1980, but strong protests against strengthened government monitoring and idea that citizens would be numbered hindered its introduction. In 2003, the Resident Registry Network was established to increase efficiency in government administrative processes, and a code was assigned to each certificate of residence[57]. With the transition of executive power in 2009 the importance of a personal ID system has been renewed and the goal of introducing such a system in 2013 was achieved with the introduction of the " マイナンバー or My Number Card" or Individual Number card. This identification device enables to verify a person's identity face-to-face using information on the card (name, address, birth date, gender, Individual Number, and facial photo). Moreover, the Card also enables secure and reliable online identity verifications and personal authentications with the use of the public certification service for individuals embedded in the

[56] Igari N., "How to successfully promote ICT usage: A comparative analysis of Denmark and Japan", *Telematics and Informatics*, Vol. 31, No. 1, pp. 115-125, 2014.
[57] Ibidem

card. Based on the Cabinet's December 2019 approval of the "Digital Government Action Plan," initiatives are being supported to convert Individual Number Cards into a platform and merge them with current cards and public services. As we shall see in the next chapter, MIC also endeavors to encourage the use and implementation of "My Number Card" by national and local governments, and also the commercial sector, as a means of increasing the convenience of public and private services in numerous sectors of daily life.

One of the factors that has influenced the poor implementation of ICT is also the structure of the working world. In fact, in the tradition of European and US societies, one of the major drivers for the introduction of ICT has been the need to reform companies or their organisational processes, also due to continuous job changes by workers. Also, in the field of public administration as well as among company officials, it is not unusual to see continuous changes of personnel, hence the need for adequate structures or programmes oriented to facilitate this transition. In Japan the situation is diametrically opposed, highlighted by some characteristic of Japan's workforce: great job security, with difficulty in firing its employees and with a labour market with 40 percent of precarious workers, such as a high rate thus undermines the flow of information between the private and public sectors and, consequently, that of the ICTs in charge of this operation[58].

A further element that has obstructed the transition to ICTs is the mistrust of the people towards the government as shown by the statistics below. The Japanese political class has been characterised over the years by continuous corruption scandals and bad public and corporate administration. According

[58] Ibidem

to Transparency International's index of perceived corruption[59], it ranks only 19th in terms of public confidence in its actions. This mistrust has led to the optional adherence of citizens to some of the government's initiatives to implement ICT for citizen services, despite the fact that according to international estimates the security levels of Japanese IT structures are among the best in the world. Once again, we find one of the characteristics of Japan: the citizen tends to have a high level of anxiety and distrust, despite being in a perfectly safe environment.

1.3 Concluding Remarks

In sum, to summarise what has been expressed thus far, we have analysed the evolution of ICT infrastructure construction history in Japan, the historical hindrances it had to overcome and the connection it managed to establish throughout the years of its evolution, both on the domestic and international field. We also experienced how the collaboration by government and private institution, namely NTT, helped pave the way to the modern FTTH/B connection, making Japan one of the first country in the world to benefit from this kind of connection network since the early 2000s. We have also analysed how this has enabled Japan network usage to evolve in the Internet age and how fixed broadband penetration has helped the linkage of almost the entirety of the country with a penetration rate of almost 100 percent. Not only that, but we had the opportunity to explore the evolution of the mobile broadband connections in Japan, and how through time, mobile subscriptions surpassed the fixed-line one. Later, we focused on ICT integration policies and have examined their evolution in the country. On a political aspect, we highlighted some of the core features of Japanese politics which led Japan to its unproductive collaboration between the various ministries, the evolving

[59] Information available at: https://www.transparency.org/en/countries/japan

power of the core executive during the first years of ICT regulation, the shortage of a "tower of command" to better organize and manage the connections of the government agencies and the emerging role of the MPT first and MIC later, in managing and promoting ICT policies. With the aim of highlighting the ramification of these aspects in modern Japan, we analysed the main national strategies which have been proposed since the early 2000s. Through their study, we examined how even though they succeeded in leading Japan to its modern high-ICT infrastructure, they failed to make the most of the opportunities ICT offers, leading to an unsteady adoption of ICT both by the private and public institutions.

Chapter 2: ICT and economic interaction/opportunities with IoT services and ICT

Many advanced and developing economies are facing a new kind if threat as a consequence of increasing life expectancies and declining fertility: population ageing. Japan is one of the world's most aged societies and has a rapidly ageing population and shrinking labour force[60]. These two factors have a heavy influence on government policy and decision making, also enhanced by the size of ICT industries and the economical factor related to it. Efficient information age infrastructures enhance productivity [61] by providing intelligent networks that can handle converging[62] voice, data, and electronic commerce applications. The use of these infrastructures provides a comparative advantage in ''knowledge-based''[63] industries, which can include diverse fields such as data processing, banking, management and technical consulting, customer relations management, business logistics, etc. It is curious to note how the track record for ICT implementation achieved by individual companies and nations does not always correlate with other indicators of success in trade, development, and quality of life[64].

Nonetheless, no one can deny that telecommunications and information processing technologies are significant agents of economic and social growth, with the impact of this business extending to a wide range of linked and

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[60] Jong-Wha L., Do Won K., Eunbi S. "Ageing Labour, ICT Capital, and Productivity in Japan and Korea", *Journal of The Japanese and International Economies, 58, 2020.*

[61] Grace, K., & Zhen–Wei Q., "Information and communications technologies and broad-based
development: A partial review of the evidence", *World Bank Working Paper No.12. 2004.*

[62] Hukill, Ono, & Vallath, "Electronic communication convergence: Policy challenges in Asia London", *Thousand Oaks, CA: Sage, 2000.*

[63] Organization for Economic Cooperation and Development. (1995). The knowledge-based economy (OCDE/GD(96)102). Retrieved from
http://www.oecd.org/dataoecd/51/8/1913021.pdf.

[64]Frieden, R., "Lessons from broadband development in Canada, Japan, Korea and the United States", *Telecommunications Policy 29, pp. 595–613, 2005.*

unconnected industries:

> "ICT can help enhance the working of markets and reduce transaction and coordination costs within and across organizations. This is of particular relevance to developing countries where transaction costs are very high because of logistical problems. ICT applications can enable improvements in productivity and quality in a number of sectors […] such as agriculture, manufacturing, infrastructure, public administration, and services such as finance, trade, distribution, marketing, education and health."[65]

Through the utilization of technology transfer and foreign direct investment, ICT provides developing nations with better potential to expedite their climb of a technological development learning curve. While ICT may initially endanger employment in rich countries through outsourcing, it may later endanger wealth production in knowledge sectors as developing nations acquire their own technological capacity. When developing countries wean themselves off of reliance on industrialized countries' patents and inventions, the upside revenue-generating prospects become more competitive among all nations.. ICT development presents both challenges and opportunities to all nations. Developing countries are no longer forced to arrange their economies purely for the advantage of rich countries. Developed nations can no longer consider technology transfer as largely a one-sided transaction that expands market penetration without risk of lost markets in the future.

2.1 Economic size of the ICT industry

The ICT's industry nominal domestic production value in 2019 was 108.4 trillion yen, accounting for 10.4 percent of all industries and making it the largest industry in the country.[66]

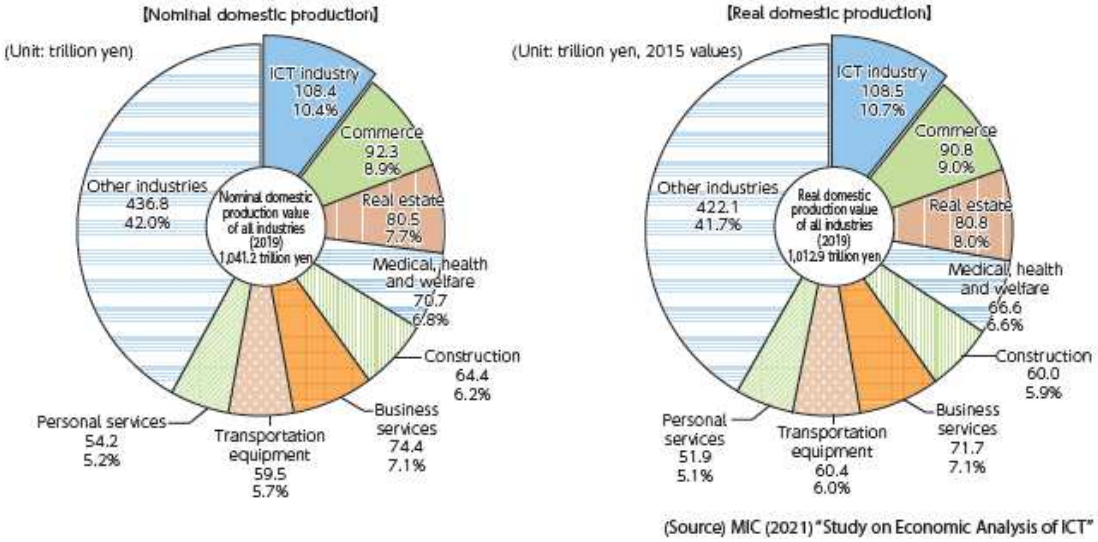

Figure 6 Domestic production values of major industries (based on nominal and real), p.44, 2021.

To have a complete understanding of the evolution and the importance of this industry, it is necessary to understand the historical background and the main events which contributed to shaping the sector. In fact, as we can observe on the following table, the nominal domestic production value had already reached 120.4 trillion yen during the year 2000, however, its production value cooled off for several years in response to the collapse of the IT bubble. Following the collapse of the "bubble economy" in 1991, Japan's production growth slowed significantly and has remained relatively low for more than 20

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[65] Sein, M. K., & Harindranath, G., "Conceptualizing the ICT artifact: Toward understanding the role of ICT in national development", *The Information Society, 20(1), pp. 15–24, 2004.*

[66] 総務省, Ministry of Internal Affairs and Communications "Information and Communications in Japan 2021", available online at: https://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/whitepaper/2021/pdf/chapter-4.pdf

years[67]. Since Japan's working age population will continue to shrink rapidly and the capital-labour ratio is already high, it seems that improving total factor productivity (TFP) represents the best way, according to many literature essays, for Japan to accomplish sustainable economic growth, in the following paragraphs we will analyse Japanese monetary policies concerning ICT in the last two decades and whether they managed to improve TFP. We can see how the value of the industry started growing again in 2005, reaching a peak of 117.3 trillion yen in 2007, but then again, we can observe its production value plummet to 101.1 trillion yen in 2009 due to the 2008-2009 global financial crisis. Even after 2010 the value of the industry continued to slide, dropping to 98.2 trillion yen in 2012 and reaching the size of the commerce business as shown in the table below. However, since 2013 signs of recovery finally started to appear thus leading the industry to reach its present nominal domestic production value of 108.4 trillion yen in 2019. This year also symbolizes the real domestic production value of the ICT industry, based on constant 2015 values, surpassing 108.5 trillion yen, accounting for 10.7 percent of all industries. In contrast to the nominal values, it has increased since 2000 and reached 105.3 trillion yen in 2007. It decreased to 93.5 trillion yen in 2012, but as with nominal values, signs of recovery could be seen from 2013[68].

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[67] Fukao, K., "Explaining Japan's unproductive Two Decades", *RIETI Policy Discussion Paper Series 13-pp. 22, 2013.*

[68] 総務省, Ministry of Internal Affairs and Communications "Information and Communications in Japan 2021", available online at: https://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/whitepaper/2021/pdf/chapter-4.pdf

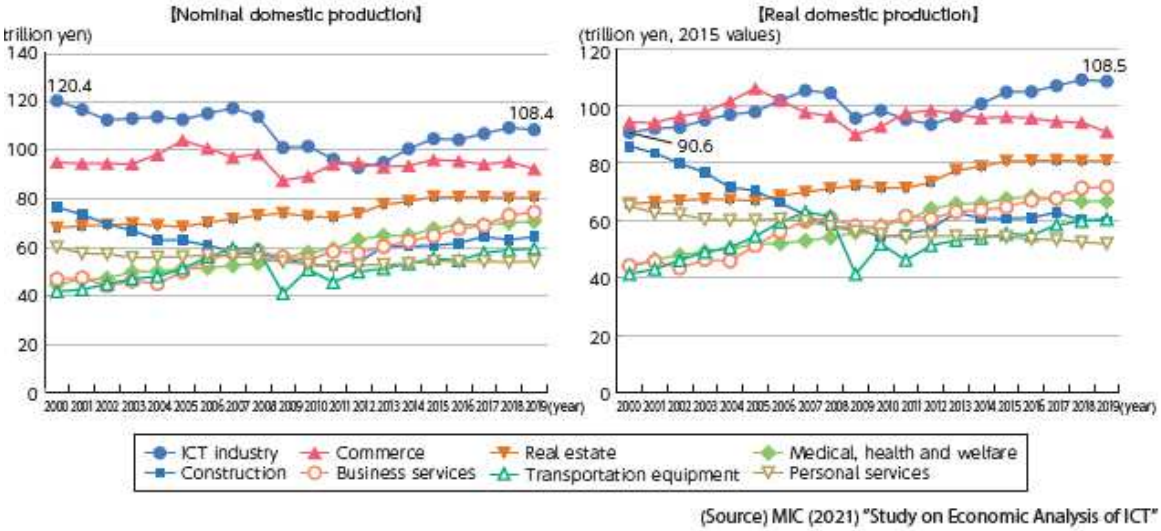

Figure 7 Changes in domestic production values of major industries (based on nominal and real), p.45, 2021.

2.1.1 Gross Domestic Product (GDP)

The nominal GDP of the ICT industry fell in 2019 by the 0.1 percent year-on-year leading it to reach 51.7 trillion yen[69]. When the nominal GDP of the major sectors is compared, the ICT industry's nominal GDP accounts for 9.4 percent of the total nominal GDP of all industries, making it the third biggest behind the commerce and real estate industries. Real GDP in constant 2015 values accounted for 9.9 percent of total real GDP.

[69] 総務省, Ministry of Internal Affairs and Communications "Information and Communications in Japan 2021", available online at: https://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/whitepaper/2021/pdf/chapter-4.pdf

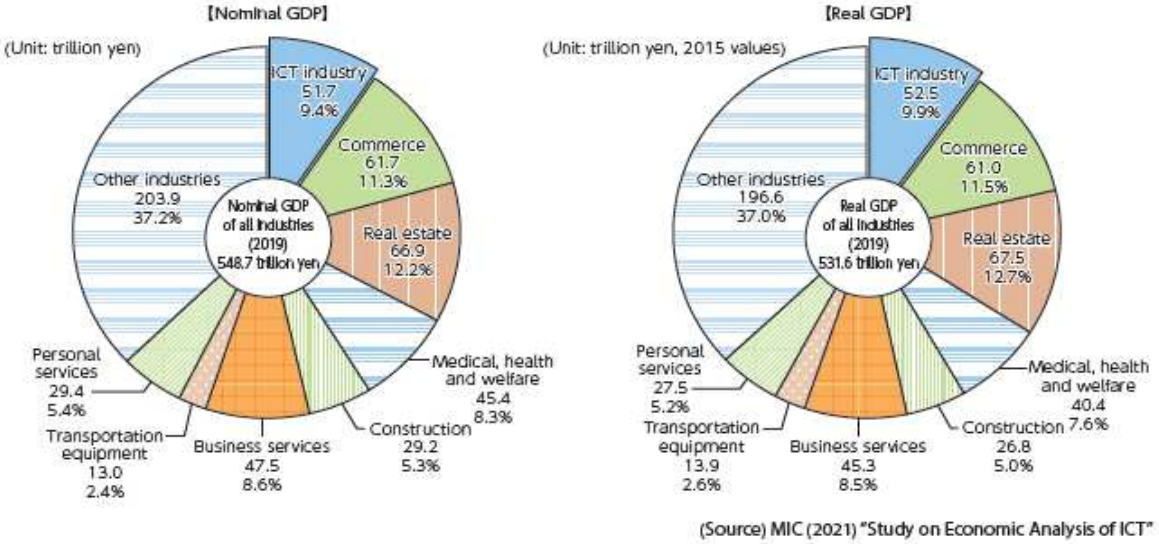

Figure 8 GDP of major industries (based on nominal and real), p.45, 2021.

Looking at the growth rate in 2018-2019 and as illustrated in the table below, ICT industry rose by 0.9 percent year-on-year, making it the fourth highest industry in the country after medical, health and welfare industry which rose of 2.4 percent, business services that experienced a rise of 1.4 percent and personal services industries of 1.1 percent[70]. The nominal GDP of the ICT-related manufacturing and ICT-related construction industries has been dropping, similar to the nominal domestic production value. On the other hand, the Internet-related services industry has grown rapidly.

[70] 総務省, Ministry of Internal Affairs and Communications "Information and Communications in Japan 2021", available online at: https://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/whitepaper/2021/pdf/chapter-4.pdf

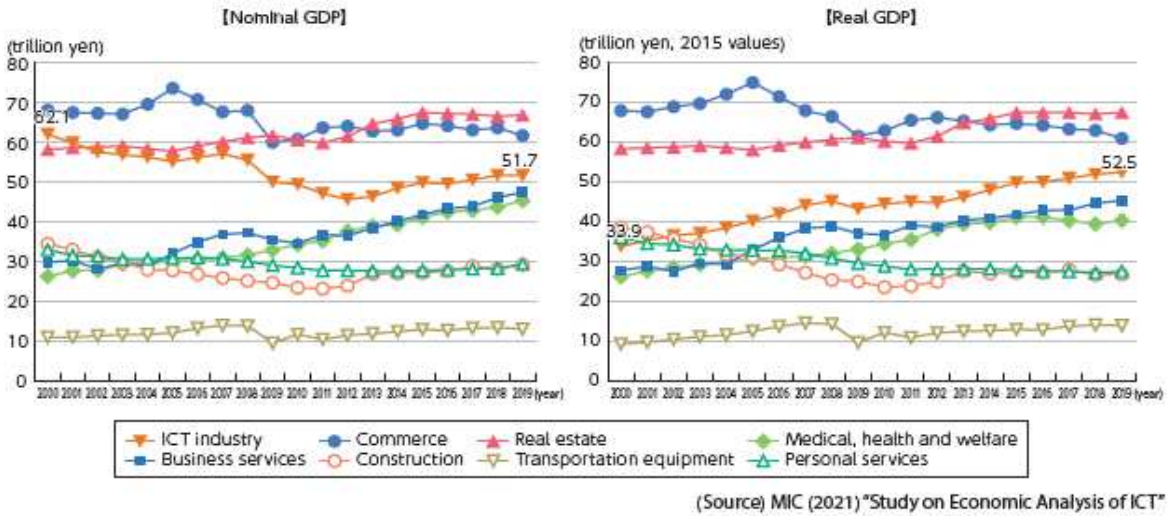

Figure 9 Changes in GDP of major industries (based on nominal and real), p.45, 2021.

2.1.2 Employment

The ICT industry employed 4.058 million people in 2019 which accounted for 5.6 percent of total employment in all industries throughout Japan[71]. Compared with the value of 2018 estimates this shows a steady growth in: Internet-related services which rose up by 6.7 percent from the previous year, ICT-related services that went up by 2.5 percent from the previous year and research which went up by 0.6 percent. However, the evaluation also shows a slowdown in the department of video, audio and text information production which fell down by 4.6 percent, communications went down by 1.5 percent and ICT-related manufacturing down by 1.4 percent.

[71] 総務省, Ministry of Internal Affairs and Communications "Information and Communications in Japan 2021", available online at: https://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/whitepaper/2021/pdf/chapter-4.pdf

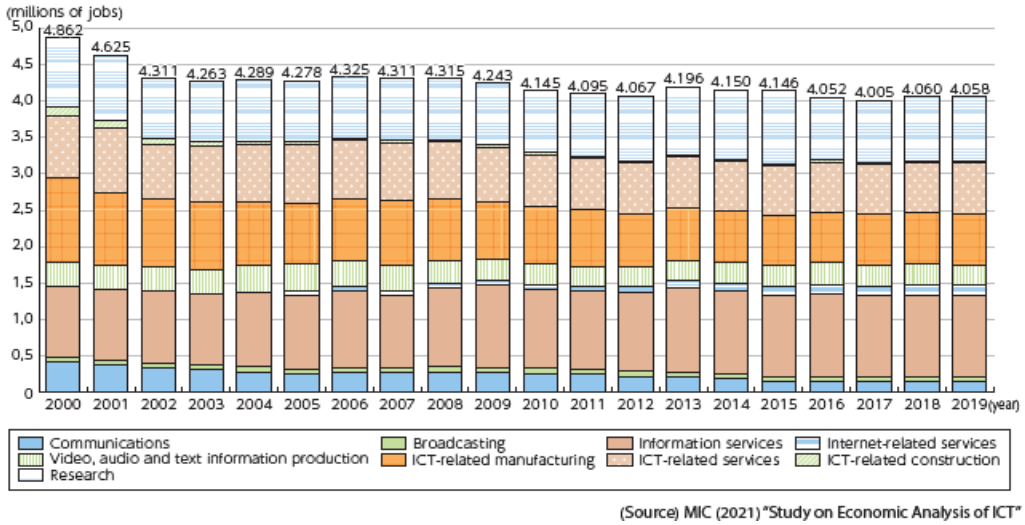

Figure 10 Changes in employemnt in the ICT industry, p.46, 2021.

2.2 ICT industry contributions to the national economy

This subparagraph delves deeper into the process of digitalization's contribution to economic growth and discusses why digitalization is also required to provide social and economic resilience. In order to realize sustainable economic growth in the future, Japan needs to overcome its socioeconomic challenges[72]. In addition to increasing productivity and providing added value, ensuring society's resilience to maintain and continue its functions in the face of pandemics and natural disasters while reducing the effect on life and the economy is an important objective in the process of establishing digitalization, and measures must be taken on both the supply and demand sides. In the table below a brief review of the discussions on what role ICT or digitalization, as included in the Information and Communications White Paper, will play to contribute to economic growth is

[72] Ishida, K., "The effect of ICT development on economic growth and energy consumption in Japan", *Telematics and Informatics n.32, pp.79–88, 2015.*

summarized[73].

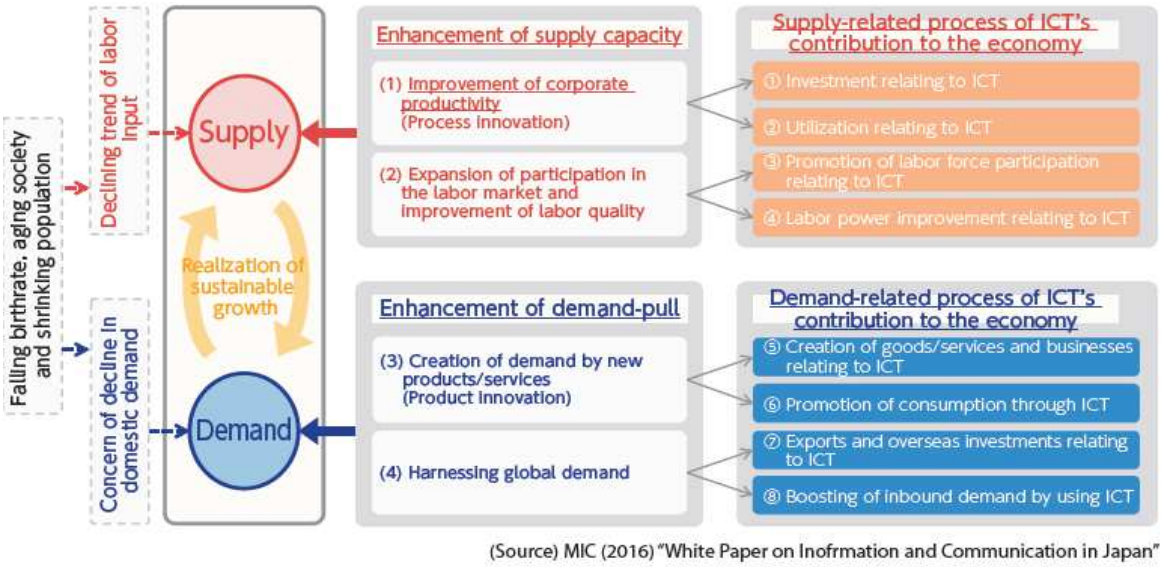

Figure 11 Process of ICT's Contribution to the Economy, p.35, 2016.

2.2.1 ICT's industry economic spill over effects

When different industries make intermediate inputs to the production activities of the ICT industry, this generates added value, for example operating surplus and employee compensation, and employment in those industries. The economic spill over effects[74] of the ICT industry were estimated to be 92.1 trillion yen in induced added value, and 8.514 million in induced employment. ICT industry shows the largest economic spill over effect in terms of induced added value in the nation, and also shows higher inducement in jobs than the transportation equipment industry, which with

[73] 総務省, Ministry of Internal Affairs and Communications "Information and Communications in Japan 2016", available online at: https://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/whitepaper/2016/pdf/chapter-2.pdf

[74] There are two methods of calculating economic spillover effects: (1) calculating the economic spillover effects for all Japan's industries brought about by each industry sector's final demand, focusing on the goods and services that constitute the industry sector's final demand and (2) calculating the economic spillover effects for all Japan's (footnote continued from previous page) industries brought about by each industry sector's production activities (total of final demand and intermediate demand), focusing on the industry sector itself. The latter method was used here.

its 2.490 million jobs is recognized as one of broad industries in Japan, once again establishing with firmness the role and importance of the ICT industry in the country[75].

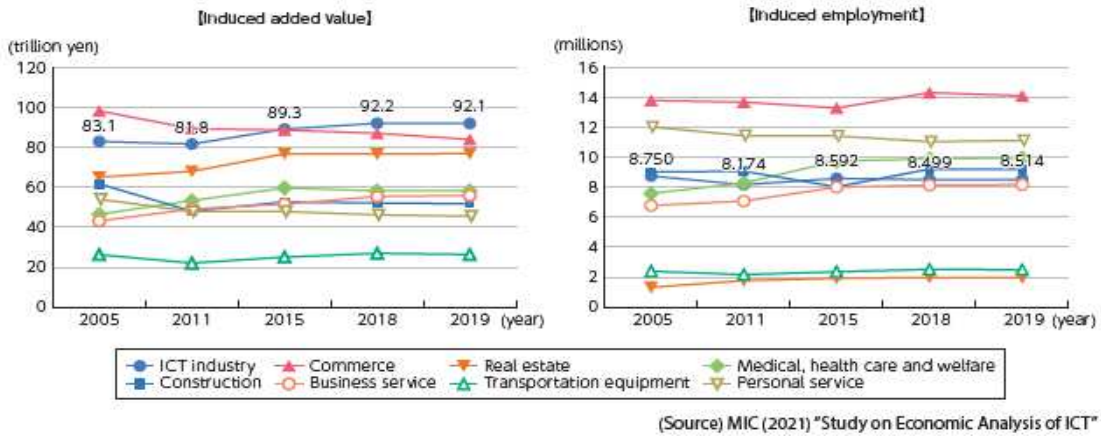

Figure 11 Changes in economic spill over effects (induced added value and induced employment) from major industries' production activities, p.47, 2021.

2.2.2 Export and import in the ICT field

The receipts from Japan's technology exports in FY 2019 totalled 3.6626 trillion yen, to which the ICT industry contributed with 497.1 billion yen, or 13.6 percent[76]. On the other hand, the payments from technology imports were 543.6 billion yen, of which 232.4 billion yen, or the 42.7 percent, came out of the ICT industry. While the balance of payments, together with the ICT industry posted export surplus in the breakdown the information and communications posted import surplus. The manufacturing of information and communication electronics equipment sector accounted for the majority of the ICT industry's technological exports, while the information and communications sector accounted for the majority of imports [77],[78].

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[75] 総務省, Ministry of Internal Affairs and Communications "Information and Communications in Japan 2021", available online at: https://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/whitepaper/2021/pdf/chapter-4.pdf

[76] Ibidem

[77] The value of technology trade is the equivalent value received from the provision (export) of patents, knowledge, technical direction, and other forms of technology transfers to other

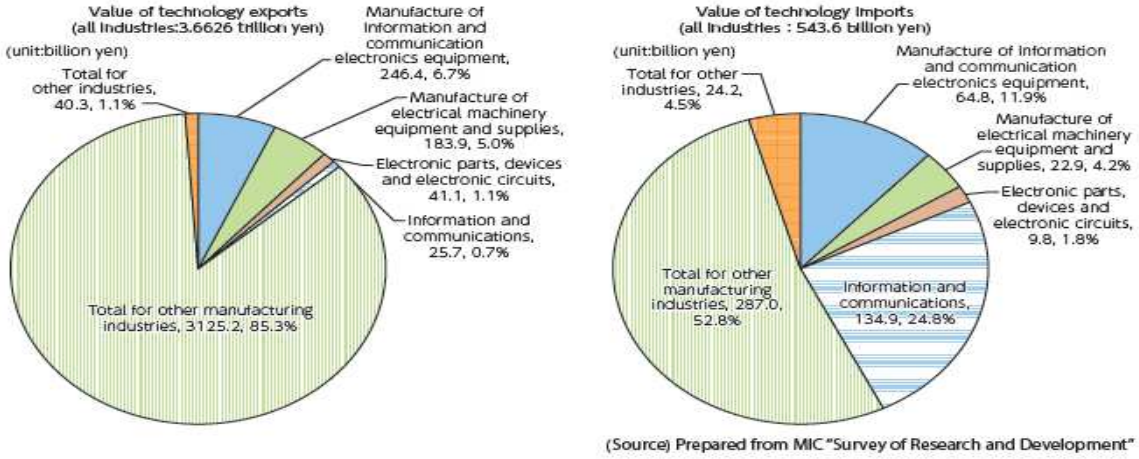

Figure 12 Technology exports and imports by industry (FY 2019), p.43, 2019.

2.2.3 State of ICT enterprise operations

A breakdown of ICT industry enterprises by capital size reveals that enterprises which capitalized at less than 100 million yen accounted for more than 60 percent of all enterprises in 8 out of 12 ICT industry sectors in all of Japan. Of particular note are the sectors in video picture information production and distribution, sound information production, commercial art and graphic design where enterprises capitalized at less than 50 million yen accounted for more than 40 percent of all enterprises in each respective sector[79].

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countries or the equivalent value paid the reception (import) of the same forms of technology transfers from other countries.

[78] 総務省, Ministry of Internal Affairs and Communications "Information and Communications in Japan 2021", available online at: https://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/whitepaper/2021/pdf/chapter-4.pdf

[79] Ibidem

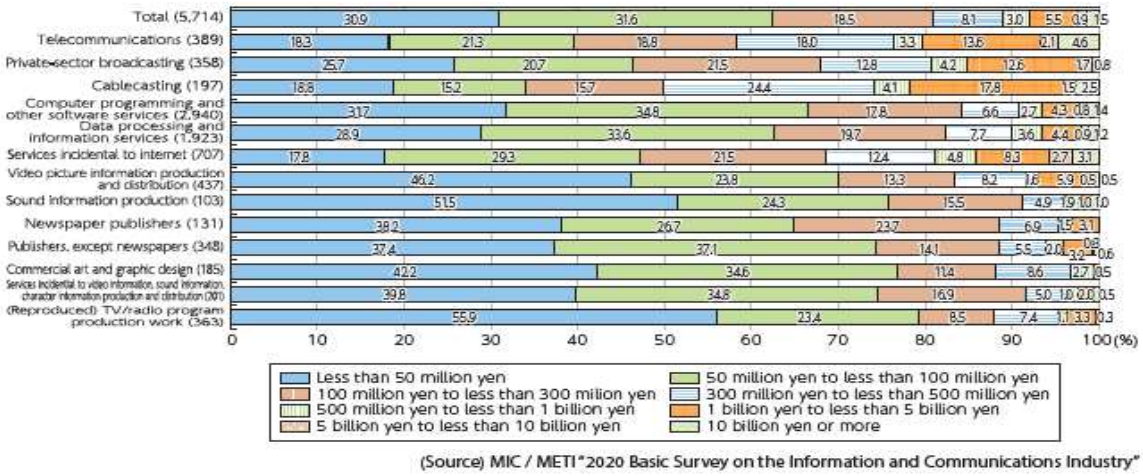


Figure 13 Breakdown of ICT industry enterprises by capital size, p.49, 2021.

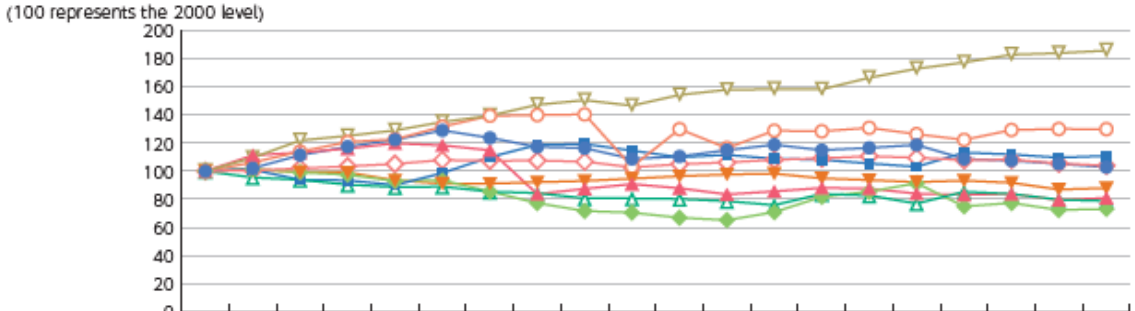
2.3 Role of digitalization and its purposes

Having now grasped an idea of the economic and political importance of the ICT industry, it is important to establish and recognize the best practices in transforming the value of this infrastructure in economic advantages and social opportunities with the evolving digital economy in Japan.

As stated before, productivity improvement is necessary for economic prosperity through the increase of GDP per capita. Japan's labour productivity in 2019 was the lowest among G7 countries and analysing the period from 2012 to 2019 we can observe how the annual growth rate of labour productivity was of 0.2 percent[80]. Given this situation, in what ways can the ICT industry contribute to the economy and in which sector has its utilization proven to be effective? We can start by analysing the table below which reports on changes in labour productivity, intended as real GDP on number of employees, of the ICT industry and general industry as index with a score of 100 representing the 2000 level, which as seen before was the period

[80] 総務省, Ministry of Internal Affairs and Communications "Information and Communications in Japan 2019", available online at: https://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2019/chapter-3.pdf

in which the industry held its major value[81].



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Commerce	100.0	102.2	111.4	117.3	122.3	128.9	123.7	117.3	116.4	108.8	110.4	115.0	118.8	114.9	116.6	118.6	108.7	107.5	105.2	102.8
Real estate	100.0	111.2	113.2	116.0	119.8	118.4	114.8	83.7	87.5	90.8	88.0	83.5	85.6	88.1	87.7	84.1	83.3	83.8	79.6	81.0
Medical, health and welfare	100.0	101.2	99.4	99.2	93.5	91.3	91.2	92.1	93.1	94.8	96.4	97.6	98.3	94.9	93.7	92.3	93.3	91.8	87.0	88.0
Construction	100.0	101.4	99.2	97.5	93.0	93.5	85.6	77.3	71.7	70.6	67.0	65.3	70.9	81.8	85.4	91.5	75.0	77.4	72.5	73.2
Business services	100.0	101.2	93.9	93.5	90.2	98.6	110.0	118.7	119.3	114.7	109.8	111.5	108.8	108.2	105.5	103.2	113.2	111.9	109.6	110.9
Transportation equipment	100.0	106.2	114.0	120.7	122.6	131.6	139.3	139.8	140.3	103.2	129.8	116.4	128.7	128.3	130.8	126.3	122.3	129.3	129.9	129.9
Personal services	100.0	95.5	93.9	90.5	88.7	89.1	85.5	84.4	80.7	80.7	80.3	78.8	75.9	83.8	82.7	77.0	85.4	83.9	79.8	78.9
ICT industry	100.0	109.5	121.8	125.1	128.9	135.0	139.4	147.1	150.4	146.5	154.1	157.8	158.2	158.1	166.3	172.7	177.2	182.7	183.8	185.6
All industries	100.0	100.5	101.9	103.5	105.2	107.9	107.4	107.5	106.8	102.7	105.0	106.1	108.1	109.1	110.6	109.6	107.9	108.2	105.5	103.9

(Source) MIC (2021) "Research on ICT Economy Analysis"

Figure 14 Changes in Labour Productivity Index of Information Communication and General Industries, p.54, 2021.

Through the Usage Trend Survey conducted by the 総務省 Ministry of Internal Affairs and Communications we can also acknowledge that, both through the use of cloud services and with the implementation of teleworking, the relationship between ICT and labour productivity is greatly in favour of companies that have made efficient use of ICT. Investments in ICT throughout the last two decades were most often aimed at improving the efficiency of existing enterprises and had only a limited effect in increasing labour productivity. For Japanese enterprises to survive in the future, it is not enough to use digital technologies as a tool for operational efficiency, they must work towards a digital transformation that creates new values through new products, services and business models, and at the same time change the organisation, culture and working style on the premise of digitisation. This

[81]総務省, Ministry of Internal Affairs and Communications "Information and Communications in Japan 2021", available online at https://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/whitepaper/2021/pdf/chapter-1.pdf

result is thought to be obtainable through the Digital Transformation.

At this moment we find the need to outline three key concepts, which are all too often confused and mistaken for each other: digitization, digitisation, and digital transformation. The first concept refers to the introduction of digital tools intended as a way to improve the efficiency of a specific process within a company, the second is a term that refers to the digitization of the whole process including its external part and business strategies. As a new and modern terminology in business and technology literature, digital transformation is typically characterized as:

> "Integration of digital technology into business that results in, sometimes fundamental, changes in business operation and delivery of value to customers […] has influence on working culture, human relations and speed of change, on microeconomic as well as macroeconomics level."[82]

Traditionally, land, physical labour, and the operation of mechanical equipment were regarded to be what brought value to goods and services.

What distinguishes the digital economy is the tremendous expansion in the capacity of data to produce value as so-called big data and AI have developed. As an example, to this we can observe how using data to create value is not limited to the giant ICT players or digital platform operators. Even non-ICT companies such as small retailers in local areas, and we will later see the importance of small enterprises in Japan's economy, also apply data to achieve huge gains in sales and profits after introducing customers-prediction and other business-forecasting solutions. This is the case of Ebiya Ltd., established in 1912, which is long-standing small business in Ise, Mie Prefecture that runs a souvenir shop and a Japanese restaurant. Ebiya

[82] Ljubiša M., "Digital Transformation and its influence on GDP", *Economics, vol.5, no.2, 2017.*

developed a system for predicting the number of customers on the following day. The system analyses sales data, meteorology, the day of the week, and the number of guests staying overnight in nearby hotels and other accommodations. Having accurate predictions avoids bringing in excess stock and significantly reduced the hours when meals are served. In the four years since the introduction of this ICT solution in 2012, Ebiya's sales have increased by four times and profit ratios by 10 time, thus proving how non-ICT companies and even local business are generating value through the application of data[83].

In recent years, and in particular with the COVID-19 pandemic, it has been brought to the surface the need to change certain aspect of modern society and it is becoming more clear that digital transformation should be promoted not only to improve productivity and create new added value, but also to help secure resilience towards infectious diseases, natural disasters, help modernize the economic landscape and realize a sustainable society[84]. In the future, Japan is ought to strategically and integrally promote digital utilization among citizens and digital transformation in private corporations and the public sector. In this respect, it is important to build digital society common infrastructure by developing 5G, IoT and other ICT infrastructure, base registries and public digital platforms such as ID, citizen digital identification, cloud and other platforms, and ensuring safety and security for the citizen with the aim of "creating a society in which people are enriched by data[85]". The efforts necessary for achieving a digitalization that "leaves no one

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[83] 総務省, Ministry of Internal Affairs and Communications "Information and Communications in Japan 2021", available online at: https://www.soumu.go.jp/johotsusintokei/whitepaper/ja/r03/pdf/n0000000.pdf, in Japanese.

[84] Ibidem

[85] Government policy name *"[de-ta]ga hito wo yutakani suru shakai*「データ」がヒトを豊かにする社会"

behind" are easily summarized in three core aspects: first, fostering the promotion of utilization of digital technologies by people who are users; two, promoting digitalization in private enterprises and the public sector who are the providers, and lastly, the construction of the common bases of digital society. Because many of these activities are interconnected, it is vital to promote digitalization not independently but strategically and collectively.

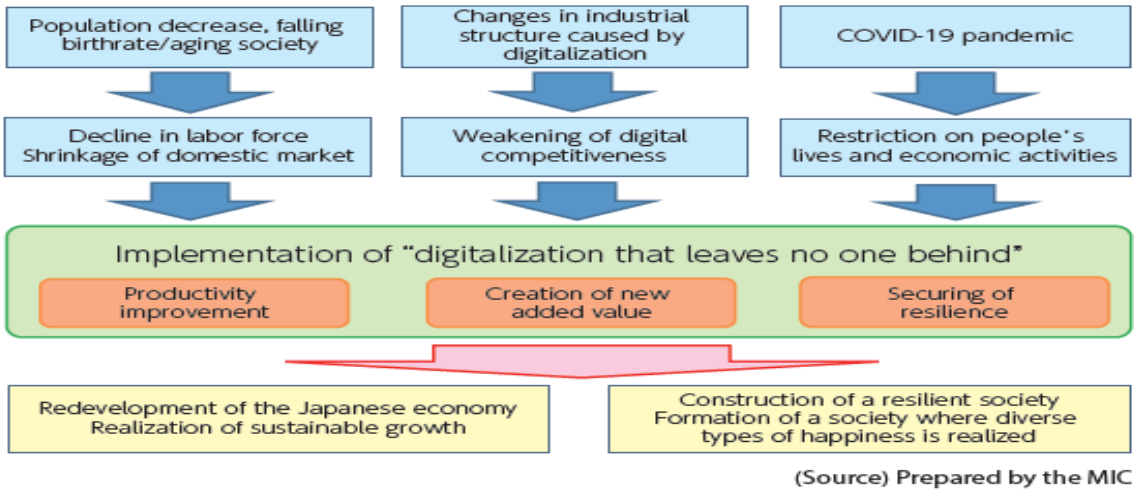

Figure 15 Digitalization Contributing to Solution of Social/Economic Challenges, p.36, 2019

2.4 5G and IoT implementation in ICT driven society

2.4.1 5G implementation

This subparagraph looks at what form 5G social implementation will take in various industries and economic sectors and what benefits it will generate. The start of commercial 5G services in Japan is expected to play a decisive role as a driver of "digitalization throughout society"[86], 5G technology is expected to become a platform that will bring great benefits for both industry and society. The question is how will 5G's implementation advance in society? Given that initially 5G services are going to utilize 4G or LTE networks before reaching a "standalone" capacity, and that this will lead to ultra-high-speed

[86] Government policy name "*Shakaizentai no dejitaru 社会全体のデジタル化*"

services to be provided mainly in areas of high communications demand, it is certain that the true value of 5G to society will come to light with the widespread implementation of IoT-related applications, such as remote control, connected cars, and robots[87]. However, in order to realize the society that "leaves no one behind" through the use of digitalization, in Japan it is necessary to identify and share other intrinsic values of digitalization throughout the entire society. In other words, it is important to realize digital transformation of the entire society by employing every available means.

2.4.2 Local 5G as a means of solving regional issues

As stated before, 5G will not be able to reach a "standalone" capacity in the first years of its implementation throughout the country and will have to lean on 4G connections until its infrastructure reach an adequate size. What are the reasons that have led to this initial delay in the provision of these ultra-high-speed networks throughout Japan? On April 10, 2019, the Minister for Internal Affairs and Communications approved the "Establishment Plans for Specified Base Stations to Deploy 5G Mobile Communication Systems"[88], obliging the four main carriers in the country with the task of providing nationwide 5G services with the aim of establishing 5G services in all prefectures within two years, and imposed a condition requiring the carriers to roll out 5G services broadly and steadily nationwide[89]. Unfortunately, the plans submitted by the carriers varied greatly in the number of 5G base stations to be installed. Furthermore, the plans did not mention the installation of 5G base stations

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[87] 総務省, Ministry of Internal Affairs and Communications "Information and Communications in Japan 2019", available online at: https://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/whitepaper/2021/pdf/chapter-4.pdf

[88] 総務省, Ministry of Internal Affairs and Communications "令和 3 年版, 情報通信白書の公表にあたって", available online at: https://www.soumu.go.jp/johotsusintokei/whitepaper/ja/r03/pdf/n0000000.pdf, in Japanese.

[89] Ibidem

evenly throughout all parts of the country, including areas with less favourable conditions and tunnels and other areas where radio signals are blocked, over their five-year term. This created the need to take measures to accelerate the early installation of 5G base stations and the optical fiber that support them in regional areas, in order to move the carriers' plan forward as much as possible[90].

Aware of these issues, on June 25, 2019, MIC established the "Master Plan on the Regional Development of ICT Infrastructure"[91]. The plan was established to make unified and effective use of ICT infrastructure development assistance measures, including 5G, and 5G use and application promotion policies and to develop ICT infrastructure nationwide as soon as possible, setting the date for the end of this policy to the last months of FY 2023.

The master plan sets targets for each policy. These include area development intended as base station installations in disadvantaged regions, the advanced installation of 5G base stations, the promotion of measures to deal with radio signal blocking in train and road tunnels, and the acceleration of area expansion and the promotion of optical fiber installation with Local 5G.

2.4.3 Introduction of Local 5G

As affirmed before, there are high expectations for the implementation of 5G, not only to generate new businesses in many fields but also to be what some would compare to a secret weapon in solving various social issues faced by regional areas. For this reason, a subbranch under the MIC examined

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[90] The total number of 5G base station installations in the companies' plans is about 70,000. The measures aim to move the installation forward of 20 percent of the base stations expected to be installed after the five-year plan terms.

[91] 総務省, Ministry of Internal Affairs and Communications "令和 3 年版, 情報通信白書の公表にあたって", available online at: https://www.soumu.go.jp/johotsusintokei/whitepaper/ja/r03/pdf/n0000000.pdf, in Japanese.

technical requirements for the introduction of Local 5G[92]. Local 5G are new mobile communication systems that a variety of entities can construct and use flexibly to suit the local region's needs or specific needs of an industrial field. Local 5G is separate from the nationwide services provided by mobile carriers which could help the government with its propagation of 5G services throughout all regions of Japan.

There are three basic concepts behind Local 5G: the first it's the use of 5G; second the construction of relatively small communication environments tailored to local regional needs; and lastly the ability to either obtain a radio station license yourself or to use the systems of another party that has obtained a license[93]. The reason for this third concept being that Local 5G is assumed to be generally used for private business purposes.

Given its nature of being tailored to local and small environments, it is widely acknowledged that the smooth dissemination of Local 5G led by regional governments and local businesses, could better identify the specific needs of that region, construct networks adapted to those individual needs, and provide the networks as telecommunication services. It is also assumed that users and local businesses without specialist knowledge about wireless technology or network technology are precisely the parties with many unfilled needs. Consequently, Local 5G must respond on a granular scale to these needs.

2.5 Internet of Things and its ramification in modern society

The concept of Internet of Things (IoT) has grown since the emergence of the co-existence of the real and the virtual world. The main, guiding principle of

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[92] Ibidem

[93] 総務省, Ministry of Internal Affairs and Communications "Information and Communications in Japan 2021", available online at: https://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/whitepaper/2021/pdf/chapter-4.pdf

the IoT is to make computers process information without receiving help or manual input from a human being[94]. The IoT is an extension of Internet technology that allows for connectivity with physical devices and everyday objects. These sensors, such as RFID (Radio Frequency Identification), infrared sensor, global positioning system, and laser scanner, can communicate and interact with each other through the Internet based on the specific communication protocol. The contributions of IoT innovation to enterprises and organizations may be divided into three categories[95]:

• The first category is "in-house usage," in which a corporation uses data to assist its main business, like in manufacturing and marketing applications.

• The second type is "data/information-provision," in which data is provided outside to give wide societal advantages.

• The third and last category is "revenue-generation," in which digital products and services are developed with the intention of producing income.

With the use of IoT, Internet connectivity allows the terminal computer to record and analyse data, such as centrally managing machines, devices, personnel, remotely operating home gadgets and vehicles in a way comparable to an automated control system, which has enormous application aspect in modern society. Consequently, data collection may collect massive volumes of data, which culminated in a revolution in data-using industries such as Database Management Systems, or DBMS. To adapt to this vast volume of data, enterprises that had previously relied on the so-called relational model, an approach to managing data that uses a structure and

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[94] Gubbi, J., Buyya, R., Marusic, S. and Palaniswami, M., "Internet of Things (IoT): a vision, architectural elements, and future directions", *Future Generation Computer Systems, Vol. 29, No. 7, pp. 1645-1660, 2013*.

[95] Hiroshi Sasaki, "Special Contribution Leading the Way: IoT Innovation in Japan and the World", *FUJITSU Sci. Tech J, Vol.52, no. 4, p.3-7, 2016.*

language consistent with first-order predicate logic, had to adapt their technology. We can thus experience the rise of a new type of DBMS, the NoSQL or non-relational one, which is increasingly used in big data and real-time web applications[96]. The presence of high-speed internet with the possibility of connecting numerous things over a wireless network is the crucial component that provides this functionality, thus Japan represents a perfect candidate for the incubation of such technology, since the growth of the IoT in Japan is fostered by the development of the technology in the field of ICT and electronics[97], as also extensively analysed in chapter 1.

Industry 4.0 is a German idea that includes cloud-based manufacturing, IoT, enterprise resource planning (ERP), and social product creation. Japan is one of the few countries in the world that is attempting to construct SMART cities around the country by utilizing several IoT ramifications. One of the main drivers of the industry 4.0 is the IoT, hence, it is important to understand the impact of the IoT on social life in the evolving Industry 4.0 economy. The main characteristics of Industry 4.0 are the digitization and digital transformation of manufacturing processes, which involve the use of the IoT[98]. The IoT improves the performance of the so-called SMART factories, by ensuring flexibility in production, customization improvements, integration of the roles of customers, companies and suppliers, and supports sustainable development[99]. SMART factories are described as factories involving a vertical

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[96] Information available online at: https://db-engines.com/en/blog_post/23

[97] Naito, K., "A survey on the internet-of-things: standards, challenges and future prospects", *Journal of Information Processing, Vol. 25, pp. 25-31, 2016.*

[98] Vaidya, S., Ambad, P. and Bhosle, S., "Industry 4.0-a glimpse", *Procedia Manufacturing, Vol. 20,*
pp. 233-238, 2018.

[99] Shrouf, F., Ordieres, J. and Miragliotta, G., "Smart factories in industry 4.0: a review of the concept and of energy management approached in production based on the Internet of Things paradigm", *IEEE International Conference on Industrial Engineering and Engineering Management. 2014.*

integration of many parts in the system with the aim to reconfigure and implement flexibility within the factory in the emerging fourth industrial revolution[100], and Japanese firms such as Kawasaki, Sony and Toyota are leading the way in the development and implementation of such factories[101]. One of the core aspects of Industry 4.0 is the use of blockchain technologies, that consists of a decentralized, distributed ledger technology with the capability to provide historical records of transactions on a peer-to-peer network[102] and which are thought to greatly enhance the security of the IoT[103], reassuring both social and industrial parties.

Because of the overall effect of the IoT on the human life and the changes it introduces, it is considered a social innovation[104]. In most research on the impact of the IoT in small- and medium-sized enterprises it is argued that the IoT brought about destructive and open innovation, which cumulates into social innovation within the society. Social innovations (SIs) are new ways of creating and implementing change in the society[105], it is a disruptive innovation that is altering the way in which information and knowledge flows, open flow of knowledge and knowledge management systems[106]. It is

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[100] Wang, S., Wan, J., Zhang, D., Li, D. and Zhang, C., "Towards smart factory for industry 4.0: a self-organized multi-agent system with big data-based feedback and coordination", *Computer Networks, Vol. 101, pp. 158-168, 2016.*

[101] Lee, S.M. and Trimi, S., "Innovation for creating a smart future", *Journal of Innovation and Knowledge, Vol. 3 No. 1, pp. 1-8, 2018.*

[102] Boireau, O., "Securing the blockchain against hackers", *Network Security, Vol. 1, pp. 8-11, 2018*.

[103]Skwarek, V., "Blockchains as security-enabler for industrial IoT-applications", *Asia Pacific Journal of Innovation and Entrepreneurship, Vol. 11 No. 3, pp. 301-331, 2017.*

[104] Temitayo, S., Dae-Woo, C., "Impact of IoT on social innovation in Japan", *Asia Pacific Journal of Innovation and Entrepreneurship, Vol. 13 No. 3, p. 341-353 2019.*

[105] Van der Have, P. and Rubalcaba, L., "Social innovation research: an emerging area of innovation
studies?", *Research Policy, Vol. 45 No. 9, p. 1923-1935, 2016.*

[106] Santoro, G., Vrontis, D., Thrassou, A. and Dezi, L., "The Internet of Things: building a knowledge management system for open innovation and knowledge management capacity", *Technological Forecasting and Social Change, Vol. 136, p. 347-354, 2018.*

concluded by many literatures works, among the most prominent the one of Balaji and Roy (2016)[107], that the IoT seeks to bridge the gap between the digital world and the real one. Social change occurs whenever there is a change in the culture, behaviour, or the value system of a group of people within a society[108]. The literature usually distinguishes three categories of SI: micro level where there is an individual-level interaction, meso level with diverse actor interaction and, lastly macrolevel with institutional level interaction[109]. The growth in the utility of the IoT in many aspects of the Japanese economy makes it a suitable case study in examining the impact of the IoT, with its ramification making it possible to cope with many problems of modern Japanese society. For example, while Japan's ageing population remains a major issue, the Internet of Things has revolutionized green farming by assisting farmers in enhancing their automation, making farming more convenient for the ageing population by increasing food production output in Japan. SI has resulted in societal and economic development in the realm of renewable energy technologies in Japan. Japan is currently utilizing the IoT to try to bring about innovation in solving real life issues in the society[110], the Japanese Government launched the u-Japan and i-Japan strategies in 2008 and 2009, respectively[111]. The u-Japan project was an

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[107] Balaji, M.S. and Roy, S., "Value co-creation with internet of things technology in the retail industry", *Journal of Marketing Management, Vol. 33 Nos 1/2, p. 7-31, 2016.*

[108] Reeler, D., "A three-fold theory of social change", 2007, available at: www.shareweb.ch/site/Poverty-Wellbeing/Documents/media_-_addressing_poverty_in_practice_-_impact_hypotheses_-_reeler_a_theory_of_social_change.pdf

[109] Wijk, J.V., Zietsma, C., Dorado, S., Bakker, F. and Martí, I., "Social innovation: integrating micro,
meso, and macro level insights from institutional theory", *Business and Society, Vol. 58 No. 5, p. 887-918, 2019.*

[110] Maruyama, Y., Nishikido, M. and Iida, T., "The rise of community wind power in Japan: enhanced acceptance through social innovation", *Energy Policy, Vol. 35 No. 5, p. 2761-2769, 2007.*

[111] Xu, L.D., He, W. and Li, S., "Internet of things in industries: a survey", *IEEE Transactions on Industrial Informatics, Vol. 10 No. 4, p. 2233-2243, 2014.*

initiative of the Ministry of Internal Affairs and Communications with the aim of the project being that of establishing connections between things and people as well as people and things in a network within the society. The i-Japan strategy, on the other hand, was developed by Japan's IT strategy headquarters with the goal of ensuring that digital information technology was available to every corner of Japanese society, with a particular focus on areas such as e-governance, health care, education, and various industrial sectors[112]. IoT use has demonstrated to offer advantages not only in the industrial and social domains, but it has also been concluded from numerous studies that the IoT has a good influence on the employment of IoT researchers, R&D spending in IoT research, and the number of hour employee labour in Japan. The results presented in various study show that the IoT has contributed to social change in the societies of these countries. Noticeably, this change has been incremental in nature and not destructive. This means that the changes introduced by the IoT are gradual increments to previous achievements within these societies[113]. The increasing demand of IoT enabled innovations and the efficiency of these technologies in meeting the needs of customers worldwide, are another key factor that underlines the importance of automation, as a result of the IoT adoption by businesses all around the world rising[114]. All around us, there is an upsurge in the improvement of everything because of the IoT[115]. Therefore, as efficiency grows, demand

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[112] Liu, Y., "Analysis of development of Internet of Things technology and training of professional
talents", *Advances in Intelligent Systems Research, Vol. 154, pp. 684-688, 2017*.
[113] Shenkoya, S., "Social change: A comparative analysis of the impact of the IoT in Japan, Germany and Australia", *Internet of Things, Volume 11, 2020.*
[114] Ibidem
[115] Gershenfeld, N. Krikorian, R. and Cohen, D., "The Internet of Things: the principles that gave rise

likewise intensifies with time. Overall, the impact of the IoT may be a consequence of the social issues the IoT is deployed to address, in Japan the decreasing in the population of workers is a problem the IoT was deployed to tackle. As the population continues to decrease many people feel the need to take on multiple roles and perhaps multiple jobs. The IoT provides the opportunity to multitask effectively and efficiently. As an example, in Japan as a result of the ageing population demand for healthcare services is more than supply[116].

2.5.1 Social and industrial application of IoT and 5G technologies

There are other areas where the impact of 5G and IoT application is remarkably advancing and that could represent an extremely important asset for ageing society such as Japan, some of those areas of life that the IoT has impacted positively include communication, health care, education, finance recreation, social networking, and security[117]. The Internet of Things is tied to the 5G network. As seen beforehand the 5G wireless network is distinguished by its fast speed, low latency, and high connection density, all of which are ideal for IoT. The enormous number of applications required by IoT necessitates Internet access with a higher transmission rate, greater reliability, and faster response which makes 5G connections a perfect companion for these applications. The impact of the IoT and 5G technology on the society is far reaching. In the era of the fourth industrial revolution the scope of these

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to the internet are now leading to a new kind of network of everyday devices, an 'internet-0", 2004, available at:
https://bertbon.home.xs4all.nl/edu/UTS/Gershenfeld%20SciAm%201004076.pdf

[116] K. Yuji , S. Imoto , R. Yamaguchi , T. Matsumura , N. Murashige , Y. Kodama , S. Minayo , K. Imai , M. Kami , "Forecasting Japan's physician shortage in 2035 as the first full-fledged aged society", *PLoS ONE 7 no.11, 2012.*

[117] Ai, Y., Wang, L., Han, Z., Zhang, P. and Hanzo, L., "Social networking and caching aided collabourative computing for the internet of things", *IEEE Communications Magazine, Vol. 56 No. 12, p. 149-155, 2018.*

technologies is unlimited. The introduction of 5G enabled applications, various technology advancement foreseeable with the usage of IoT such as SMART factories and SMART cities, and the combined use of both these technologies in modern society will lead to the development of new types of services such as never seen before[118]. The following are just few examples that show the extent of the use of these technologies in modern Japan:

- In the agriculture field, the use of IoT and 5G conjunct has proven to be successful. Smart agriculture makes use of robots, AI, the IoT, and other cutting-edge technologies. Adding 5G to smart agriculture for real-time remote monitoring, remote instructions and support, and remote surveillance of agricultural equipment and facilities is expected to further boost productivity through automation of agricultural operations and application of data. The use of 5G and IoT, is expected not only to improve productivity through smart agriculture but also to maintain and rejuvenate communities in underpopulated areas by improving living conditions and attracting more permanent residents. Furthermore, the IoT is breeding Smart farms. This is a necessary response to the renewable resources of energy, globally. In the future, because of extensive and improved use of 5G and IoT, the global agricultural food supply chain will be standardized and optimized with better monitoring systems. What's important when applying these technologies in agriculture and agricultural communities is ensuring use cases take shape on the ground, while keeping in mind installation costs and the status of establishing conditions for their usage[119].

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[118] E. Martínez-Caro, J. Cegarra-Navarro, A. García-Pérez, M. Fait, "Healthcare service evolution towards the Internet of Things: an end-user perspective", *Technol. Forecast Soc. Change 136, p.268–276, 2018.* doi: 10.1016/j.techfore.2018.03.025

[119] 総務省, Ministry of Internal Affairs and Communications "Information and Communications in Japan 2019", available online at: https://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/whitepaper/2021/pdf/chapter-4.pdf

- Remote operation and control of construction equipment and machinery requires building wireless communication systems that can send and receive lots of information, such as image data and control signals to operate machinery. While with the use of traditional wireless network, construction companies tend to face the problem of communication latency and insufficient speeds and capacities, by adopting 5G networks such problems are significantly less present[120]. During a slinging operation, the operator often has several blind areas and hence operates the crane in accordance with verbal instructions. 5G can remove blind spots for safer crane operations by streaming high resolution 4K video of blind areas to the operator's cab. We can then deduce that 5G provides services that allow the operator to securely operate the crane while monitoring video[121]. Construction companies in Japan are also experiencing remunerative and remarkably progress thanks to the introduction of IoT to improve their proficiency. One of such applications is the use of a 3D intelligent building technique known as BIM[122], which drastically reduces the timing for planning, designing and constructing building through the use of 3D conformable models. The extensive use of this technology makes Japan one of the few countries in the world that has used the IoT to advance building information modelling[123] and this could potentially pave the way for the rise of new business models in Japan that dramatically reduce construction times and give birth to new construction techniques, which would result in a cutting of costs in the

[120] Ibidem
[121] Ibidem
[122] Zhong, R.Y.P.Y., Xue, F., Fang, J., Zou, W., Luo, H., Ng, STs., Lu, W., Shen, Q.P. and Huang, G.Q.,
"Prefabricated construction enabled by the internet-of-things", *Automation in Construction, Vol. 76, p. 59-70, 2017.*

building sector and that would generate additional value. The various industrial field of use for 5G enabled applications, the ramification of the IoT in modern society which will eventually lead to SMART factories and SMART cities, and their combined uses has proven to be an essential factor in society application and in the following paragraph, a brief overview of these technologies diverse field of application will be presented:

- In the medical fields, IoT is leading to the development of new Smart devices that can be carried around by individuals. These devices improve data mining and the monitoring of the human health by medical practitioners. While in the past, healthcare monitoring used a reactive framework (post facto diagnose-and-treat reactive) in the future this system will be improved to accommodate a proactive framework (prognosis), as some literature works explains[124]. The changes that will be introduced by the IoT will ensure better diagnosis, research, and personalization of treatments for patients[125].
- Another industrial sector with potential applications of 5G, is the mobility field. Such applications are expected in remote operation of vehicles and autonomous driving, such as truck platooning that takes advantage of 5G's ultra-low latency. A key technology behind these applications is the Adaptive cruise control (ACC), which adjusts vehicle speed to maintain a safe distance between vehicles, is now becoming practical. Because ACC is based only on distance information between vehicles, there is a delay between when the leading vehicle begins to decelerate until the interval distance changes

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[123] 総務省, Ministry of Internal Affairs and Communications "Information and Communications in Japan 2021", available online at: https://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/whitepaper/2021/pdf/chapter-4.pdf

[124] M. Hassanalieragh, A. Page, T. Soyata, G. Sharma, M. Aktas, G. Mateos, B. Kantarci, S. Andreescu, "Health monitoring and management using Internet- of-Things (IoT) sensing with cloud-based processing: opportunities and challenges", *Proc. IEEE Int. Conf. Serv. Comput, 2015, doi: 10.1109/SCC.2015.47*

[125] Ibidem

and the trailing vehicle begins to decelerate. Consequently, to avoid rear-end collisions, a long distance between vehicles is necessary. A MIC comprehensive 5G demonstration trial in FY 2019 tested the transmission of monitoring video with handover among four 5G base stations in a vehicle-to-network (V2N) system that communicates between vehicles. Another test of direct vehicle-to-vehicle (V2V Direct) communications demonstrated cooperative adaptive cruise control (CACC) for a platoon of trucks on the Shin-Tomei Expressway. Using ultra-low latency 5G communications, the test successfully controlled and steered the trucks with a separation of 10 meters[126].

- IoT and 5G combined application is a factor which will undoubtedly bring change to the way business is being conducted. The traditional company paradigm, which includes physical premises, is increasingly being dismantled in favour of internet retailers for the intrinsic advantages of this technology, some of which are a more efficient operation management, better use of resources and assets and cost-effective operation. As an example to this we find the case usage of IT for product inspection, which is a technology that makes use of laser distance measurement and weight measurement dispositive. The examination is conducted through the uses of an AI which substitutes for visual inspection, and by combining this technology with Deep Learning, the benefit is a recollection of confusing images at a high-speed without the need of the product being directly examined[127]. According to some literature works[128], this change is leading to sustainable development

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[126] 総務省, Ministry of Internal Affairs and Communications "Digitalization throughout society", available online at: https://japan.kantei.go.jp/policy/it/2017/20170530_summary.pdf

[127] Nakura Masahi, "Examples of how SMEs are using AI and IoT", *SME Support Study Vol.8, 2021, in Japanese*

[128] V. Krotov, "The Internet of Things and new business opportunities", *Bus. Horiz. 60 no.6, p.831–841, 2017.*

because the borders of doing business are becoming invisible and access to quality service is increasing. Also, as stated before, the IoT is leading to the growth of the concept of Smart cities all over the world. This is a response to the climate change issues currently facing the world. This is changing the way firms think about profit because profit making and sustainable will become inseparable[129].

To summarize what has been expressed thus far, it is evident that the efficient use of IoT and 5G in Japan was the result of these technology being deployed to target a specific need within the society. This means that, for the these technologies to be successful in any society, their usage must be tailored to specific issues within that specific society[130]. Furthermore, the IoT and 5G uses can only be efficiently deployed if the required institutional change that is required, exist. This means these technologies can only be deployed successfully if the prerequisite infrastructures, in which they can build on exist, which is the case for Japan, as it has been discussed in chapter 1. Governments in undeveloped or impoverished nations, on the other hand, should refrain from deploying IoT since they lack the necessary infrastructure. This is because these infrastructural loopholes can be explored by hackers to steal important information and data, rendering, de facto, useless the use of blockchain technology[131]. To summarize, the adoption of IoT, 5G, and their combined use in all parts of human civilization ensures its growth through time. The forecast of the outlook on the growth of the IoT

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[129] S. Bresciani, A. Ferraris, M. Del Giudice, "The management of organizational ambidexterity through alliances in a new context of analysis: Internet of Things (IoT) smart city projects", *Technol. Forecast Soc. Change no.136,p.331–338, 2018, doi: 10.1016/j.techfore.2017.03.002 .*

[130] Ibidem

[131] Shenkoya, S., "Social change: A comparative analysis of the impact of the IoT in Japan, Germany and Australia", *Internet of Things, Volume 11, 2020.*

based on the number of active devices shows that by 2040 its number will be about 140 million, as expressed in the table below[132]. The expected growth rate of the usage of IoT devices and non-IoT devices from 2020 to 2040 is expected to be 1330 percent and 114 percent respectively. This shows that the IoT is undoubtedly the technology of the future.

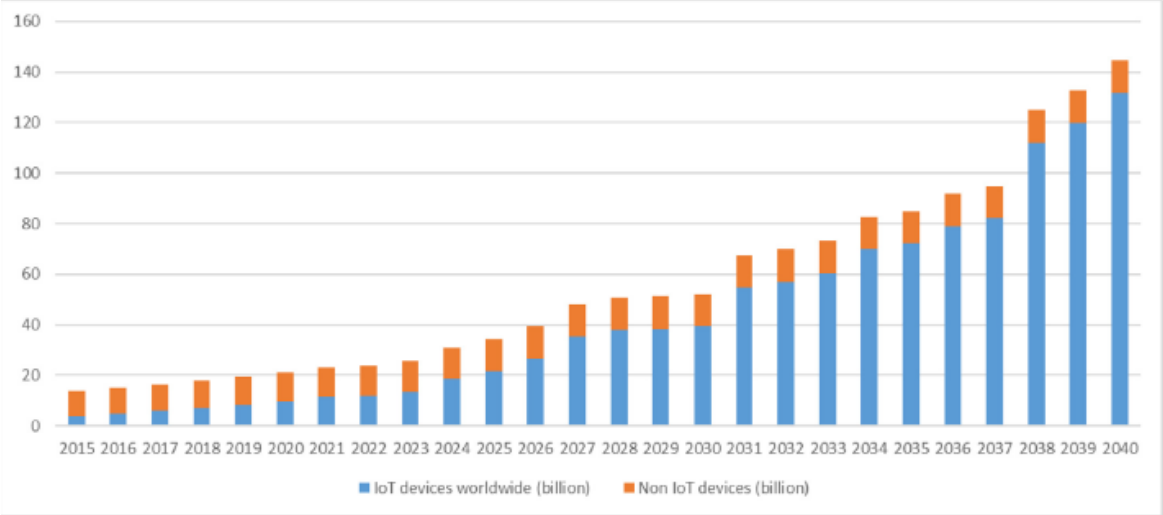

Figure 16 Future outlook of IoT devices, Columbus[133]

2.6 ICT and offshoring in Japan

With the growing demand for skilled workers relative to unskilled workers, the wage inequality between skilled and unskilled workers is increasing in many countries. It is widely believed that low skilled workers are significantly affected by the ICT and offshoring in Japan. The main intent of this paragraph is to provide insight and bring an understanding of the link between ICT, offshoring, and the skill structure of labour demand in Japan. We will examine how offshore is related to increased demand for highly skilled individuals, as well as the consequences of offshoring on the categories of middle-high, middle-low, and low skilled workers. It is reported how

[132] Columbus, L., "Roundup of Internet of Things forecasts and market estimates", *2018.* https://www.forbes.com/sites/louiscolumbus/2018/12/13/ 2018- roundup- of- internet- of- things- forecasts- and- market- estimates/#56f0b5567d83.

industries with higher ICT stock shifts demand from middle-low skilled workers to middle-high and low skilled workers, which is consistent with ICT-based ''job polarization''. On this paragraph the focus will be on manufacturing to better understand the effect of offshoring in Japanese society. One of the reasons for that is that offshoring has developed widely in the manufacturing sector. Offshore in the industrial sector was first detected in the 1980s, while offshoring in services is a relatively recent phenomena that emerged with the development of ICT technology in the 1990s[134].

A key element in analysing Japanese and many other modern countries society and economy, is the growing demand for skilled workers relative to unskilled workers and the wage inequality between such workers[135]. This can theoretically be explained by both offshoring and skill-biased technological change due to the use of computers and other high-tech equipment[136]. In Japan, the demand for part time workers as well as full time workers has been a growing concern in recent years, mainly due to the large wage gap between such workers, which is larger than that in Europe countries[137]. Because the share of part-time workers is increasing while the growth of their wages remains low, including part-time workers is important in the context of the Japanese labour market[138].

The literature which has studied this particular phenomenon is divided into

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[133] Ibidem

[134] Kiyota, K., & Maruyama, S., "ICT, Offshoring, and the Demand for Part-time Workers: The Case of Japanese Manufacturing", *Keio-IES Discussion Paper Series. Keio University, 2016.*

[135] Ibidem

[136] Feenstra, R. C., "Offshoring in the global economy: Microeconomic structure and macroeconomic implications", *Cambridge, MA: MIT Press, 2010.*

[137] Interim reports on 'a policy of equal pay for equal jobs' for 'a better deal for non-regular workers' ('Hiseiki Koyou no Taigu no Kaizen' no tameno 'Douitsu Roudou Douitsu Chingin'), *by the investigation committee of the labour relations issues in the Liberal Democratic Party, April 8th, 2016.*

[138] Ahn, S., Fukao, K., & Ito, K., "Outsourcing in East Asia and Its Impact on the Japanese and Korean Labour Markets", *OECD Trade Policy Working Papers no,65, 2018.*

three main strands: the first strand is composed of studies that estimate a system of labour demands, controlling for the effects of skill-biased technological change and offshoring simultaneously. This approach was first proposed by Hijzen, Gorg, and Hine[139] who examined the skill demand in the United Kingdom. Another key study which contributes to this strand of literature is the one of Ahn, Fukao, and Ito[140], who applied this framework to Japan and Korea. Through the use of detailed industry data in Japan and Korea between 1988 and 2002, they found that the labour demand shifted to skilled workers in Japanese manufacturing due to offshoring. The second strand of the literature studies part-time workers. Several studies examined the supply and wages of part time workers in Japan. One of main questions that was being addressed was that of firms increasingly employing part-time workers in jobs traditionally offered to full-time workers. Using establishment data for the period between 1999 and 2001, the results from this strand of literature found that 'manufacturing firms are outsourcing in lieu of hiring domestic part-time workers''. It is unclear why, despite growing outsourcing by manufacturing businesses, demand for part-time workers grew rather than declined[141]. The third strand includes studies that investigate the determinants of demand for non-regular or temporary workers in Japan. For example, Asano, Ito, and Kawaguchi[142] examined the effects of ICT on non-regular workers, using firm-level data for the period between 1998 and 2006 in Japan. Non-regular workers are defined as the total of part-time and temporary

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[139] Hijzen, A., Görg, H., & Hine, R. C., "International outsourcing and the skill structure of labour demand in the United Kingdom", *Economic Journal, no.115, p.860–878, 2005.*

[140] Ahn, S., Fukao, K., & Ito, K., "Outsourcing in East Asia and Its Impact on the Japanese and Korean Labour Markets", *OECD Trade Policy Working Papers no.65, 2008.*

[141] Gaston, N., & Kishi, T., "Part-time workers doing full-time work in Japan", *Journal of the Japanese and International Economies, no,21, p.435–454, 2007.*

[142] Asano, H., Ito, T., & Kawaguchi, D., "Why has the fraction of nonstandard workers increased? A case of Japan", *Scottish Journal of Political Economy, no.60, p.360–389, 2013.*

workers in this body of literature. The part-time workers are workers who work shorter hours or days than regular workers. A more recent study by Tanaka[143] examined the effects of offshoring on the demand for temporary workers, using firm-level data in Japan for the period between 2001 and 2007. According to his research, outsourcing boosted the need for temporary labour. Using all three strands of literature, a comprehensive work by Kozo Kiyota and Sawako Maruyama extends these findings into a few main aspects that will be analysed in this section. Their study uses a more detailed classification of skills than previous studies, in particular their focus is explicitly on low-wage part-time workers, who are defined as workers whose average number of hours worked in a week is less than 35.9. Not only that, but their study also covers a longer period of time than the other studies, from 1980 to 2011. Finally, their study presents a comprehensive picture of Japanese manufacturing for the last 30 years, making it the latest update of studies on the effects of ICT and offshoring on the skill structure in Japan[144].

The table below presents the disparities in average wages per hour across six workers' categories in Japanese manufacturing in 1980 and 2011. These six categories are: university graduates or higher; college graduates; high school graduates; junior high school graduates; part-time workers; and self-employed workers. Each category is represented by a horizontal line segment, the length of which indicates the worker share of the labour force. The average hourly wage is indicated by the vertical position.

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[143] Tanaka, A., "Foreign direct investment and temporary workers in Japan", *Manuscript. Chuo University, 2016.*

[144] Kiyota, K., & Maruyama, S., "ICT, Offshoring, and the Demand for Part-time Workers: The Case of Japanese Manufacturing", *Keio-IES Discussion Paper Series. Keio University, 2016.*

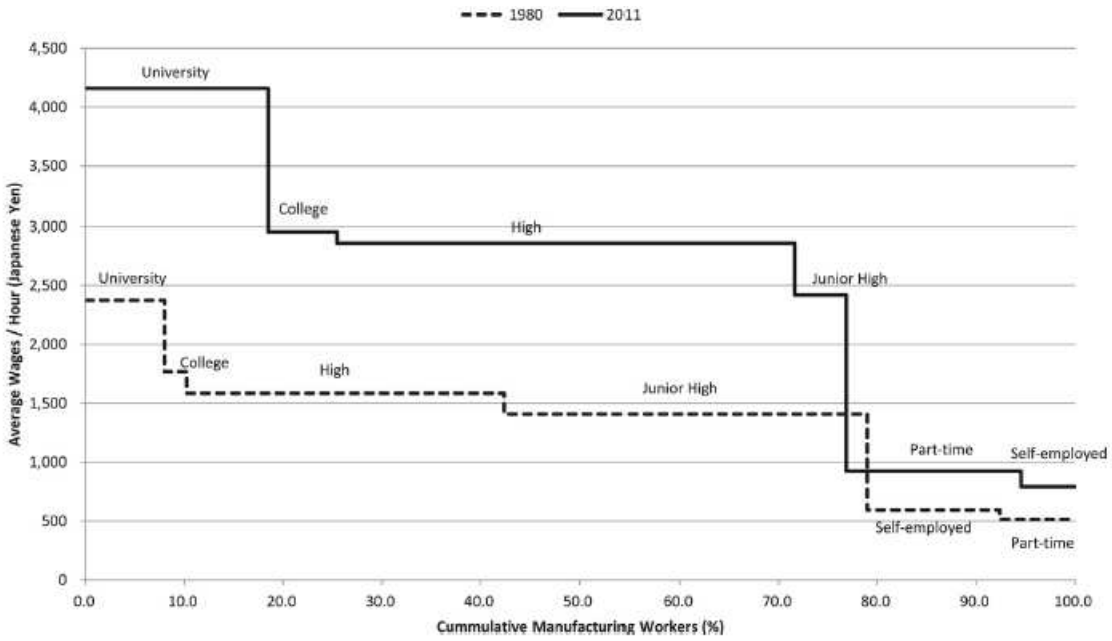

Figure 17 Average wages in Japanese Labour markets, 1980 and 2011, JIP Databese 2014.

By analysing this table, we can highlight three notable findings. First is that the average wages are different across educational levels and worker types, so that average wages of part time and self-employed workers are less than half that of junior high school graduates. Second, we find that share of part time workers in manufacturing employment expanded significantly. The employment share of part-time workers grew from 7.7 percent in 1980 to 17.7 percent in 2011. If we take into account that the share of university graduates was 18.5 percent in 2011, the size of part time workers is not negligible in the Japanese manufacturing employment[145]. Lastly, we see how both the share of the highest wage category and that of the lowest wage categories increase from 1980 to 2011. On the other hand, the proportion of people in the intermediate salary brackets, such as college, high school, and junior high school graduates, has decreased over time. Such results may imply the ''job polarization'' of the labour market, a phenomenon that occurs where there is

[145] Ibidem

a simultaneous growth of high-education, high-wage jobs at one end and low-education, low-wage jobs at the other end, both at the expense of middle-wage, middle education jobs [146]. Another key aspect which is important to analyse in order to better comprehend the scale of such findings, is the average wage per hours, as presented in the table below. The results which will be taken into consideration are the one for the aforementioned six categories of workers from 1970 to 2011. The first result is that the average hourly wages of part time and self-employed workers are almost constant from the early 1990s, even though that of junior high school graduates grew in the 1990s [147]. If we assume that the average hourly wages reflect the marginal product of labour, then these results imply that the part time and self-employed workers are different from other worker categories[148]. As a second result, we can see how the wage gap between college on high school graduates, and junior high school graduates start expanding from the 2000s. The average wage of these group was almost at the same level of college and high school graduates up until the 2000s, but after that it gradually declined and as a result the average wage of junior high school graduates was 20 percent lower of that of college and high school graduates in 2011.

[146] Goos, M., & Manning, A., "Lousy and lovely jobs: The rising polarization of work in Britain", *Review of Economics and Statistics, no.89, p.118–133, 2007.*
[147] Kiyota, K., & Maruyama, S., "ICT, Offshoring, and the Demand for Part-time Workers: The Case of Japanese Manufacturing", *Keio-IES Discussion Paper Series. Keio University, 2016.*
[148] Ibidem

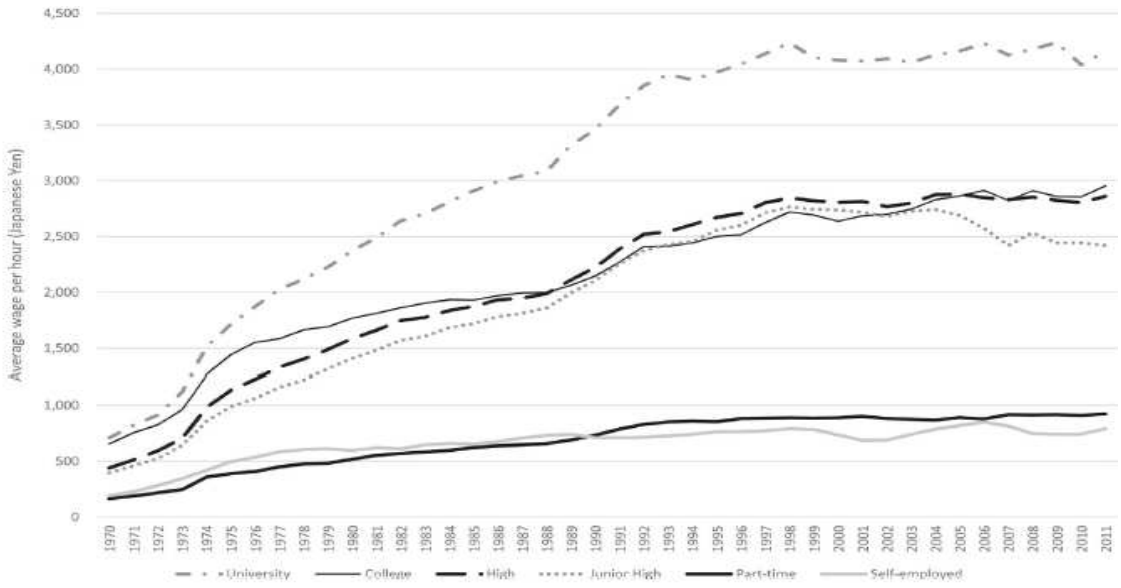

Figure 18 Average wage per hour, by education and type of workers: manufacturing in Japan, JIP Databese 2014.

In order to understand the entire picture of labour demand in Japan, it is necessary to investigate how demand for part-time employees differs from demand for full-time workers. In both full-time and part-time workers, increases in wages have positive effects on the demand for materials. This implies that labour and materials substitute for each other[149]. The work of Kozo Kiyota and Sawako Maruyama explains how offshoring has insignificant effects on the demand for both full-time and part-time workers and that the effect of the ICT capital on the demand for part-time workers is significantly positive, but it is insignificant for full-time workers. Finally, the effect of non-ICT capital is insignificant for the demand for both full-time and part-time workers[150]. These findings imply that neither outsourcing nor ICT capital is detrimental to the demand for part-time labour. Indeed, ICT capital has significantly positive effects on the demand for part-time workers. However, the effects on full-time workers could be different across skill groups.

[149] Ibidem

To summarize, the consequences of ICT and outsourcing varied across social categories. The demand for middle-low skilled workers has negative effects from ICT. The middle-high and low skilled workers have positive effects from ICT while the high skilled workers benefit from offshoring. The work of Kiyota and Maruyama also points out how offshoring has insignificant effects on middle-high, middle-low, and low skilled workers.

2.7 ICT and TFP productivity

2.7.1 Introduction to TFP in Japan

Following the burst of the "bubble economy" in 1991, productivity growth in Japan declined notably and has remained at a relatively low level for more than 20 years. Since Japan's working age population will continue to shrink rapidly and the capital-labour ratio is already high, improving total factor productivity (TFP) for many literatures representative, represents the only way for Japan to accomplish sustainable economic growth.

In this paragraph we are going to analyse Japan's TFP not only at the macro level, but we will thoroughly take into account the sectoral, firm and establishment level. Also, through the use of micro data, it will be possible to examine productivity dynamics and the role played by the so-called "zombie firms", profitless and high-indebted company. Through the use of many literature works and research, most notably the ones of Fukao Kyoji[151], we are going to examine the Japanese economy from a long-term perspective by contrasting Japan's productivity performance at the sectoral and micro levels since the 1990s with that of the 1970s and 1980s

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[150] Ibidem

[151] Jong-Wha L., Do Won K., Eunbi S. "Ageing Labour, ICT Capital, and Productivity in Japan and Korea", *Journal of The Japanese and International Economies, 58, 2020.*

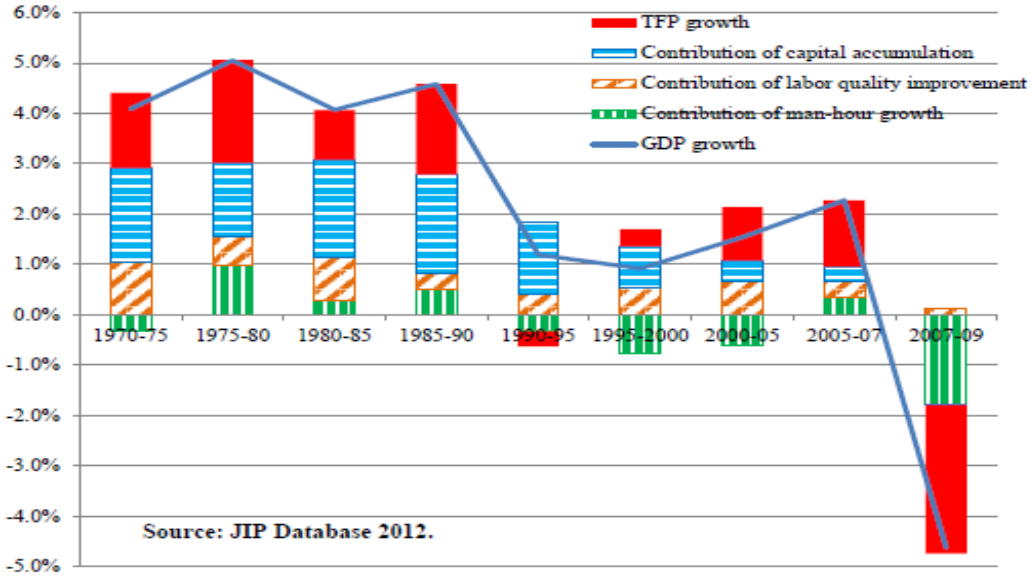
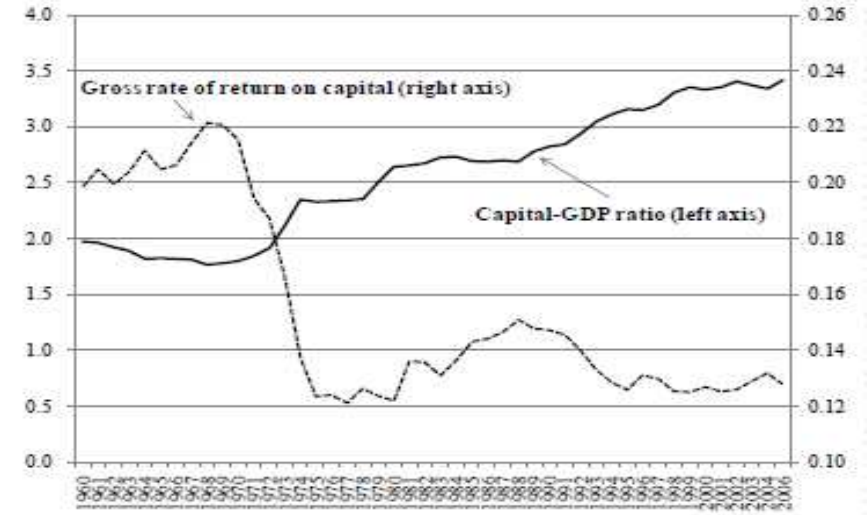


Figure 19 Growth Accounting for Japan's Macro-economy, JIP Database 2012.

Figure 19 indicates that after 1990, all three drivers of economic growth, namely capital accumulation, labour input growth (defined as man-hour input growth + labour improvement growth), and TFP growth, significantly slowed and contributed to the slowing of GDP growth. Through the use of the Japan Industrial Productivity database, the study of Fukao Kyoji compares the 1970–1990 period with the 1990–2007 one, where the annual contribution of the three sources of economic growth declined by 1.0, 1.0, and 1.1 percentage points respectively. In the 2000s, TFP growth gradually recovered until 2007, but the average annual TFP growth rate during 2000– 2007 was still of 1.1 percent, and it was still only about two-thirds of the TFP growth rate during 1970–1990, which was 1.6 percent[152].

[152] Fukao, K., "Explaining Japan's unproductive Two Decades", *RIETI Policy Discussion Paper Series 13-pp. 22, 2013.*



Source: Fukao (2012). The original data for 1975-2006 are taken from the EU KLEMS Database, November 2009.
Notes: Capital-GDP ratio = Gross capital formation deflator×Real capital stock/Nominal GDP.
Gross rate of return on capital = Gross operating surplus/(Gross capital formation deflator×Real capital stock).

Figure 20 Capital Coefficient and Gross Rate of Return on Capital in Japan, EU KLEMS Database & Fukao 2012

The fact that Japan's growth has been led by capital accumulation can be seen by analysing the main engines of labour productivity in the country. For Japan the contribution of each of the source of economic growth, mainly the TFP component is shorter than that of other economies, namely the United States one, which explicates how the country's labour productivity growth was accomplished mainly by physical and human capital deepening and not by TFP growth[153].

Figure 20 shows how TFP, on a value-added basis, in Japan's manufacturing and non-manufacturing sectors changed over time. TFP growth in the industrial sector fell precipitously after 1991. The dotted line in the image depicts the manufacturing sector's TFP level, assuming that the TFP growth rate from 1992 onwards was the same as the average annual TFP growth rate in 1970-1991. TFP growth in the manufacturing sector accelerated again after 2002. However, since the stagnation of TFP growth in the 1990 and the early

[153] Ibidem

2000s was so pronounced, there is a huge gap between the past trend line and the actual TFP level. If Japan's manufacturing sector had been able to maintain TFP growth as high as that in 1970–1991 after 1991, the manufacturing sector's real value added now would be more than two-thirds larger, without increasing factor inputs, than the actual current level[154].

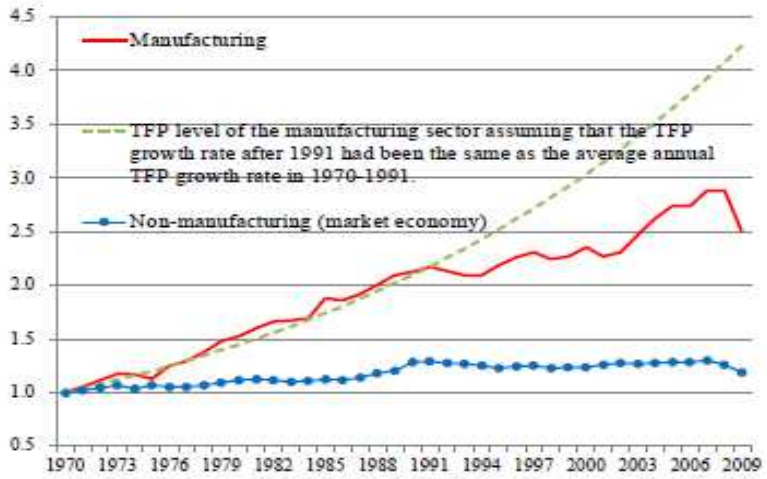


Figure 21 TFP Level of the Manufacturing and the Non-manufacturing Sector in 1970-2009, JIP Database 2012.

In the case of the non-manufacturing sector, TFP growth in Japan, like in other countries, has been much lower than that in the manufacturing sector. Nevertheless, there is also a distinct difference between before and after 1991. Until 1991, the non-manufacturing sector saw gradual but consistent TFP growth, with TFP in 1991 being 29% greater than in 1970. However, after 1991 there was almost no TFP growth in this sector. Since the nominal value-added share of the non-manufacturing sector, or market economy, is more than twice as large as that of the manufacturing sector, the contribution of the slowdown of TFP growth in the non-manufacturing sector to the slowdown of TFP growth in the macro-economy was slightly greater than that of the manufacturing sector. Overall, it seems fair to say that both the manufacturing and the non-manufacturing sector almost equally dragged

[154] Ibidem

down macro TFP growth after 1991[155].

2.7.2 Why was Japan left behind in the ICT revolution?

Using firm-level data for Japan, we will now see why Japan was left behind in the ICT revolution, whereas other major economy managed to succeed.

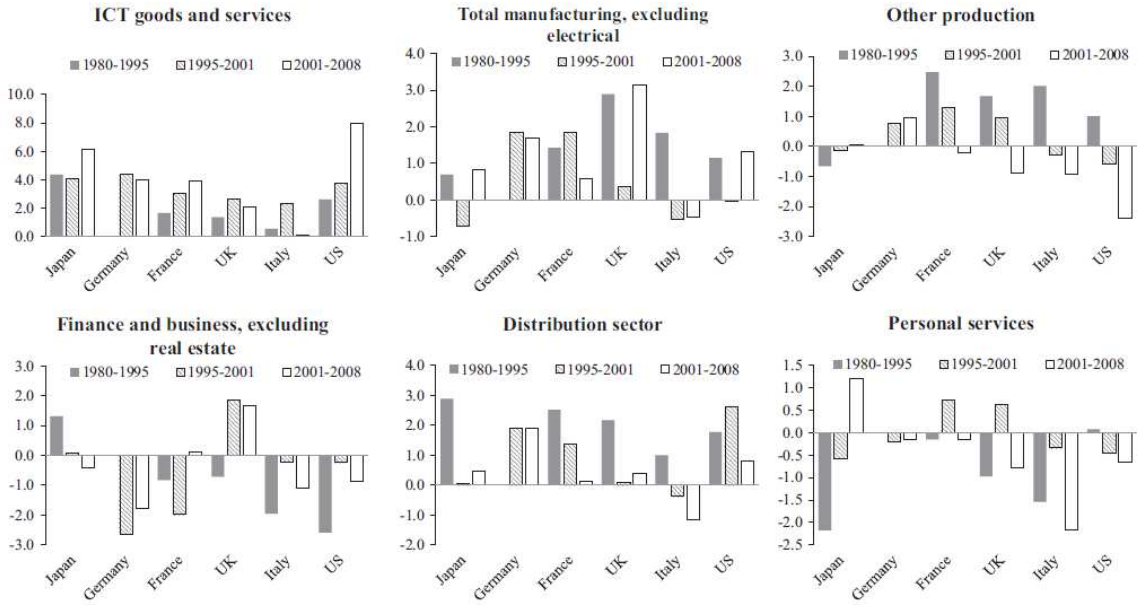


Figure 22 TFP Growth in the market sector, by sector and country: 1980-1995, 1995-2001, and 2001-2008, EU KLEMS Database.

The figure above depicts how the United States experienced an acceleration of TFP growth not only in ICT-producing services, but also in ICT-using sectors. Japan also experienced relatively high TFP growth in ICT-producing sector, however, TFP growth in ICT-using services declined substantially after 1995, in line with the research result witnessed before. Furthermore, these ICT-using industries are substantially larger than the ICT-producing sector: the ICT-production sector's average labour input share of total labour in Japan was just 4.1 4.1 percent, while other input shares of distribution were near 22.8 percent. It's also interesting that like Japan, also Italy and France experienced slowdown in TFP growth in ICT-using sectors, while Germany

[155] Ibidem

experienced high growth.

So, the question remains, why did an ICT revolution of this magnitude not occur in Japan, Italy, and France? One possible explanation is the small ICT investment in ICT-using sectors in these countries, as shown in the table below which illustrates contribution of increases in ICT capital service input to sectoral real gross value-added growth. The table indicates that during the period from 1995 to the early 2000s the contribution of ICT investment to economic growth in Japan was not substantially smaller than that of the United States, but then declined notably after the 2000s. At sectoral level Japan, France and Italy registered active ICT investment in ICT goods and services but in most of the other sectors ICT investment was much less active[156].

	1995–2000						2000–2007					
	Japan	Germany	France	UK	Italy	US	Japan[b]	Germany[a]	France	UK	Italy[a]	US
Market economy	0.50	0.68	0.54	0.95	0.43	0.57	0.37	0.34	0.26	0.56	0.13	0.57
ICT goods and services	1.30	0.18	0.16	2.46	0.80	0.82	0.77	0.25	0.65	0.96	0.15	0.45
Total manufacturing, excluding electrical machinery	0.32	0.20	0.33	0.46	0.28	0.24	0.21	0.12	0.09	0.21	0.06	0.31
Other production	0.22	0.09	0.28	0.20	0.15	0.64	0.12	0.03	0.07	0.17	0.06	0.32
Finance and business, excluding real estate	0.16	0.49	0.54	0.81	0.46	0.53	0.08	0.21	0.19	0.55	0.07	0.54
Distribution sector	0.45	2.13	1.00	1.73	0.76	0.75	0.37	0.99	0.51	1.01	0.34	1.04
Personal services	0.12	0.27	0.48	0.49	0.38	0.57	0.08	0.10	0.09	0.21	0.12	0.17

[a] 2000–2005.
[b] 2000–2006.

Figure 23 Contribution of increases in ICT capital service input to real gross value added growth: by sector and country, EU KLEMS Database, Fukao, Miyagawa, Pyo and Rhee.

However, the relation between ICT investment and TFP growth is not straightforward: while the United Kingdom had high levels of ICT investment in the distribution sector, TFP did not expand significantly in the 2000s, unlike in the United States. It thus appears that TFP growth is affected not only by the level of ICT investment but also by factors such as how ICT is used at firm level[157] and the outsourcing of ICT activities. It thus seems that the ICT

[156] Fukao, K., Ikeuchi, K., YoungGak, K., Hyeog Ug, K., "Why was Japan left behind in the ICT revolution?", *Telecommunications Policy no.40, p.432–449, 2016.*

[157] Bloom, N., Sadun, R. ,& Van Reenen, J., "Americans do IT better: US multinationals and the productivity miracle", *American Economic Review, no.102(1), p.167–201, 2012.*

revolution did not happen in Japan, and other countries like France and Italy, since they did not accumulate sufficient ICT capital in their correlated using sectors[158]. It is interesting to note that Japan's ICT investment in some sectors has been low in comparison with other countries since 1970s, it therefore cannot be argued that the economic slump after 1991 has been the main cause of Japan's low ICT investment[159].

2.7.3 ICT investment in Japan

Figure 24 ICT Investment-GDP Ratio in Major Developed Economies: Distribution Services, EU KLEMS Database 2009.

Several structural barriers to ICT investment in Japan can be identified. First, as seen in other works of the literature such as the one of Kenta Ikeuchi, Young Gak Kim, Hyeog Ug Kwon, Kyoji Fukao[160], the introduction of ICT to save unskilled labour input. Second, initial fixed costs are an impediment to small firms which tend to have a lower ICT intensity than larger firms. There is no straightforward linear link between firm age and ICT intensity in the case of company age. Both young and very old firms tend to have a higher

[158] Ibidem
[159] Fukao, K., "Explaining Japan's unproductive Two Decades", *RIETI Policy Discussion Paper Series 13-pp. 22, 2013.*
[160] Fukao, K., Ikeuchi, K., YoungGak, K., Hyeog Ug, K., "Why was Japan left behind in the ICT revolution?", *Telecommunications Policy no.40, p.432–449, 2016.*

ICT intensity, while those in between have a lower one[161]. Probably because of this characteristic of ICT technology, younger and growing firms tend to be more active in ICT investment. The work of Fukao, K., Miyagawa, T., and Pyo, H. K., proves that in Japan's non-manufacturing sector, younger firms have higher software stock/sales ratio[162]. However, because of the low entry and exit rates in Japan, firms that have been around for 45 years or more have a majority of market share in all industries except transportation, communication, and public services as shown in the table below.

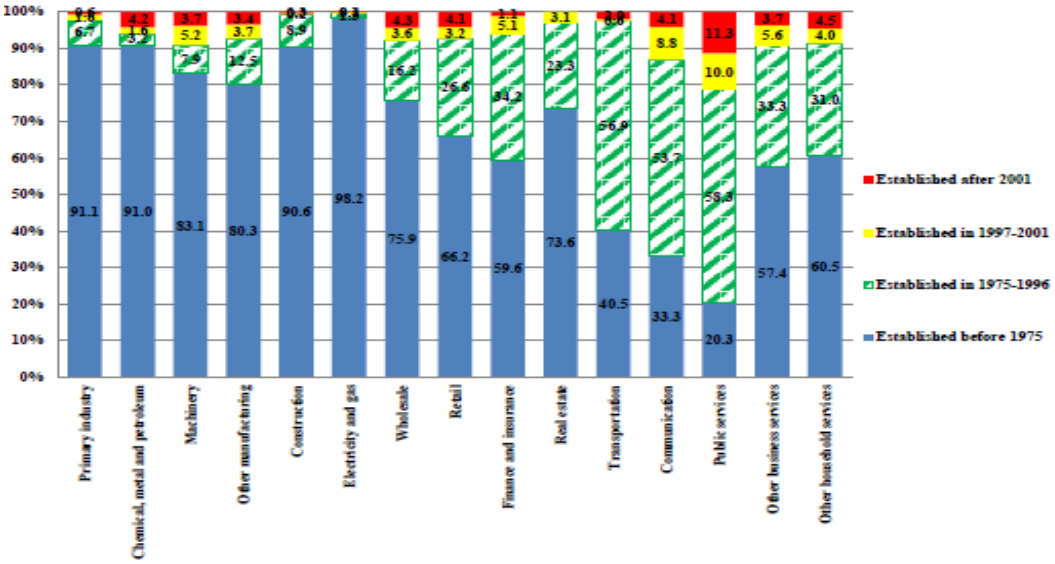


Figure 25 Sales Share by Firm Age Group in 2009, Fukao et al. 2012.

This low metabolism has probably impeded ICT investment in Japan. Because each business utilizes different bespoke software, Japanese enterprises tend to choose custom software over packaged software, making ICT investment

[161] Ibidem

[162]Fukao, K., Miyagawa, T., Pyo, H.K., & Rhee, K.H., "Estimates of total factor productivity, the contribution of ICT, and resource real location effect in Japan and Korea", *InM. Mas, & R. Stehrer (Eds.), Industrial productivity in Europe: Growth and crisis, p. 264–304, Edward Elgar: Edward Elgar, 2012.*

more expensive and network externality effects less[163]. Through the analysis of the composition of ICT expenditures by firm-age group, the literature work proves that the group of youngest firms spend more on ICT hardware and software and that the group of oldest firms spend more in ICT service input and other ICT expenditures[164]. There are two potential explanations to this: production function differs by firms' size and age and the fact that because of some constraint on ICT input, smaller firms cannot increase their ICT input to the optimal level[165].

How can we explain that smaller firms appear to adopt less ICT-intensive production technologies? Most plausible answer is that factor prices firms face differ by size. Their findings proceeds assuming that there are two factors, ICT inputs and labour, and two technologies, an ICT-intensive one and a non-ICT-intensive. Under these circumstances, the literature work by illustrates that cost minimization implies that smaller firms will choose the non-ICT-intensive technology and larger firms will opt for ICT-intensive technologies. So, it is possible to theorize that when in early stage of production new firm must choose their production technology, they tend to maintain the one they end up choosing, given the high cost in changing the technology of choose. Since there are continuous innovations in ICT and their importance decreases over time, younger firms tend to be more ICT intensive, because older firms' choice of technology took place in a non-ICT-age[166]. Another factor is the age of the workers: firms with a higher share of older employees tend to not adopt new or significantly improved tech, because

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[163] Fukao, K., "Explaining Japan's unproductive Two Decades", *RIETI Policy Discussion Paper Series 13, p.22, 2013.*

[164] Fukao, K., Ikeuchi, K., YoungGak, K., Hyeog Ug, K., "Why was Japan left behind in the ICT revolution?", *Telecommunications Policy no.40, p.432–449, 2016.*

[165] Ibidem

[166] Ibidem

older employees tend to be less ICT literate, thus they are slower to adopt to new ICT[167].

What are the factors that might make smaller firms in Japan face a higher price for ICT inputs? Since it is costly for small firms to have their own ICT service division, having access to efficient vendors of ICT services is a key factor for ICT inputs at a reasonable price. The market for Business Process Outsourcing (BPO) in Japan is underdeveloped. The size of the BPO market in Japan was 663 billion yen in 2012, whereas in the United States it was 12 trillion yen in the same year[168]. The underdevelopment of BPO market in Japan is related with the rigidity of the labour market, as seen in chapter 1. Because it is difficult for Japanese companies to lay off employees, they are reluctant to reorganize costly internal business processing divisions, and even if they do, worker transfer is inadequate. Because of this, Japanese firms cannot procure business services from the most productive vendors, reducing and keeping BPO market underdeveloped[169]. This underdevelopment makes it difficult for firms to find reliable vendors, as a result BPO is mainly conducted by large firms, in addition to this the supply of ICT software experts in Japan is much smaller than that in the United States[170].

What factors prevent smaller and younger firms from raising their ICT input to the optimal level? One potential explanation is liquidity restrictions for ICT hardware and software purchases, data processing and input spending, and

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[167] Meyer, J.," Work force age and technology adoption in small and medium-sized service firms", *Small Business Economics, no.37(3), p.305–324, 2011.*

[168] METI (Ministry of Economy, Trade and Industries), "Service Sangyo no Kofukakachi-ka ni Kansuru Kenkyukai Hokokusho (Report of Study Group on Increasing Added Value of Service Industry)". *METI, 2014.*

[169] METI (Ministry of Economy, Trade and Industries), "BPO (Gyomu Process Outsourcing) Kenkyukai Hokokusho (Report of Study Group on BPO (Business Process Outsourcing)", *METI, 2014.*

divisional labor expenses. Considerable corporations generated a large quantity of liquid assets over the two lost decades, but investment opportunities were scarce. In contrast, smaller and or growing young firms need to finance their investment externally, but because most Japanese banks require tangible assets as a collateral, it is difficult for small or young firms to finance intangible ICT investments[171]. Another plausible explanation is that many small businesses in Japan lack sufficient knowledge of modern ICT and are unaware of the potential benefits of ICT inputs. According to a survey by the Japan Electronics and Information Technology Industry association (JEITA) the share of respondents in Japanese firms that had never heard or know about private clouds, public clouds, business use of mobile technology and big data were 45.8 percent, 45.8 percent, 21.8 percent and 42.6 percent respectively[172].

Another crucial aspect as to why Japan seems to have fallen behind in the use of ICT is the fact that small firms are a prevalent reality, as opposed to other major economies where there is a prevalence of big realtors. Specifically, in the case of all industries, 42.5 percent of employees in Japan work at firms with fewer than 100 employees, while 27.8 percent work at firms with 1000 or more employees. In the United States, the corresponding shares are 36.5 percent and 43.8 percent respectively[173]. These figures signify that in addition to the impediments to raising ICT input faced by smaller firms in Japan, such

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[170]Arora,A., Branstetter, L.G., & Drev, M. "Going soft: How the rise of software based innovation led to the decline of Japan's IT industry and the resurgence of Silicon Valley", *Review of Economics and Statistics, no.95(3), p.757–775, 2013.*

[171] Ogawa, K., & Tokutsu, I., "Productivity, firm size, financial factors, and exporting decisions: The case of Japanese SMEs", *RIETI, 2015.*

[172] JEITA (Japan Electronics and Information Technology Industries Association), "IT wo Katsuyoshita Keiei ni Taisuru Nichi-Bei Kigyo no Soi-Bunseki (Comparative analysis of Japanese and US firms on management with full use of IT)", 2013.

firms also play a much larger role in Japanese economy, and it is the combination of these factors that explains why average ICT intensity the country is lower than that in US[174].

Other factors that contribute to low ICT intensity in all Japanese firms are the fact that ICT soft- and hardware tend to be more expensive that in other countries[175]. As pointed out by Allen[176], it was probably the extremely cheap energy available in Britain at the time that made Britain the birthplace of the first industrial revolution, so by making use of the existing infrastructure and by lowering the prices of ICT inputs, Japan could foster the perpetuation of the fourth industrial revolution in its domestic territory. Another aspect which could be taken into consideration is how, during the two lost decades, Japanese firms reduced intangible investment[177] probably for cost cutting purposes. Intangible investment is defined as expenditures by firms for future production and profits and includes training of workers and the revision of firms' organizational structure. ICT input and intangible assets may be close complements. The reduction of intangible investment by Japanese firms may have contributed to the low productivity of ICT Inputs and may have hampered investment in ICT inputs[178].

To summarise what has been exposed thus far, it seems that Japan's TFP growth declined substantially after 1991 both in the manufacturing and the

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[173] Haskel, J., Jarmin, R. S., Motohashi, K., & Sadun, R., "Retail market structure and dynamics: A three country comparison of Japan, the U.K. and the U.S", *Harvard Business School Working Paper, 2007.*

[174] Ibidem

[175] Fukao, K., Ikeuchi, K., YoungGak, K., Hyeog Ug, K., "Why was Japan left behind in the ICT revolution?", *Telecommunications Policy no.40, p.432–449, 2016.*

[176] Allen, R.C., "The British industrial revolution in global perspective", *Cambridge University Press, 2009.*

[177] Fukao, K., Miyagawa, T., Mukai, K., Shinoda, Y., & Tonogi, K., "Intangible Investment in Japan: Measurement and contribution to economic growth", *Review of Income and Wealth, no.55, p.717–736, 2009.*

[178] Ibidem

non-manufacturing sector. Before 1991, Japan's TFP was rapidly catching up with that of the United States, but after 1991, Japan's TFP level relative to that of the United States declined by 19 percent in the manufacturing sector and 8 percent in the non-manufacturing sector. TFP development in ICT-using industries, such as distribution services and the rest of the industrial sector, began to accelerate in the United States in 1995. It appears that a similar ICT revolution did not occur in Japan and other European countries, simply because they had not accumulated sufficient ICT capital. Japan's accumulation of intangible capital was also very slow, and given the fact that ICT capital and intangible assets may be close complements, it seems that the stagnation of these two types of investment mutually reinforced each other. The literature arguement is that excessive regulations and a lack of competition in service sectors may have prevented the enhancement of ICT-usage effects[179]. It was also pointed out how ICT capital accumulation was very slow in non-ICT manufacturing and service industries, especially among small and medium-sized enterprises, contributing to declining TFP growth during the "two lost decades"[180].

2.8 Ageing society and ICT opportunities

Having now addressed the topic of ICT in a comprehensive way, starting from its role and importance from an economic perspective to the investments and opportunities it can represent for Japan's evolution towards Industry 4.0, it is now time to look at how ICT can help the nation tackle one of its major problems: the rapid ageing of its population.

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[179] Ibidem

[180] Fukao, K., Ikeuchi, K., YoungGak, K., Hyeog Ug, K., "Why was Japan left behind in the ICT revolution?", *Telecommunications Policy no.40, p.432–449, 2016.*

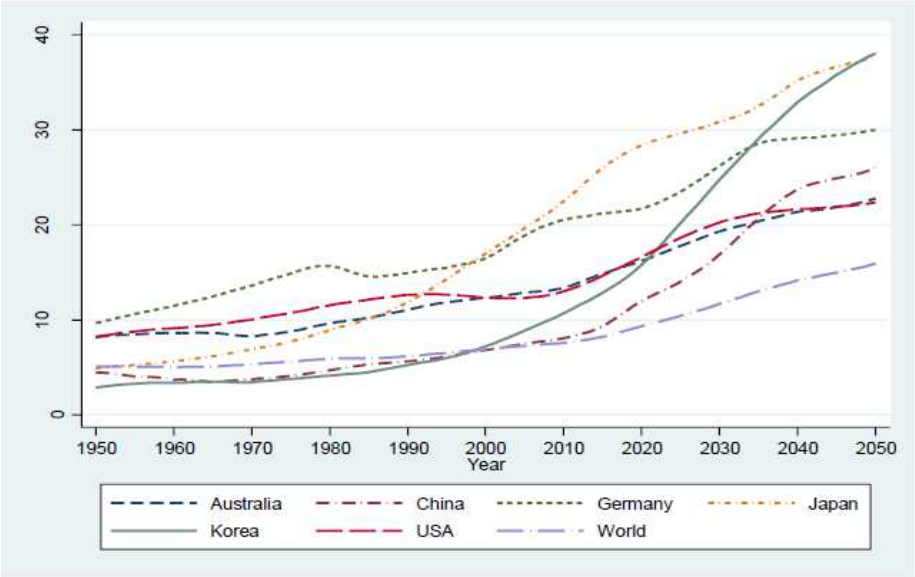

Figure 26 Share of Population Aged 65 and Above in Total Population

As seen before, population ageing stands out as an extremely relevant challenge to many advanced and developing economies, and Japan is one of the world's most aged societies with a rapidly ageing population and shrinking labour force[181]. As of 2019 the percentage of the elderly, intended as population over the 65 years of age, accounted for 28 percent of Japan's population, number which is forecasted to increase to a staggering 30.9 percent by 2040[182]. Of course, this problematic also reflects within Japan's workforce, as presented in the figure below which illustrates the percentage of population aged 50 to 64 years in the workforce and furthers highlights the urgency of the problem in the country.

[181] Jong-Wha L., Do Won K., Eunbi S. "Ageing Labour, ICT Capital, and Productivity in Japan and Korea", *Journal of The Japanese and International Economies, 58, 2020.*
[182] Ibidem

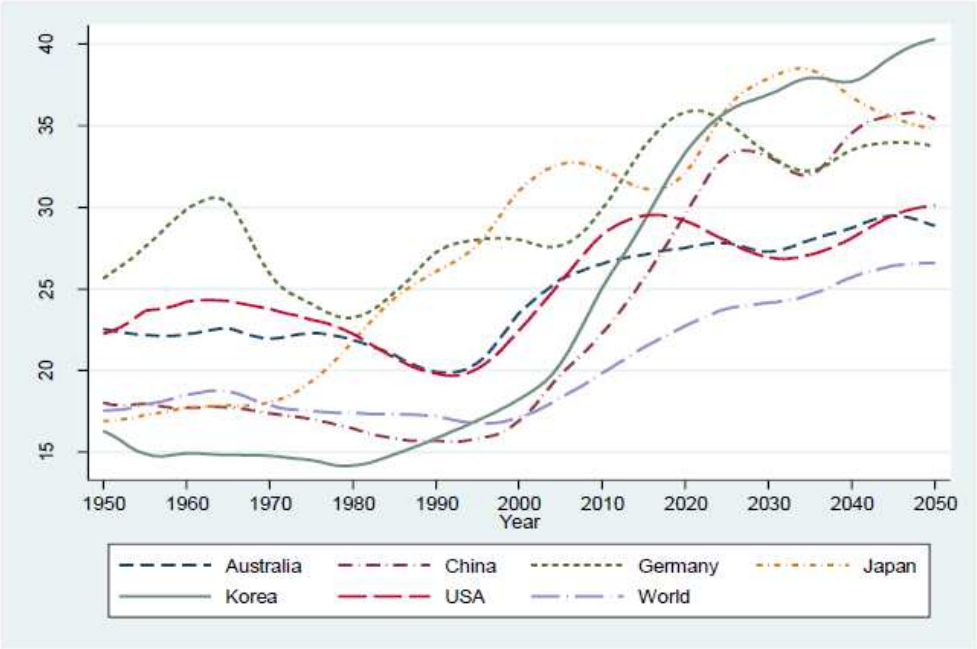

Figure 2 Share of Population Aged 50–64 in Working-age Population (16–64 years)

Figure 27 Share of Population Aged 50-64 in Working-age Population (16-64 years)

As we have discussed in the previous paragraph Japan maintained relatively higher ICT investment share over the past two decades, rising gradually from 7.4 in 1985 to 15 in 2000, and even though the share of investment has declined since, the number of patents and the use of ICT makes it one of the most prominent economies in Asia which is investing in new technologies[183]. In this paragraph we will focus on the role of ICT investment in improving the productivity of the share of workforce which is categorizable as elderly. It is commonly acknowledged that, due to a deterioration of cognitive and physical capacities, workers' productivity declines with age[184], but with the adoption of technologies and by investing in the possibility enabled by

[183] C., Chomik, R., Piggott, J., "Demographic and technological change: Two megatrends shaping the labour market in Asia", *ARC Centre of Excellence in Population Ageing Research Working Paper 2010/2011., 2019.*

[184] Truxillo, D. M., Cadiz, D. M., Hammer, L. B., "Supporting the aging workforce: A review and recommendations for workplace intervention research", *Annual Review of Organizational Psychology and Organizational Behavior no.2, p.351-381, 2015.*

industry 4.0, this does not have to be the case any longer. The literature is divided on this issue: some papers argue how an ageing workforce can lead to a negative effect on TFP growth[185], while others report a positive relationship between the proportion of older population and GDP per capita, their argument being that an ageing population can have a positive effect on productivity growth, as a shortage of young and prime-age workers can lead to a facilitation of the adoption of automation technologies[186]. As discussed in more detail in the last subparagraph, studies using micro-data at the firm level provide evidence of the link between ICT adoption at the firm level and productivity growth. Productivity growth reported in Japan from 1995 to 2005 was strong in ICT-producing manufacturing sectors such as electrical machinery and electronics, but relatively weak in ICT-using service sectors such as retail, wholesale, and transport[187].

Despite the fact that the labour market is undergoing a rapid change and that the significant opportunities represented by new technologies such as ICT and artificial intelligence (AI) in workplaces in Japan, there are still not enough studies that have analyzed the interplay of ICT and older workers in Japan and its consequence on productivity. Nonetheless, one of the most important work in the field, the one of Kawaguchi and Muroga[188], explains how by using Japanese industry-level data, there are no empirical evidence supporting the idea that population ageing encourages the adoption of robots or ICT and that technological progress has a mitigating effect on the decline in

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[185] Aiyar, M. S., Ebeke, M. C., "The impact of workforce aging on European productivity", *IMF Working Paper, WP,16/238, International Monetary Fund, 2016.*

[186] Acemoglu, D., Restrepo, P., "Secular stagnation? The effects of aging on economic growth in the age of automation", *American Economic Review no.107, p.174-179, 2017.*

[187] Fukao, K., Miyagawa, T., Pyo, H. K., Rhee, K. H., "Estimates of multifactor productivity, ICT contributions and resource reallocation effects in Japan and Korea", *RIETI Discussion Paper Series no.09, 2009.*

older workers' productivity in Japan. It is brought to the attention how many ICT-unrelated industries, including real estate, woods and mining, show significant increases in the share of older workers over the period from 1973 to 2005. During the same period, the growth in the proportion of older employees was minimal in industries with a higher proportion of ICT capital. Overall, the empirical results that are provided by the literature provide evidence of a complementary effect between ICT capital and older workers Japan, implying that ICT capital is more effective for older workers than for younger workers[189]. Japanese industries with a higher value of ICT share may enjoy significant productivity gains from the ageing process. However, he also pointed out that the complementary effect is only observed when older workers are poorly educated, implying that a higher ICT share will have a positive impact on the productivity effect of poorly educated older workers[190].

2.9 Concluding remarks

To summarize the finding of the literature and what has been analysed thus far, there is a factor which could be exploited in regard to the use of ICT and the rapid ageing society in Japan: the complementary effect between ICT capital and older workers. It has been proved that the ageing process has positive effects on labour productivity when the older workers work in industries with a large share of ICT in the capital stock. It thus appears that ageing has positive effects on labour productivity when older workers are low educated in Japanese industries, and this finding is consistent across all industries in Japan on average[191]. Thus, an increase in low-educated older

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[188] Kawaguchi, D., Muroga, K., "Population aging, productivity, and technology in Japan", *Working Paper, 2019.*

[189] Jong-Wha L., Do Won K., Eunbi S. "Ageing Labour, ICT Capital, and Productivity in Japan and Korea", *Journal of The Japanese and International Economies, 58, 2020.*

[190] Ibidem

[191] Ibidem

workers in Japan can enhance labour productivity and represent a useful asset which should be taken into consideration for future investment in Japanese economy. The research also shows how the complementing effect of ICT capital and elderly employees is evident in Japan for both high- and low-educated workers. Consideration of the relationship between educational attainment, industry factors, and production processes is critical in explaining disparities in older worker productivity. As explained before, in Japan ageing has positive effects on labour productivity when the low-educated older workers are in either the manufacturing or service sector, or when the high-educated older workers are employed in service industries. The complementary effect of ICT capital with low-educated older workers is observed in both the manufacturing and service sectors in Japan. The finding experienced thus far, have shown how rapid demographic shift toward aged societies is not necessarily an economic threat. Productivity decline due to ageing can be mitigated by increasing investments in ICT. Investing in ICT capital and technologies can help improve productivity and extend the working age of ageing populations. Concurrently, the complimentary relationship between ICT capital share and older workers, particularly low-educated ones, may suggest that during the sample period, enterprises in both nations may substitute ICT capital for young individuals, contributing to a reduction in job prospects for young workers.

Chapter 3: Applications, technology, and history of the "マイナンバー".

During last administration, the former Prime Minister of Japan 菅義偉 Yoshihide Suga, made it one of its priorities to push for the digitalization of not only the government, but also for the digital transformation of the private sector, in an effort to transform and address the problem faced by the Japanese economy and society[192]. To this end, during the September of 2021 with the "デジタル社会形成基本法 [193] or Basic Law for the Formation of a Digital Society" [194], the government finalized the creation of the "デジタル庁, or Digital Agency". With the creation of the "Digital Agency" the government intends to bring in private expertise and create a structure for digitalization, this intention is further explicated by the words of former Prime Minister 菅義偉Yoshihide Suga when discussing the theme of digital revolution during a plenary session of the House of Representative, as reported in an article of the 朝日新聞社[195]of the 18th of January 2021:

> "The creation of the Digital Agency is a symbol of the revolution, which will lead the digitalisation of the whole country by eliminating the vertical divisions of the organisation and acting as a command post with strong powers […]. The Government will start the process of conversion, and over the next five years will integrate and standardise the systems of local governments to improve the efficiency of operations and provide better services to the public."[196]

In a recent interview, 村井純 Murai Jun, distinguished Professor at the Keio University, Special Adviser to the Cabinet on digitalization policy, renown as

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[192] Information available on the website of "the Japan times": https://www.japantimes.co.jp/news/2020/09/30/national/japan-number-card-digital-transformation/ (last accessed: 16/02/2022)

[193] Transliteration: Dejitaru shakai keisei kihon-hō

[194] Overview of the policy available on: https://cio.go.jp/sites/default/files/uploads/documents/digital/20210901_laws_r3_35_outline.pdf. In Japanese, (last accessed: 16/02/2022)

[195] Asahi Shinbunsha

[196] 菅義偉 Yoshihide Suga, 朝日新聞社 *Asahi Shinbunsha*, 2021 年 01月19日: http://database.asahi.com/library2e/topic/t-detail.php, in Japanese (last accessed: 14/02/2022)

the “father of the internet” in Japan, and whom has recently been appointed as a Chair of the newly established “Digital Agency”[197], stated that through the employing of these experts the Digital Agency’s intent is to make experts work together with human resources from regional governments and other government agencies, set realistic goals, and guide their implementation:

“The intent is to train those human resources which will then return to their regional governments and organizations, in order to make the skills they have created design extend and reproduce, thus creating a “revolving door” through which private companies, government administrators, and the staff of regional governments can pass to and from. Unless we do that, the digitalization of society won’t happen in time”[198].

村井純 Murai Jun has also emphasized the importance of two characteristic of Japan: the first being that Japan is divided into a plethora of municipalities of cities, towns, villages and special wards, and the second the fact that all of these government bodies’ leader are chosen in election[199]. Under those leaders, some municipalities made progress in using IT and some did not, resulting in a diversity of systems from municipality to municipality. The new agency is set to play a role as a control tower for digitalizing the government’s administrative work and unifying the IT procurement of ministries and agencies which, as seen in previous chapter, has proven to be a major hindrance to the introduction of e-government policies, and an obstacle to the cooperation between multiple governmental bodies in Japan. Another major task of the “Digital Agency” is that of drastically expanding the usage of the government issued “マイナンバー or My Number” identification card, so that citizen can gain the access to various government services online, with the aim of reducing unnecessary process in government to citizen interaction and the intention to have almost all residents in Japan own one by the end of

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[197] 内閣官房 Cabinet Secretariat: https://www.kantei.go.jp/jp/content/20201013_houdou.pdf, in Japanese (last accessed: 17/02/2022)

[198]村井純 Murai Jun, *JapanPolicyForum,* information available at: https://www.japanpolicyforum.jp/society/pt2021122820174711790.html (last accessed: 16/02/2022)

[199] Information available at: https://cn.japanpolicyforum.jp/society/pt202201082101038781.html (last accessed: 15/02/2022)

March 2023[200]. The "マイナンバー or My Number" is a unique 12-digit number issued to all resident in Japan, including foreign, who create a resident certificate for the first time. The "マイナンバーカードor My Number Card" is the Card which comes associated with such request to make use of various administrative services accessible online, and that can be used as an identification device as well as allowing administrative organizations to accurately identify each individual and prevent fraud in relation to taxed and social insurance payments, and the government intends to use it to unlock country's digital transformation[201]. The card can also be used as an online identify authentication for the one-stop administrative service "マイナポータル or Mynaportal" and grants the access to the so-called "マイナポイントor Myna Points". The intention to make the "My Number" a core element to promote digitalization throughout Japan, is disclosed in the aforementioned plenary session of House of the Representative by former Prime Minister 菅義偉 Yoshihide Suga:

"In order to promote the use of "My Number card", the "Myna Point" system will be extended by six months. This March, we will begin to combine the card with health insurance cards, and four years later we will begin to combine the card with driving licences. We will develop a systematic, so-called base registry of the registration data of legal persons and other entities held by the government, to promote the use of data as essential for the formation of a digital society[202]".

3.1 "My Number", "My Number Card", "Mynaportal and Myna Points"

3.1.1 Brief overview of theマイナンバーor My Number

The "マイナンバー or My Number", as stated before, is a unique 12-digit number issued to all resident in Japan, including foreign, who create a

[200] 菅義偉 Yoshihide Suga, 朝日新聞社 Asahi Shinbunsha, 2021 年 01月19日: http://database.asahi.com/library2e/topic/t-detail.php in Japanese

[201] Information available at: https://www.japantimes.co.jp/news/2020/09/30/national/japan-number-card-digital-transformation/(last accessed: 8/02/2022)

[202] Ibidem

resident certificate for the first time. Its use is mainly focused on verifying that information on an individual on multiple organisation is that of the same person, and is mainly focused on three areas of application: social security, tax and disaster management.[203] Until now, the exchange of this information between national government agencies and local authorities has always been a complicating factor since every agency managed the said information under its own number, such as resident registration code, basic pension number or health insurance insured person number. This resulted in rendering the scrutiny of eligibility for welfare services, social insurance premium reduction and the exchange of information across governmental agencies more time and effort demanding than necessary. Thus, the implementation of a common cross-sectoral number, such as the "My Number", for the three domains of social security, taxation, and disaster management will allow persons to be identified accurately and swiftly. Let us now examine how administrative procedures have been affected since the introduction of the "My Number". The number of administrative procedures that have been rendered more convenient since the introduction of the card was esteemed to be 1,221, as of October 2018 [204] . Previously, administrative procedures required the government to review a large number of documents, which had the effect of lengthening the timing of some practices. Now, through the introduction of the "My Number" system the administrative procedure has gotten smoother since the government no longer needs to review an excessive number of documents, and consequently the time required for completing the process has been shortened[205]. As of the 13th of November 2017, it was reported that the "My Number" system started sharing data between government bodies, thus fulfilling one of the core intentions behind the government implementation of this initiative[206].

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[203]内閣府, Cabinet Office: https://www.cao.go.jp/bangouseido/case/individual/caution.html, in Japanese (last accessed: 15/02/2022)
[204] Ibidem
[205] Ibidem
[206] Information available on the website of "the Japan times": https://www.japantimes.co.jp/news/2017/11/13/national/number-system-begins-sharing-data-government-bodies/ (last accessed: 14/02/2022)

The company number is a 13-digit number that is assigned to corporations including joint stock companies and is used by the government in a way analogous to that of the “My Number”, one of the main differences being that the corporate number is published on the National Tax Agency's corporate number publication site. The number allows the public to access the following basic information: first, the trade name or name of the company, second the location of the head office or primary office address, and lastly the corporate number. These three elements can be the source of multiple advantages in the information exchange sector at an industrial level: if the trade name or location changes, as an example, the information will be updated, and history of changes will also be displayed. It is also easier to check the name and location of the company using the company number as a key; the company number allows to obtain the most up-to-date name and address information, making it more efficient to register and update businesses partners' information; if different codes are used in different departments, adding the corporate number to the business partner information will improve the efficiency to register and update businesses partners' information. Furthermore, to provide a better understanding of the status of the use of the corporate number and the website for the publication of the corporate number, the National Tax Agency's website for the publication of the corporate number provides information on the number of cases in which the corporate number has been published, and the status of the use of various functions on the website for the publication of the corporate number[207].

3.1.2 Brief overview of the マイナンバーカードor My Number Card

The “My Number Card” is a plastic card that is issued to Japanese and foreign residents upon application. The front side of the card shows your photo, name, address, date of birth, gender, municipality of emission and it also can be used as an identification document.

[207] 内閣府, Cabinet Office: https://www.cao.go.jp/bangouseido/case/individual/caution.html in Japanese (Last accessed 18/02/2022)

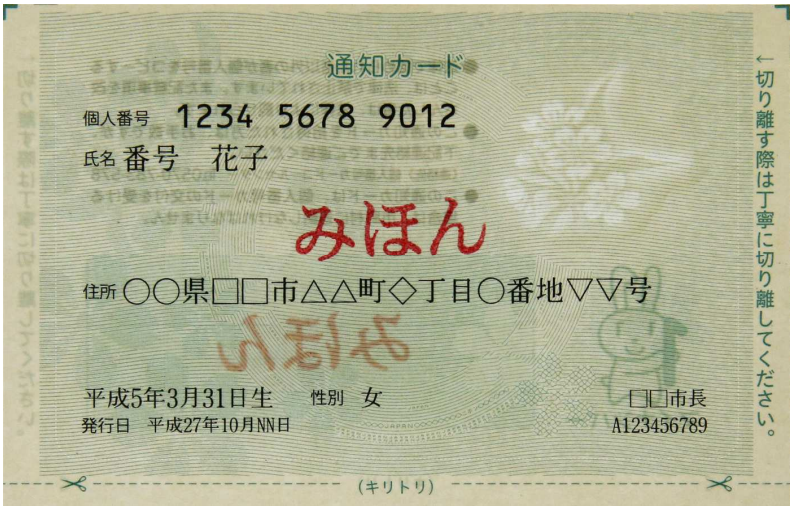

Figure 28 Sample of a "My Number Card"

The back side of the card contains the “My Number”, which can be used as an authentication method various government service. According to data published by the Ministry of Internal Affairs and Communications on the “My Number Card”, the penetration rate has reached 30 percent as of the 1st of May 2021[208]. The notification card is often confused with the “My Number Card”, this is the document that gets delivered to the citizen once it starts the application process, and it also contains your number, but it is only a notice and cannot be used as an official identity card. The notification card must be returned upon receiving the “My Number Card”. There are four different method to apply for a “My Number Card”: you can send in an application form or by post, or you can use a computer, smartphone or certain photo identification machine. The following process map illustrates the differences in the process, from the government standpoint and the citizen one, between the four different methods, as far as time demand and approach method chosen for the application process.

[208] Information available on the website of “the Japan times”: https://www.japantimes.co.jp/news/2021/10/20/national/my-number-insurance/(Last accessed 14/02/2022)

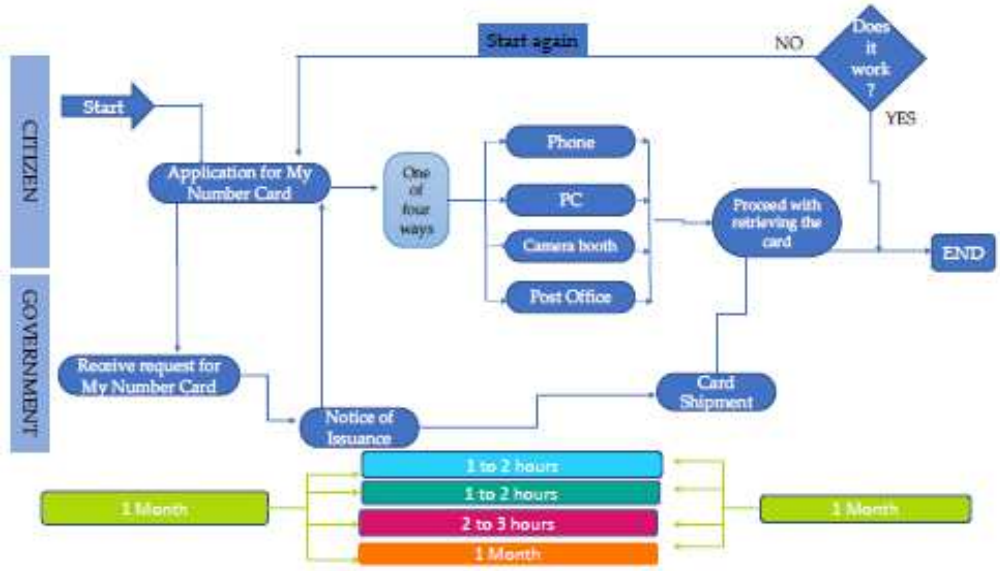

Figure 109 Process Map of the application process for the "My Number Card" made by the candidate during the project "Mentoring for International Experience", with the aid of professional figure Vittoria Muollo of SYSCOM JP

The "My Number Card's" IC chip is equipped with functions such as an electronic certificate and it can be used for a variety of services, including those provided by private companies and to make electronic applications to government agencies, such as tax returns. As documented earlier the "My Number Card" can also be used as a health insurance card[209]. In addition to this, by using the electronic certificate on the IC chip, it is possible to use online administrative procedures such as e-Tax and private services that make use of public personal identification services using electronic certificates. Or access to the "Mynaportal", a government service where "My Number" card holders can check their prescription records and the results of their health check-ups[210]. Medical institutions and pharmacies that are accepting My Number cards as health insurance cards currently account for only about 8% of a total of some 230,000 such facilities across Japan[211].

[209]内閣府, Cabinet Office, Illustrative pamphlet on how to make the "My Number Card" into a health insurance card, https://www.cao.go.jp/bangouseido/pdf/leaf20210430_hokensho_moshikomi.pdf, *in Japanese* (last accessed: 17/02/2022)
[210]Information available on the website of "the Japan times": https://www.japantimes.co.jp/news/2021/10/20/national/my-number-insurance/((last accessed: 17/02/2022)
[211] Ibidem

3.1.3 Brief overview of theマイナポータル or Myna Portal

The “Myna Portal” is an online service operated by the government. It is the citizen’s own personal website, and it allows it to search for administrative procedures and apply online for one-stop services, including childcare and nursing care, as well as receiving notifications directly from government agencies. The following image, provided by the official website of the Cabinet Office, provides a through overview of the services enabled by the “Myna Portal”:

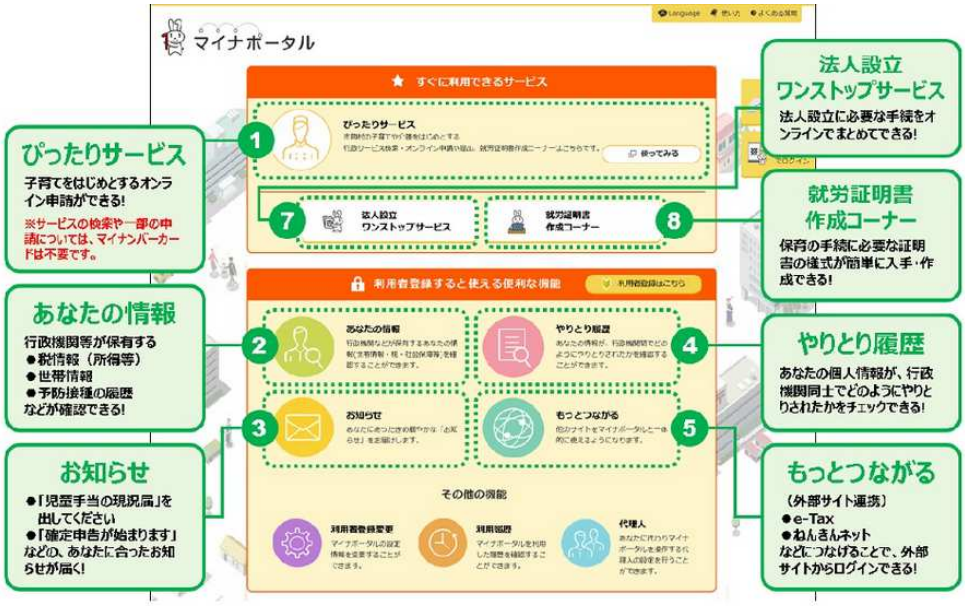

Figure 110 Myna Portal official personal homepage explanation, information provided by the Cabinet Office of Japan official website, available at: https://www.cao.go.jp/bangouseido/myna/index.html

1. Service search and online application function: it enables the research for and appliance method online for services in your municipality, including childcare and nursing care services.
2. Self-information display: it allows the access to information about yourself held by government agencies.
3. Notifications: where notifications sent from government agencies are displayed.

4. Display of records of information provision: allows control to the history of how your personal information has been exchanged between government agencies.
5. More connections: by registering to an external site, it allows the access and possibility to link the "Myna Portal" to external site such as e-Tax
6. Cooperation with private delivery services: notices from private companies by using private delivery services by associating the "Myna Portal" with "e-Post Office Box" and "My Post", which are private delivery services; also the procedures for year-end adjustment and tax return can be simplified.
7. One-Stop Service for Incorporation: a service that allows the citizen to carry out all of its procedures online, after applying with an electronic signature through the use of the "My Number Card". As of the 26th of February 2021, all administrative procedures including the certification of the articles of association and the registration of the establishment of a company, can be carried out in a one-stop service[212].
8. Working Certificate Corner: "Myna Portal" provides easy access to the "Certificate of Employment" which is required when applying to use a licensed nursery.

In order to open an account and access to the "Myna Portal" a "My Number Card" with an IC chip containing a digital certificate for user certification is required. There is also the need of a PC and an IC card reader that can read your "My Number Card". Since this practice proved to be a major hindrance to applicant, it was later enabled the function to scan the IC chip with a smartphone that can read your "My Number Card", it has to be NFC

[212] 内閣府, Cabinet Office: https://www.cao.go.jp/bangouseido/case/individual/caution.html, in Japanese (last accessed: 17/02/2022)

compatible[213].

3.1.4 Brief overview of theマイナポイントor Myna Points

To encourage people to acquire My Number cards, the government launched the “Myna Point” incentive program in September, rewarding card users with shopping points if they link their cards with a cashless payment service. These “Myna Points” have been at the centre of many governments’ policy to promote the use of the “My Number Card” and cashless payment throughout Japan. A first example to this is the allocation of 15,000-yen worth of points to citizen who would register their “My Number Card” as a health insurance card and to those who register a savings account through the government's 'Myna Portal' website[214]. The intent of the government to expand the usage of cashless payment method is further illustrated in the choosing of the Cashless Promotion Council, a general incorporated association, as the scheme’s secretariat of the second round of the “Myna Points”. This second policy was announced at the beginning of 2022 and will allow citizen that acquire a “My Number Card” to gain a value of “Myna Points” worth up to 20,000 yen[215].

3.2 Outline of the process of how the “Number Law” was passed

Having now acquired a comprehensive knowledge of the “My Number” policy and its ramification, it is important to understand the historical background behind its evolution, from its predecessor, the first draft proposal to the enacting of the “Number Law” in 2013. On the 24th of May 2013, the 183rd session of the National Diet of Japan passed the "行政手続における特定の個人を識別するための番号の利用等に関する法律、番号法[216] or Act on the Use of Numbers to Identify Specific Individuals in Administrative Procedures,

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[213] Ibidem

[214] “マイナポイント１． ５万円、６月ごろから付与 保険証・口座登録で, Myna points 1.50,000 yen, to be awarded from around June, with registration of insurance card and airtime”, 朝日新聞社, *no.00019, p.003, 2022 年01月21日.*

[215] “マイナポイント、９月申請分まで, Myna Point, September Application Only", Asahi Shimbun”, 朝日新聞社, *no.00017, p.006, 2022 年01月22日.*

[216] Transliteration: Gyōsei tetsudzuki ni okeru tokutei no kojin o shikibetsu suru tame no bangō no riyō-tō ni kansuru hōritsu, bangō-hō

Number Law". The Act introduces a numbering system in which a unique number, or personal number, is assigned to each resident of Japan and it also provides for the introduction of a corporate number. When the numbering system starts and the citizen request such number, its municipality will initiate the practice and after a month of the start of the procedure it will proceed to send the notification card containing your personal number.

The numbering system has been originally considered as a taxpayer numbering system. We can distinguish two aspects, during the early 2000s which led to the establishment of the My Number Card as intended nowadays: the first one being the political action undertook by the 自民党, *Jimintō* or Liberal Democratic Party (LDP) and the公明党, *Kōmeitō* or New Komeito Party. These two parties made a proposition, in the "平成21年度（2009年度）税制改正大綱 [217] or 2009 Tax Reform Proposal" to establish a study group on taxpayer identification numbers, which will be set up within the ruling party to vigorously discuss the introduction of the system [218]. The complementary aspect took place around the same time, in December 2008, when the 民主党, *Minshutō* or Democratic Party of Japan (DPJ) announced in its "民主党税制抜本改革アクションプログラム [219] or Action Program for Fundamental Reform of the Democratic Party of Japan's Tax System" that it would proceed to:

> "Establish a system for correctly identifying income in order to make social security more accessible to those who truly deserve it. In order to make social security more available to those who truly deserve it, it is essential to establish an environment for a proper income monitoring system, and for this purpose, we believe that the introduction of a number system is necessary. Based on this thinking, we will promote the rapid introduction of a number system that

[217] Transliteration: Heisei 21-nendo (2009-nendo) zeisei kaisei taikō

[218] 内閣府 Cabinet Office, "資料（納税者番号制度）Shiryō (nōzeishabangō seido)"or Documents (taxpayer number system), https://www.cao.go.jp/zei-cho/history/1996-2009/gijiroku/sg/2009/pdf/sg1kai1-1.pdf, in Japanese. ((last accessed: 17/02/2022)

[219] Transliteration: Minshutō zeisei bappon kaikaku akushon puroguramu

can be used for both social security benefits and tax payments[220]".

The second factor which lead to the establishment of the "Number Law" is the ""次世代電子行政サービス（eワンストップサービス）の実現に向けたグランドデザイン[221] or Grand Design for the Realization of the Next Generation e-Administrative Services (e-One-Stop-Services)[222]" compiled by the Project Team for the Examination of the Next Generation e-Administrative Service Infrastructure during the course of May 2010. This policy owes a lot of its core characteristics to two strategies established by the IT Strategic Headquarters: the first one being the "IT新改革戦略政策パッケージ[223] or IT New Reform Strategy Policy Package" established by the on April 5, 2007, and the second one being the "重点計画—2007[224] or Priority Plan 2007" which was entrenched July 26, 2007. The Grand Design policy states that a national ID system will be introduced by 2013 as a common platform for e-government, which will ensure the protection of personal information and will enable data linkage between ministries, agencies and local governments, while at the same time ensuring consistency with the consideration of a common number for social security and tax purposes. In this document it is also stated the intention, on behalf of the Government, to promote the appropriate use of information by administrative organs so that, information already held by administrative organs will not need to be entered or attached when applying for various administrative procedures[225].

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[220]民主党, **Minshutō,** "民主党税制抜本改革アクションプログラム("Minshutō zeisei bappon kaikaku akushon puroguramu" "Democratic Party Tax Reform Action Program" http://archive.dpj.or.jp/news/?num=14851 In Japanese (last accessed: 17/02/2022)

[221] Transliteration: Jisedai denshi gyōsei sābisu (e wansutoppusābisu) no jitsugen ni muketa gurando dezain

[222] 首相官邸, Shusōkantei, Prime minister office "ＩＴ新改革戦略　政策パッケージ (IT shin kaikaku senryaku seisaku pakkēji) or IT new reform strategy policy package" , https://www.kantei.go.jp/jp/singi/it2/kettei/070405honbun.html, in Japanese (last accessed: 17/02/2022)

[223] Transliteration: IT shin kaikaku senryaku seisaku pakkēji

[224] Transliteration: Jūten keikaku

[225] 首相官邸, Shusōkantei, Prime minister office, 高度情報通信ネットワーク社会推進戦略本部. "新たな情報通信技術戦略 (Kōdojōhōtsūshin nettowāku shakai suishin senryaku honbu. "Aratana jōhō tsūshin gijutsu senryaku) or Advanced Information and Communication Network Society

The number system, which has been mainly considered as a taxpayer identification number system, was discussed in the "社会保障・税に関わる番号制度に関する検討会[226] or Study Group on the Number System for Social Security and Tax" held by the National Strategy Office of the Cabinet Secretariat from February to May 2010 and incorporated the back-office coordination and national ID system, which has been considered as an IT strategy as described in the previous paragraph. It is a commonly held knowledge in the literature that the basic direction leading to the current Number Law was formed by incorporating the ones established in the national ID system. After that, the government and the ruling party's social security reform task force decided on 31 January 2011 to adopt the "社会保障・税に関わる番号制度についての基本方針 [227] or Basic Policy on the Number System for Social Security and Tax". We must now highlight three core publication which will culminate in the enacting of the “My Number Bill”: the first publication happened during the April 2011 and it was named " 社会保障・税番号要綱 [228] or Outline of the Social Security and Tax Number System"; the second one, which was enacted during the June 2011, was called 社会保障・税番号大綱 [229] or Social Security / Tax Number Charter”; lastly, during the December of 2011, we can find the "社会保障・税番号制度の法律事項に関する概要[230] or Outline of the Legal Matters Concerning the Social Security and Tax Number System". All three of these steps culminated, as stated beforehand, in the " 行政手続における特定の個人を識別するための番号の利用等に関する法律案、マイナンバー法案[231], or Act on the Use of Numbers to Identify Specific Individuals in Administrative Procedures, My Number Bill"

Promotion Strategy Headquarters. New Information and Communication Technology Strategy”, https://www.kantei.go.jp/jp/singi/it2/100511honbun.pdf, in Japanese. (last accessed: 16/02/2022)

[226]Transliteration: Shakai hoshō zei ni kakawaru bangō seido ni kansuru kentōkai

[227]Transliteration: Shakai hoshō zei ni kakawaru bangō seido ni tsuite no kihon hōshin

[228]Transliteration: Shakai hoshō zei bangō yōkō

[229]Transliteration: Shakai hoshō zei bangō taikō

[230]Transliteration: Shakai hoshō zei bangō seido no hōritsu jikō ni kansuru gaiyō

[231]Transliteration: Gyōsei tetsudzuki ni okeru tokutei no kojin o shikibetsu suru tame no bangō no riyō-tō ni kansuru hōritsu-an, mainanbā hōan

which was initially submitted to the 180th session of the Diet. Although the bill was abolished it was the cause of continuous deliberation which led to it being resubmitted to the 183rd reunion Diet and finally, enacted on 24 May 2013.

3.2.1 Changes from the first draft of the Bill and amendments made in this National Assembly

The main differences between the bill of the 180th session of the Diet and the law enacted in the 183rd meeting of the Diet, except for the principle and effort provisions, can be summarized in the two following aspect: first, the introduction of the My Number Card, and secondly the use of the storage area of the personal number card by the state organizations and private enterprises. The following is an analysis of the evolution of the “My Number” policy, since its first proposal in the 180th session of the Diet to its enaction with the 183rd meeting of the Diet.

In the original draft of the law proposition, municipalities were supposed to simply notify people of their personal numbers, but in the “My Number Bill” it was established that every applicant citizen would receive a number notification card. However, since the card does not contain a photograph, another document such as a driving license is required for identification. Disregarding the option when the number notification card is replaced by a “My Number Card” at the request of the individual, in that case the citizen can be identified even by the “My Number Card”, since it contains a photograph.

As for the storage aspect, the first draft of the bill permitted only to municipalities the independent use of the initially proposed card. In contrast, the current “My Number Card” allows not only its data fruition to prefectures and national institutions, but also permits private companies the use of the data contained in the card. The main change from the previous bill can be said to be the supplementary provisions concerning the future. Changes were made such as the provision of the information disclosure system, the” マイ・ポータル or My Portal”, so that within one year of the enforcement of the law it was explicitly stated that the private sector would be able to use the My Portal. In the deliberation at the 183rd Diet session, a provision was added to the Supplementary Provisions stating that "when the Government considers

the introduction of a tax credit with benefits measure[232], it shall consider the establishment of a system necessary for the implementation of such a measure by making use of the system concerning the use of personal identification numbers in relation to information on personal income taxation that is not held by national tax offices, in order to ensure that the affairs concerning such a measure are properly implemented"[233]. This is due to the fact that "the national tax authorities have not conducted benefit administration for those who are not obliged to pay tax until now, and if benefit administration is to be incorporated into the tax system, how to coordinate and share various data with local governments will be an issue"[234]. Thus, in order to promote the reform of the social security system and the tax system in an integrated manner, it is necessary to promote the coordination of information between local governments and national institutions, which as analysed in other chapter as always been a core hindrance in the Japanese government. Furthermore, in order to ensure that benefits are not extended to individuals who hold a large number of financial assets, it was necessary to implement a legal record based on the "My Number" in ways to collect financial income. It can be said that the "My Number" policy was introduced by the government with the strong belief that the taxation infrastructure that could be achieved through the use of the "My Number" was indispensable. The addition of the two supplementary provisions discussed so far makes this principle even clearer.

Regarding the need to expand and improve the efficiency of information sharing among the national and local government agencies, the mayor of Mitaka stated, during a discussion in the Diet:

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[232] Which means a mechanism for appropriately combining benefits and tax credits, or other similar measures

[233] 附則第 6 条第 7 項, *Fusoku dai 6-jō dai 7-kō*, Supplementary Provisions, Article 6, Paragraph 7.

[234]栗原克文 "About the issue of execution of tax credit system with benefits" National Tax College, *no. 18, p.112, 2002, in Japanese.* (last accessed: 15/02/2022)
栗原克文, "給付付き税額控除制度の執行上の課題について". 税大ジャーナル. *no. 18, p.112, 2002, in Japanese*
https://www.nta.go.jp/about/organization/ntc/kenkyu/backnumber/journal/18/pdf/04.pdf (last accessed: 15/02/2022)

"At the moment, it is the time of levying the citizen's tax, so the data of the final tax return is received electronically, but it is difficult to match it with the data of the citizens that we have, so we have to hire temporary staff and compare their names, addresses and ages"[235]

Although it is possible to link information without a personal number (we will later discuss the state of the technologies behind this process and the concerns related to it in modern Japan), a large amount of personnel costs is incurred in this process. If this cost can be reduced by the introduction of the "My Number" system, it will be easier to introduce a new system such as a tax credit with benefits. In order to facilitate the coordination of information between such administrative bodies, the "My Number Law" introduced the following three mechanisms:

1. The introduction of a personal number that uniquely identifies the individual; Article 7[236]
2. An information provision network system is established to link information between administrative bodies; Article 21[237]
3. Administrative organs may request the provision of information from other administrative organs through the information provision network system, and the administrative organs that receive such requests are obliged to provide the information; Article 22, paragraph 1[238]

It is through these three mechanisms that the government tries to overcome the lack of cooperation, which has characterized Japan in its early ICT uses.

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[235]衆議院, House of Representatives "第 6 号平成 25 年 4 月 5 日（金）", No. 6 April 5, 2013, in Japanese.
https://www.shugiin.go.jp/internet/itdb_kaigirokua.nsf/html/kaigirokua/000218320130405006.htm. (last accessed: 15/02/2022)
[236] Information available at: https://elaws.e-gov.go.jp/document?lawid=425AC0000000027(last accessed: 17/02/2022)
[237] Ibidem
[238] Ibidem

Through the use of the “My Number Law” if an administrative organ has received a request for the provision of information through the Information Provision Network System, the administrative organ may and shall provide the information without obtaining the consent of the individual, thus accelerating the process of knowledge sharing in governmental bodies. According to a document[239] published on the government's Social Security and Numbering System website on 9 April 2013, and as illustrated in the table below, an administrative body (information enquiry body A) that obtains information from another administrative body first sends the code A corresponding to the personal number to the information provision network system (1). The information coordination infrastructure converts it into code B for information provider B (②) and sends it to information provider B (③). Information provider B identifies the target person from the code B and sends the information-to-information reference agency A (5).

[239]内閣官房, Cabinet secretariat, “番号制度における個人情報の管理の方法について, How to manage personal information in the number system”, https://www.cas.go.jp/jp/seisaku/jouhouwg/dai6/siryou1.pdf , *in Japanese* (last accessed: 17/02/2022)

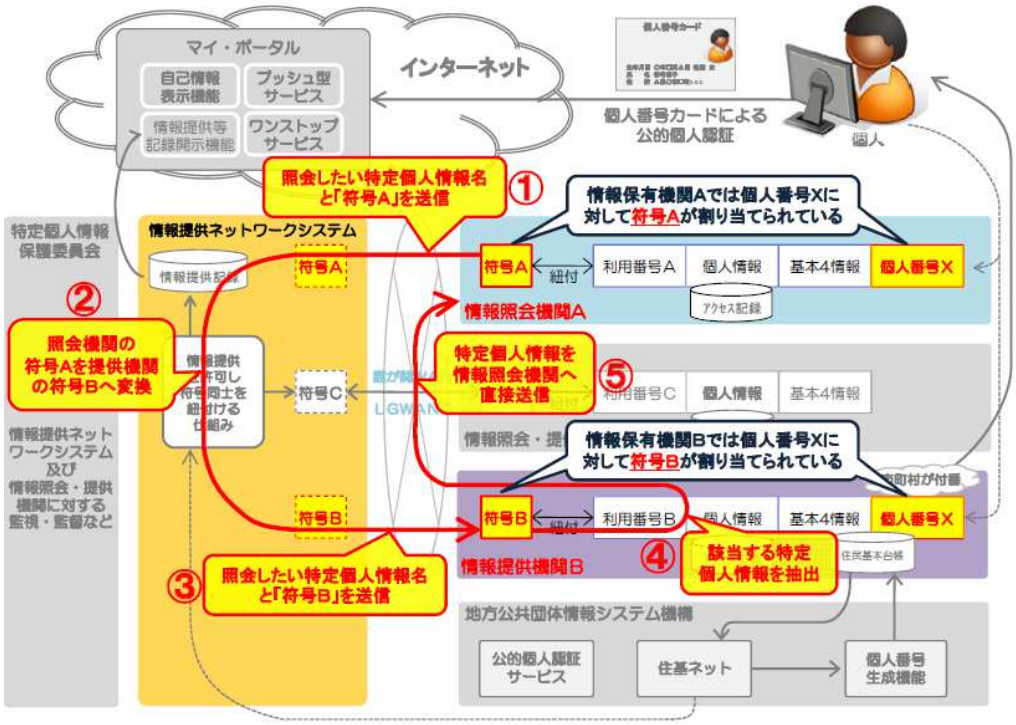

Figure 31 Illustration of the process of management method of personal information in the "My Number" system, information provided by the Cabinet Office of Japan official website, available at: https://www.cas.go.jp/jp/seisaku/jouhouwg/dai6/siryou1.pdf

If the frequency of information enquiries is extremely low, it is possible to carry out enquiry-response processing by this alone, but if multiple enquiries are carried out simultaneously, the information-providing organisation A which has acquired the information will not know whose information it is. For this reason, the information provision network issues an identification information, or token, to identify the enquiry and response process concerned and then proceeds to convey it to both the information provider A and the information provider B. Information provider then B sends the information including the token to information provider A, so that information provider A knows that the received information corresponds to code A.

3.2.2 Reasons which led to "My Number" not being directly used for information linkage

According to the "Interim Summary"[240] of the Working Group on Infrastructural Technology for Information Linkage[241], there are two main reasons which led to the "My Number" initially not being used for direct information linkage between administrative agencies.

The first reason is that, on June 23rd of 2011, the Supreme Court's constitutional decision on the Basic Resident Registration Network System, or Juki-net[242], pointed out that as a precondition for the constitutionality of the Juki-net, "there is no organization or entity capable of centrally managing personal information handled in administrative affairs"[243]. Therefore, in order to ensure that the Information Provision Network System is also constitutional, it is necessary for some fundamental aspects to be respected:

- The personal information will be managed decentralized through the databases of the information holding institutions.
- The information coordination infrastructure does not directly use the "My Number" which is already used in the same manner in "civilian-private sector-governmental" connection but rather uses the "My Number" to identify the individual concerned.
- The fact that measures will be taken to ensure that the personal code cannot be guessed from the "My Number Card".

The second reason can be found by taking into account the point of view of future expandability issues: since it is necessary to consider cooperation between information holding institutions that hold identification number and

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[240]内閣官房, Cabinet secretariat , "情報連携基盤技術ワーキンググループ. "中間とりまとめ, Working Group on Infrastructural Technologies for Information Cooperation. "Interim Summary", https://www.cas.go.jp/jp/seisaku/jouhouwg/renkei/cyukan/cyukan.pdf, in Japanese

[241] Official website: https://www.cas.go.jp/jp/seisaku/jouhouwg/index.html

[242] Japan University NETwork (JUNET) was a computer network created by Murai Jun, which connected three universities: Tokyo University, Tokyo Institute of Technology and Keio University, and played an important role in the development of the Internet in Japan.

information holding institutions that hold other numbers in exceptional cases, when information is to be coordinated, “My Number” cannot be used as a common identifier to identify individuals. It is possible that the use of “My Number” will be permitted for private commercial use in the future, and in order to enable information linkage with administrative agencies via the information provision network, it is considered efficient to establish a linkage method that does not directly use “My Number” from now on[244].

Despite these main hindrances, what are the reasons that have led to the introduction of the “My Number”? First, the card is it to be used for data matching within the same administrative organ, aiming to cross-check the data of multiple systems. The “Number Law” states, in its Article 9, that the “My Number” shall only be used "in order to efficiently search and manage personal information”[245]. A second factor that can be recognized, is that the “My Number” was esteemed to be necessary to accurately link each person's data with a unique code. The value of the code is determined by the information provision network system and each administrative body needs to obtain the code of each person from the information provision network system. In so doing, it is envisaged that the “My Number” will be used to identify the subject, this is because there is a possibility of mistakes in the identification of the subject using only name and address. In addition, a large amount of labour costs would be required to ensure that no mistakes are made and as a way of reducing cost, a personal number which can be filled in by the citizens themselves was considered to be very useful in the case of information linkage between institutions through the use of codes.

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[243] 内閣官房 Cabinet secretariat、 “個人情報保護ワーキンググループ報告書, Report of the Personal Data Protection Working Group”, https://www.cas.go.jp/jp/seisaku/jouhouwg/houkokusho.pdf, in Japanese

[244] Ibidem

[245] Information available at: https://elaws.e-gov.go.jp/document?lawid=425AC0000000027 (last accessed: 15/02/2022)

3.3 Reasons behind low usage of "My Number Card" and information protection technologies

Since "My Number Card" began to be issued in January 2016 in Japan its penetration rate has only reached 30 percent[246]. One reason behind this low uptake is that the usage of the card is limited, which is why the government is planning to expand this significantly in the future and has undertaken some of the strategies we have analysed thus far. Another reason is people's deep-rooted worries over invasions of privacy and the leaking of personal information if a "My Number Card" is lost because it is a commonly diffused wrong belief that the card holds highly private information related to taxes or social security. This has raised concerns among the public over what the government could do if it unilaterally controls and collects citizens' personal information in one place. The volume of data in society is expected to rise in the next years, thanks to the emergence of new businesses focusing on big data analysis and the continued evolution of the Internet of Things (IoT). The utilization of data in business will become increasingly vital in this context. The use of personal information such as location information, behaviour history, and purchase history in industries such as healthcare, finance, and retail sales are highly expected, as it has been discussed in the previous chapter. Conversely, personal information can include sensitive information that, if handled improperly, can seriously harm a company's reputation and commercial operations. In July 2013, "東日本旅客鉄道[247] or East Japan Railway (JR East)" attempted to sell de-identified passenger-riding history from its Suica, a prepaid e-money card train pass system. Many individuals voiced their concerns with JR East's actions, making comments including, concern about company selling their data for their own advantage[248]. As a

[246] Information available on the website of "the Japan times": https://www.japantimes.co.jp/news/2021/10/20/national/my-number-insurance/ (last accessed: 17/02/2022)

[247] Translitteration: Higashinihon ryokaku tetsudō

[248] Information available at: https://yab.yomiuri.co.jp/adv/chuo/dy/opinion/20140303.html

result of the outcry, JR East was obliged to discontinue this service[249]. When the “My Number” system was being considered for deployment, some people were concerned that their personal information might be leaked to third parties, or that they would be spoofed using other people's My Numbers. To ensure that the “My Number“system can be used safely, strict security measures have been implemented to protect personal information on both on a systemic and on an institutional basis.

- In terms of the systemic safeguards of the "My Number," rather than centralizing the management of personal information, it will be managed in the same way as hitherto, with pension information held by pension offices and local tax information held by municipalities. When exchanging information between administrative bodies, the "My Number" will be substituted with a specific code rather than the "My Number." The technology is only accessible to a small number of people, and all communications are encrypted. A brief overview of the process is summarized in the picture below[250].

[249] Koichi, I., Jun, K., Takeshi, S., Hiroshi, T., “パーソナルデータのプライバシー保護を実現匿名化 ・暗号化 技術, Anonymisation and encryption technology to protect the privacy of personal data”, *Fujitsu, no.67, p.26-33, 2016, in Japanese.*

[250] 内閣府, Cabinet Office: https://www.cao.go.jp/bangouseido/case/individual/caution.html, in Japanese

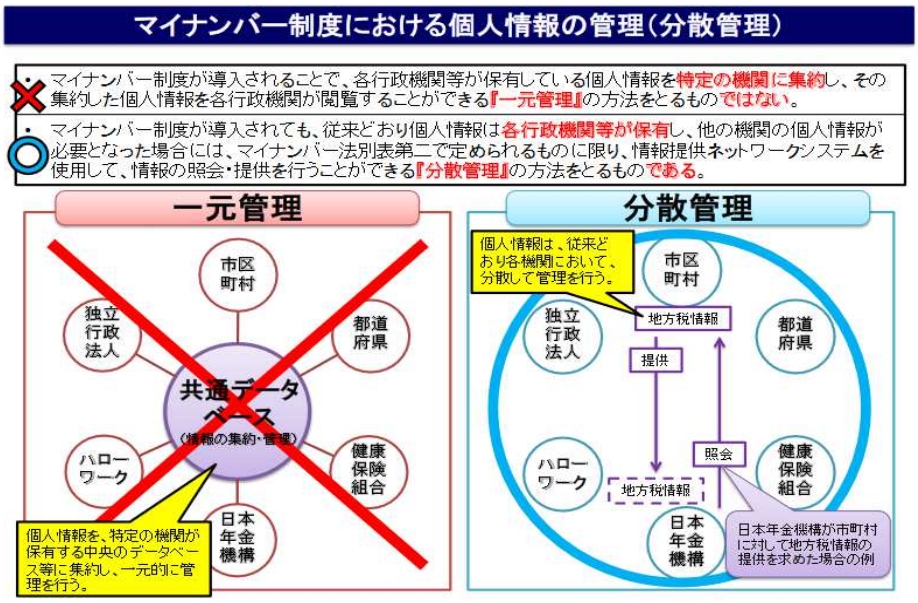

Figure 32 Illustration on distributed management of personal information in the My Number system, information provided by the Cabinet Office of Japan official website, available at: https://www.cao.go.jp/bangouseido/seido/index.html

- As for the Institutional safeguards, except when required by law, the government is prohibited from collecting or storing any personal information, including the citizen "My Number". The "個人情報保護委員会[251] or Personal Data Protection Commission is a third-party entity which has been given the task of proper maintenance and regulation of personal data and has led to amend the "個人情報保護法[252] or Personal Information Protection Law" in 2015 and putting it into effect in 2017[253].

[251] Translitteration: Kojin jōhō hogo iinkai
[252] Translitteration: Kojin jōhō hogo-hō
[253] Information available at: https://elaws.e-gov.go.jp/document?lawid=415AC0000000057

3.3.1 International trends in laws and regulations covering personal information

The following paragraph describes trends in laws and regulations covering personal information in an international context. Namely it will be taken into consideration the regulation of the EU, the US and that of Japan before and after the amended "Personal Information Act":

1 European Union

The "EU Data Protection Directive" was adopted in 1995 to regulate the protection of personal information and to serve as a basis for related legislation in each of the EU member countries. However, the lack of compatibility in regulations among the member countries placed a great burden on business conducted by multinational companies. To rectify this problem, the "EU General Data Protection Regulation" was proposed in January 2012 as a comprehensive regulation covering the entire EU with the aim of passing this proposal through the European Parliament in 2015 and enacting it in 2017. The definition of personal information here is broad and it included biological information, location information, and IP addresses. A violation can incur a fine of up to 5% of sales, imposed by data protection agencies of EU member states with supervisory authorities. Regulations have also been established on the transfer of data overseas. All in all, the General Data Protection Regulation provides for rigorous protection of personal information.

2 United States

Although there is no unified law covering the protection of personal information, the Federal Trade Commission (FTC) mediates on individual cases of data usage that raise privacy concerns. For example, the Netflix Prize, given for the most accurate method of making movie recommendations on the basis of DVD rental history was discontinued in 2010 after the FIC intervened in the case. Although the U.S. has generally placed more importance on data usage than privacy protection, the submittal of the Consumer Privacy Bill of Rights Act[254] by the White House in March 2015 signals a shift toward more privacy protection.

[254] Information available at: http://www.nytimes.com/2010/03/13/technology/13netflix.html?_r=0

3 Japan

Despite the enactment of the Personal Information Protection Act in April 2005, the definition of personal information and rules governing its use were still vague, and there was no organization for supervising personal information as a whole. There are numerous features in the amended Act, a significant one is that personal information that has been processed into "de-identified information" may be provided to third parties without the consent of the individuals involved under certain conditions, as an example re-identification of individuals from the provided data is prohibited[255]. De-identified information, of course, refers to data that has been processed so that a specific individual cannot be identified. As a result, interest in "de-identification technology" as a way of achieving such processing is increasing. This technology is predicted to sustain an exponential growth in importance and usage in the next years[256]. A common trend among them in laws and regulations in the EU, U.S., and Japan is the strengthening of laws and regulations concerning privacy and efforts at achieving a system in which users can entrust their personal information to organizations without causing concerns.

3.3.2 De-identification technologies

There are a variety of technologies available for converting personal information into de-identified data. The Personal Information Protection Commission intends to develop field-by-field standards for de-identification technology. Even though no choice has been reached on which technology would be implemented, de-identification technology is thought to be a strong candidate. A plethora of technologies have been created, each with advantages and limitations. We shall now examine the three most significant technologies: "仮名化[257] or pseudonymization" and " k-暗号化[258] or k-

[255] Koichi, I., Jun, K., Takeshi, S., Hiroshi, T., "パーソナルデータのプライバシー保護を実現匿名化・暗号化 技術, Anonymisation and encryption technology to protect the privacy of personal data", *Fujitsu, no.67, p.26-33, 2016, in Japanese.*

[256] Ibidem

[257] Transliteration: Kanaka

[258] Transliteration: K-angōka

anonymization"[259], and “準同型暗号化[260] or Homomorphic encryption”.

• Pseudonymization is a technology that involves replacing authentic names with aliases, such as temporary IDs which are unrelated to the real identities, in an effort to stop individuals from being identified. One advantage of this method is the capacity to track a specific element of a person. However, at the same time, a problem is that a combination of attributes like as gender and age, which could also indirectly identify an individual, can thus be used to identify the individual corresponding to a specific record. The figure below shows an example of pseudonymization.

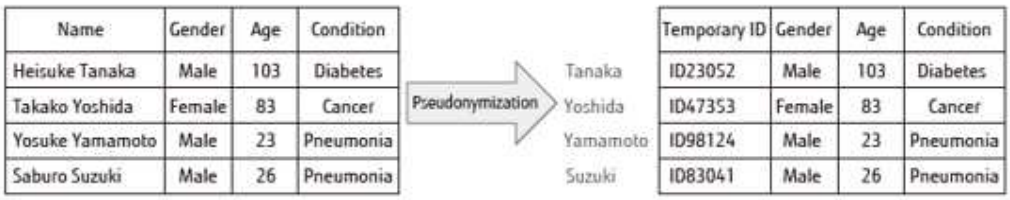

Figure 33 Pseudonymization example, provided by Fujitsu, no.67, p.29, 2016

• K-anonymization addresses this problem by defining attributes which can be used to indirectly identify an individual as quasi-identifiers (QIs) and handling data in such a way that at least *k* individuals end up having the same combination of QI values. Thus, preventing an individual corresponding to a particular record from being identified. In order to manage input data, k-anonymization requires that this should be read into main memory. However, if the amount of incoming data is excessively vast, it will be unable to store it all in main memory, and processing speed would suffer as a result. An example of k-anonymization is depicted in the figure below.

[259] Ibidem

[260] Transliteration: Jun dōkei angōka

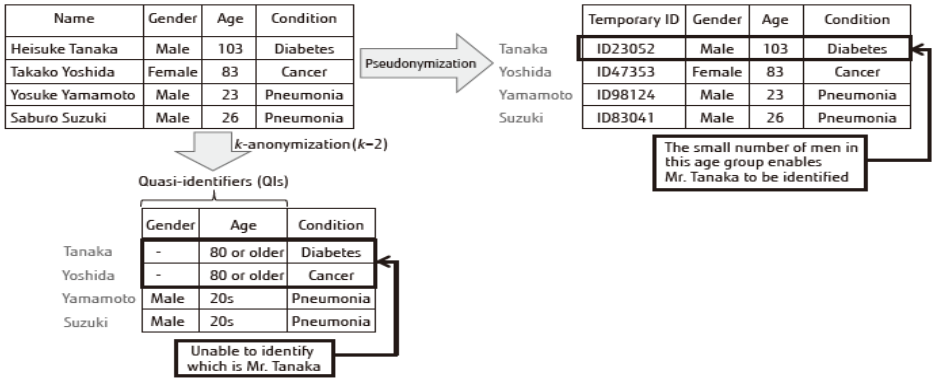

Figure 34 Illustration of k-anonymization, provided by Fujitsu, no.67, p.30, 2016

• De-identification technology processes the data and decreases the amount of data so that an individual cannot be identified. This may have a negative effect on information analysis accuracy. Anonymizing genome sequencing prohibits it from being analyzed in genome analysis. In response to this dilemma, Fujitsu Lab is developing "homomorphic encryption" as a privacy-protection solution that can be employed in such areas[261]. Homomorphic encryption allows mathematical operations like addition and multiplication to be performed on encrypted data while the input data remains concealed. In concept, combining such techniques should allow any processing to be performed on encrypted data. Homomorphic encryption can thus be used to determine the similarity, Hamming distance, between two sets of encrypted vector data. It also enables concealed searching of character strings, that is, the searching of data and search keys in their encrypted form. Because of all these features, as well as the capacity to conceal search results, homomorphic encryption shows promise for its use in genetic-information searches in the research and for converting personal information into de-identified data. The illustration below depicts an example homomorphic encryption.

[261] Koichi, I., Jun, K., Takeshi, S., Hiroshi, T., "パーソナルデータのプライバシー保護を実現匿名化 ・暗号化 技術, Anonymisation and encryption technology to protect the privacy of personal data", Fujitsu, no.67, p.26-33, 2016, in Japanese.

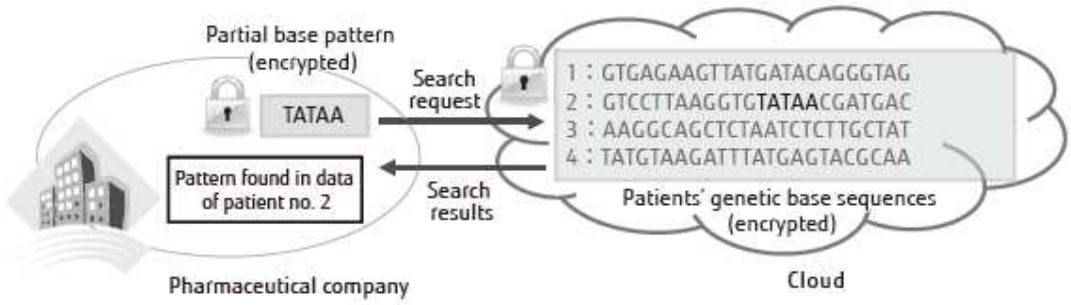

Figure 35 Illustration of homomorphic encryption, provided by Fujitsu, no.67, p.32, 2016

Conclusion

To summarize all the findings that have been expressed thus far throughout the various chapters of this dissertation, we can state that Japan presents a state-of-the-art Information and Telecommunications technology infrastracture. This was a result of a peculiar historical evolution of the infrastrcuture in the country which led it to present a national coverage rate for fiber optic broadband services at 99.1 percent and a mobile broadband penetration rate of 142 percent. Nonetheless, for various reasons the government was not able to utilize this infrastructure properly: the shortage of a central agency which would cohordinatinate the interaction between different government bodies, between government and public and private sector, and that could properly introduce the benefit of this higly perfomative ICT infrastructure to the citizen leading to a digitalization of society. We also assayed how literature arguement that this digital revolution did not occur in Japan, because they had not accumulated sufficient ICT capital throughout the last two decades and that excessive regulations and a lack of competition in service sectors may have prevented the enhancement of ICT-usage effects. It was also pointed out how ICT capital accumulation was very slow in non-ICT manufacturing and service industries, especially among small and medium-sized enterprises, contributing to declining Total Factor Productivity growth during the "two lost decades". The lack of these investment in modern Japanese industry has also severe ripercussion on a threat that many advanced and developing economies are facing: population ageing. Through the analysis of various literature works we have assessed how here is a factor which could be exploited regarding the use of ICT and the rapid ageing society in Japan: the complementary effect between ICT capital and older workers. The literature has proven how productivity decline due to ageing

can be mitigated by increasing investments in ICT and how rapid demographic shift toward aged societies is not necessarily an economic threat. In the end, we analysed some of the political policy and strategy through which the government aims at closing the digital gap between the ICT infrastructure and the lack of its usage by the citizen, namely the creation of the “Digital Agency” and the “My Number”. Through these two components, the main intention is to cope with the absence of a control tower for the digitization of government administrative work and by unifying the IT procurement of ministries and agencies with the digital agency. While with "My Number", the goal is to promulgate the use of ICT to citizens and at the same time prove the security of this system through huge investments in the field of de-identification. These technologies will become increasingly integrated at the level social also through the introduction of the benefits deriving from the use of 5G and IoT technologies.

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