Moonshot R&D MILLENNIA* Program

*Multifaceted investigation challenge for new normal initiatives program

A society where everyone can have and raise children with dreams and hopes if they wish.

Initiative Report

2021, July

Goal Review Team「Team for building a society of procreation」
Team Leader：Shinya Yoshida（Tohoku University, Graduate School of Engineering, Project Associate Professor）
Sub Leader：Sunyoung Lim（NPO Sharing caring culture・Director Knots associates Inc.・Engagement Booster）
Team Members：Ai Kajiyama（Crane Vascular Inc. CEO）
Toshikazu Tanaka（Ryukoku University, Department of Modern Economics, Associate Professor）
Urara Satake（Keio University Graduate School, Graduate School of System Design and Management, Project Assistant Professor/Lecture・General Incorporated Association TAMANI, Representative Director）
Daisuke Ito（Tohoku University, Graduate School of Medical Engineering, Assistant Professor）
Okiharu Kirino（Crytal Optics Inc. Senior Managing Director and Representative Director）
Yusuke Matsubara（Tohoku University, URA Center, Research Promotion and Support Organization, Project Assistant, Professor）

Contents

workers (employment rate)

1.2.4 Questionnaire survey of 1,100 men and women of childbearing and childrearing age in Tokyo and three prefectures

1.2.5 Social structure of poor families

1.2.6 A set of variables that affect multiple variables in the loop surrounding poor families

1.2.7 Connecting the declining birthrate loop between the state and families (right) and the loop of supporting poor families (left) to capture the overall structure of society

1.2.8 Weak Safety Nets Accelerate Fertility Decline

1.2.9 Social structure assumed in this study and summary of this section

2. Overview of research and development to be conducted to achieve the relevant MS goals

2.1. Vision①Anyone can have a genetically related child at any time if they wish.

2.2. Vision②We can look forward to our children with hope, and all parents and children can grow up healthy and safe.

3. Japan's position in overseas trends

3.1. Vision①Anyone can have a genetically related child at any time if they wish.

3.2. Vision② We can look forward to our children with hope, and all parents and children can grow up healthy and safe.

3.2.1 About Target ① and ②

3.2.2 About Target ②, ③ and ④

III. Plan for Realization

1. Area and field of challenging R&D, research subject for realization of the Goals

1.1. Vision①Anyone can have a genetically related child at any time if they wish.

1.2. Vision② We can look forward to our children with hope, and all parents and children can grow up healthy and safe.

2. Direction of R&D for realization of Goals

2.1. Vision①Anyone can have a genetically related child at any time if they wish.

2.2. Vision② We can look forward to our children with hope, and all parents and children can grow up healthy and safe.

3. International cooperation

4. Interdisciplinary cooperation

5. ELSI (Ethical, Legal, Social Issues)

I. Concept

1. Proposed MS Goal

1.1. Proposed MS Goal title

By 2050, we create a society where everyone can have and raise children with dreams and hopes if they wish.

1.2. Vision for 2050 society

The vision of society in 2050 that we should aim for consists of the realization of the following two visions.

Vision① Anyone can have a genetically related child at any time if they wish.

Vision② We can look forward to our children with hope, and all parents and children can grow up healthy and safe.

As a basic premise, the society of the future should allow people to make choices of their own free will, whether to have a genetically related child or not, to adopt a child, or to remain single.

In addition, if a person chooses to have a child, he or she should be able to do so without any anxiety, and in a good sense, "comfortably" give birth to and raise a child. Our proposal is not to strongly encourage people to have children, but to research and develop science, technology and social systems that will enable people to realize their desire to have children with their beloved partners. This desire is a universal human need at the genetic level, which may be good or bad.

We also want to realize a society where men and women of all ages can raise their unborn children with joy, pleasure, and comfort. We will not be tormented by loneliness, anxiety, and excessive parental responsibility, as we are today. On the other hand, the children who are born into this world are the assets of the future society. Therefore, we would like to realize a society where children can grow up in health and safety with their parents, being blessed and watched over by the whole society. Currently, there is a big gap from the vision of the society that we are aiming for due to the biological limitations, the pursuit of convenience in science and technology, and the changes in social and industrial structures. In this project, we will create science and technology that can overcome this gap and contribute to well-being, and implement them in society, as well as reform the social system to realize the above vision of society.

Vision of this proposal

① Anyone can have a genetically related child at any time if they wish.

② We can look forward to our children with hope, and all parents and children can grow up healthy and safe.

2. Targets

2.1. Vision①Anyone can have a genetically related child at any time if they wish.

The pain of wanting a child but not getting one is eliminated. By freeing themselves from the time and gender constraints of fertility, women and sexual minorities in particular feel less "uncomfortable" with life. Reproductive rights (the right to decide for oneself whether to have a baby or not, when to have a baby, and how many children to have) are guaranteed. The right to choose when and how many children to have is guaranteed. Sexual minority couples will be able to have children who are genetically related to them. In order to realize this target, technological innovations that reduce the physical, psychological, and economic burdens of current fertility treatments are necessary.

By 2030, people will be able to live their lives in a way that allows them to understand, avoid, and reduce the processes and risks that lead to infertility.

By 2040, basic and applied research on development will have progressed, and fundamental treatments for infertility will have been established through the development of regenerative medicine and transplantation technologies, with due consideration of bioethics and a consensus among the international community.

By 2050, technologies such as gametogenesis, human augmentation, and artificial organs (in this case, artificial wombs) will have achieved the ability to transcend biological sex, or ex-vivo human reproduction. This will free us from the restriction that only women are biologically able to have children, and create a world where a variety of options exist. For example, sexual minorities will be able to have children with their beloved partners, even if they are biologically male. In the future, the healthy life span of human beings will be greatly extended, and life may become 100 years or even 150 years. In such a situation, it will be possible to have children in the "second and third life" as well, and the society will be able to achieve self-realization through multiple ways of living in one life.

2.2. Vision② We can look forward to our children with hope, and all parents and children can grow up healthy and safe.

The prerequisites for achieving change in this area are policy steering and the design of necessary incentives, which are outside the scope of this proposal. According to a Hitachi-Kyoto Lab AI-based simulated analysis published in 2019,[1] in order for Japan to continue to exist in a sustainable manner, it is essential to steer the country toward a decentralized social design. If we cannot have hope in life itself, we cannot have hope in raising children. In order to realize "a society where everyone can have children and raise them with dreams and hopes for the future if they wish," it is obvious that the country itself must be at least "sustainable,"

and this research can be positioned in a series of vectors aiming for a decentralized society. In other words, the purpose of this study is to clarify the requirements for a decentralized society from the perspective of "child-rearing" and "national wellbeing. Based on the above premise, by 2030, among the various functions that are currently carried out by the "public" and "services," the research, design, and construction of digital-based platforms will be carried out in the direction of having local communities take on the role of public-private partnerships in the fields where human interaction can be created and residents can benefit greatly by having local communities take on the role (such as childcare and recurrent education). Research, design, and construction of digital-based platforms are underway, and research and demonstration experiments are being conducted by local governments on a five-year basis in cooperation with smart city initiatives. In addition, during the above process, specific changes in "people-to-people connections" are being measured, and research and demonstration experiments are being conducted to strengthen interaction within the community while effectively drawing out the natural mechanisms of human mind and behavior. These processes will be carried out in collaboration with movements to measure and improve the wellbeing of local communities on a municipal basis (Smart city[2], Smart city institute[3] etc) and movements to support the distribution of people and goods in local communities by creating platforms (Digital Architecture Design Center[4]). The project will be promoted in cooperation with the Digital Architecture Design Center and other movements that aim to support the distribution of people and goods in local communities by creating platforms.

This is the phase in which research and demonstration experiments will be conducted in an iterative manner to improve and expand the system, with a specific focus on the realization of an autonomous, decentralized, and well-being society in which individuals can easily demonstrate their abilities, incorporating technology and the mechanisms of mutually beneficial behavior inherent in humanity.

In 2040, the social system obtained as a result of the above will be implemented and operated with improvements in many communities, and through the use of the functions installed in the community, residents will be able to connect with their neighbors who fit their individuality without any burden. As a result, a social system is being built that makes it easier to foster the peace of mind and joy of living in a community, even as it reduces the hassle of getting to know your neighbors. It is an image of a large, loose family-like connection, where people do not need to be together all the time, but can talk to each other or ask for advice when they need it, loosely overlapping and spreading in a network around their homes and rooms.

In such a society, the sense of anxiety, burden, and loneliness regarding childbirth and child rearing has been greatly reduced. At the same time, social systems and technologies have been

implemented that allow both parents and children to receive appropriate oversight and support. For example, for children, load-free sensors and painless sampling technologies have made it possible to monitor their growth and mental state, and in case of danger, alerts are sent to the appropriate authorities, and society as a whole has begun to implement social systems and technologies to watch over children. For parents, technology has been implemented that allows them to objectively grasp the state of their mental health and other burdens, and an environment and technology (perhaps based on AI) are in place that makes it easier for them to get the support they need. Through such a system, the government, NPOs, and public organizations (child guidance centers, etc.) are able to understand the social and economic status as well as the status of the parents and children, and provide more effective and efficient administrative support without leaks.

In 2050, the regions described above will have spread across the country. As a result, it will become easier for people to "learn about their own experiences and relativize them through the input of other people's examples and to learn about events they have not yet experienced (through the observation of others)," which has become difficult to obtain due to smaller families and loss of ties within the community. In such a society, people naturally desire to have more children and enjoy child rearing more.

In addition, the responsibility for the upbringing of children does not fall solely on genetically related parents, and the society has become one where unhealthy upbringing in closed rooms is eliminated. Parents are human beings, and of course they are not perfect. By 2050, we must not only strengthen support for such cases, but also develop human rights-conscious behavior change techniques for parents who are dependent or unable to control their emotions. If this is accomplished, the cycle of poverty and abuse will be stopped, and the number of crimes will be reduced. We can also expect to give back to society by working hard. The administrative and social burdens placed on these problems will be reduced, and society as a whole will be stabilized.

Well-being is also known to be correlated with productivity and creativity. A society in which everyone can feel secure in their desire to have and raise children is a well-being society in which people are optimistic and feel that they can manage, and a society in which productivity and creativity are high. This series of changes will be the driving force that creates a virtuous cycle in society as a whole, and by 2050, an even more powerful, flexible, and well-being society will be formed in which "all parents and children can grow up healthy and safe, hoping for a child with hope”.

3. Background

3.1. Why now

3.1.1 【Problem of low birthrate】

Since the mid-1970s, the birthrate has been declining for more than 40 years, and the number of children has been decreasing (Fig. I-1) . 2019's total fertility rate (hereafter referred to as fertility rate) is 1.36, and 2020 is already reported to be 11% lower than last year due to corona. The fertility rate is already reported to have fallen by 11% from last year. It was in 1974 that the fertility rate fell below the population replacement level, and since then it has been consistently stagnant, much lower than in developed countries such as Europe and the United States. If this trend continues, it is predicted that the population will reach 100 million by 2050 and less than 60 million by 2100. Some people are willing to accept the decline in population, but the essence of the problem is that unless the birth rate is restored to the population replacement level, there will be no more Japanese. In terms of the economy, the GDP per capita of the Japanese people is around $40,000 per year, and if the population continues to decline at this rate, it is inevitable that the country's national power and international influence will decline in proportion to the decline in population. It takes a long time for a person to have a child, and no matter what measures are taken, it will take about 5-10 years for the birth rate to reflect this. Therefore, if we are to look to the future in 2050, this is an issue that must be addressed urgently now that human contact has been greatly reduced due to the corona disaster.

There are various factors that affect the declining number of children, such as changes in the work environment and declining birth rates due to the use of alternative methods of marriage and later marriages. Unfortunately, the current system is not expected to recover enough to solve the problem of declining birthrates. As seen inFig. I-2(a), For the younger generation, socio-environmental factors and economic factors are the main factors that prevent them from having children. On the other hand, for those over 30, health and medical factors (biological factors) are the main factors. Therefore, it is necessary to promote both "reform of the social system" and "improvement of medical care related to reproduction.

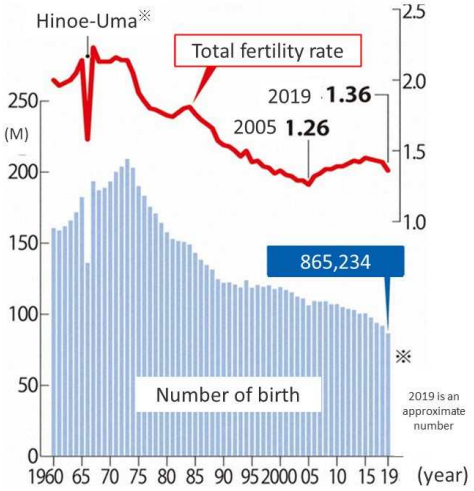


Fig. I-1 Number of Births and Fertility Rate [1]

As one of the data on fertility decline, it is reported that there is a clear correlation between the gender gap index and the total fertility rate. (Fig. I-2(b))。In the Global Gender Gap Report 2020, the World Economic Forum published the Gender Gap Index as one of the indicators of gender disparity in each country, and Japan was ranked 121st out of 153 countries in 2020. The implications of this data are as follows

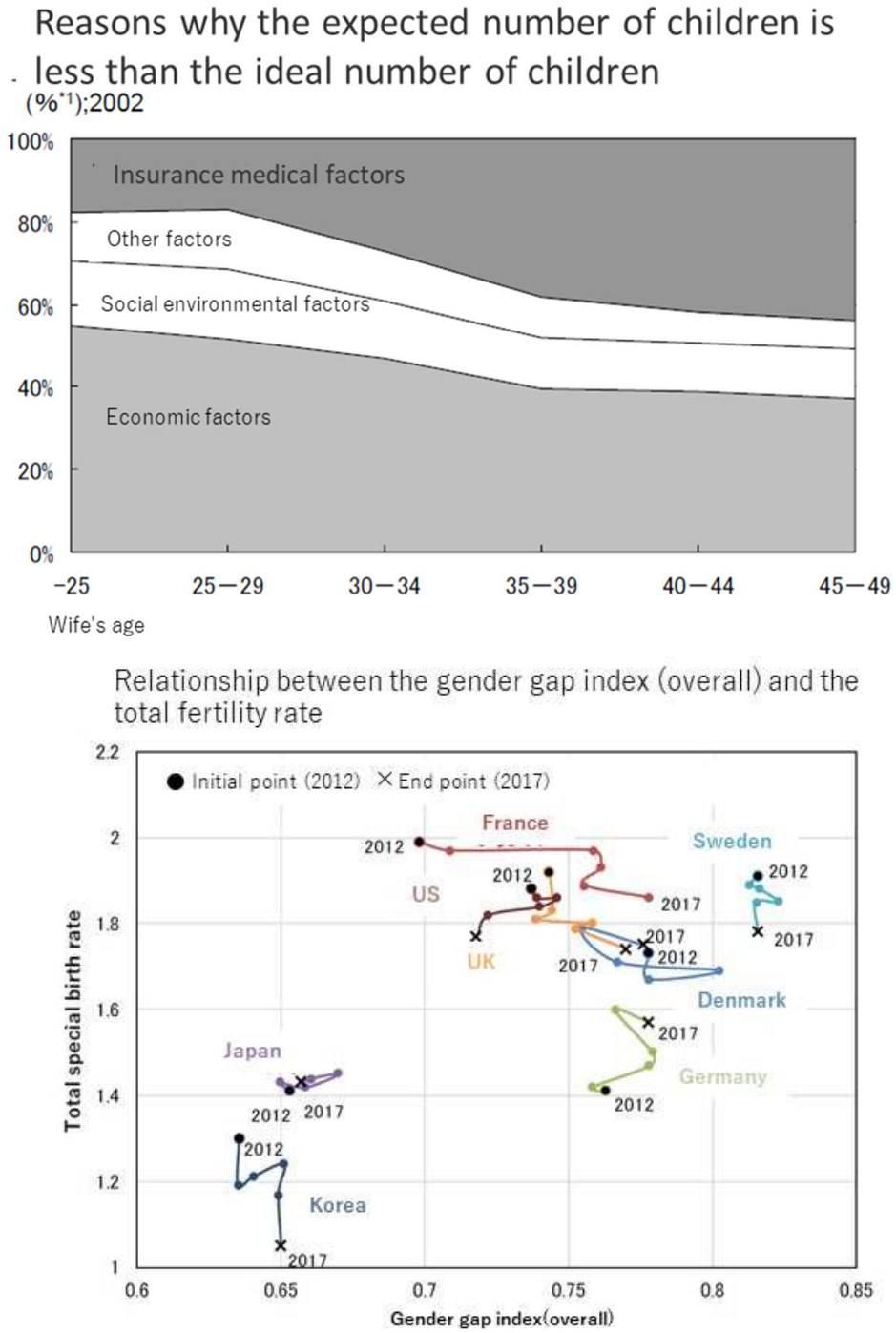


Fig. I-2 (a) Analysis of the causes of infantilization [2], (b) Relationship between the Gender Gap Index and the Total Fertility Rate [3]

The more equal a society is between men and women, the more women can have children with peace of mind. This gender equality seems to be based on a fair balance between women's advancement in society and men's advancement in the family.

3.1.2 【Increasing number of infertile patients and problems】

As mentioned above, the younger generation postpones having children due to economic and social environmental factors. The childbearing age then rises after a certain level of social status and economic foundation has been established, resulting in many infertile patients starting their fertility activities in a state of reduced fertility. According to the Japan Society of Obstetrics and Gynecology, more than 47,000 children are born annually in Japan as a result of assisted reproductive technologies such as in vitro fertilization (IVF) (2014), and approximately one in 21 children born that year is born as a result of advanced infertility treatment (Fig Ⅰ-3). It has the highest number of treatments in the world.

However, there are many problems associated with this fertility treatment and assisted reproductive medicine. First of all, it has been reported that the treatment result (birth rate) is the lowest in the world. Of course, it is possible that the number of fertilized egg transplants is more limited than in other countries in order to prevent multiple pregnancies, but since there are no treatment guidelines to begin with, treatment policies vary from clinic to clinic, causing confusion. In addition, infertility is not a category of disease such as malignancy, and there are ethical barriers to its research and development. From the perspective of gender equality and support for women's advancement in society, how to support women who are undergoing fertility treatment while working is also a major issue. It has been pointed out that it is difficult to balance work and infertility treatment due to the difficulty in scheduling hospital visits and the physical burden of medication and injections (Fig Ⅰ-4). Some quit their jobs in order to concentrate on treatment, and some estimates put the number of such "infertility retirees" at nearly 24,000 nationwide. According to a survey conducted twice in 2015 and 2005 by Fine (Tokyo), a non-profit organization that supports people suffering from infertility, a total of 7,800 people responded to the survey, and more than 90% of them answered that it was "difficult" to balance treatment and work.[5],[6]

In addition, many of the retirees cite personal reasons and do not disclose the fact that they are actually retiring for medical treatment. It is difficult for companies to see the reality of infertility retirement. Even women who do not resign from their jobs are often torn between prioritizing treatment, which makes it difficult for them to schedule important meetings and business trips, and quitting their jobs, which makes it difficult for them to pay for expensive infertility treatment. According to Fine's estimate calculated from the survey, 23,951 people nationwide have resigned due to infertility treatment. Along with that, the economic loss is

estimated to be about 208.3 billion yen, adding the average wages of the retirees, the cost of training them up to that point, and the cost of hiring new personnel.

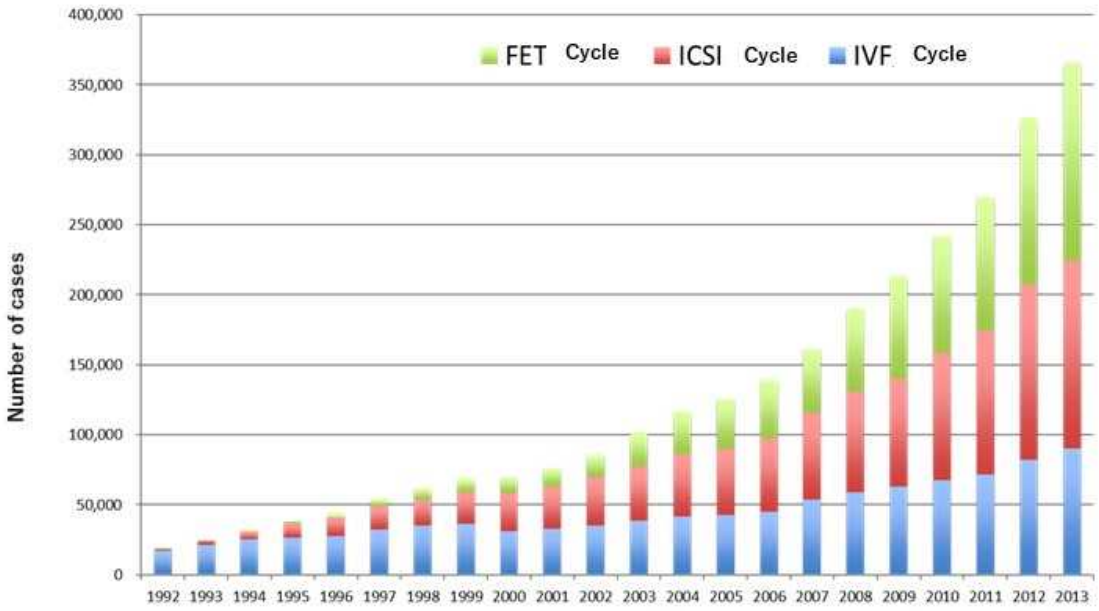


Fig Ⅰ-3 Number of cases of non-fertility in Japan (「ＡＲＴデータブック」の「２０１３年ＰＰＴＸ版」[4])

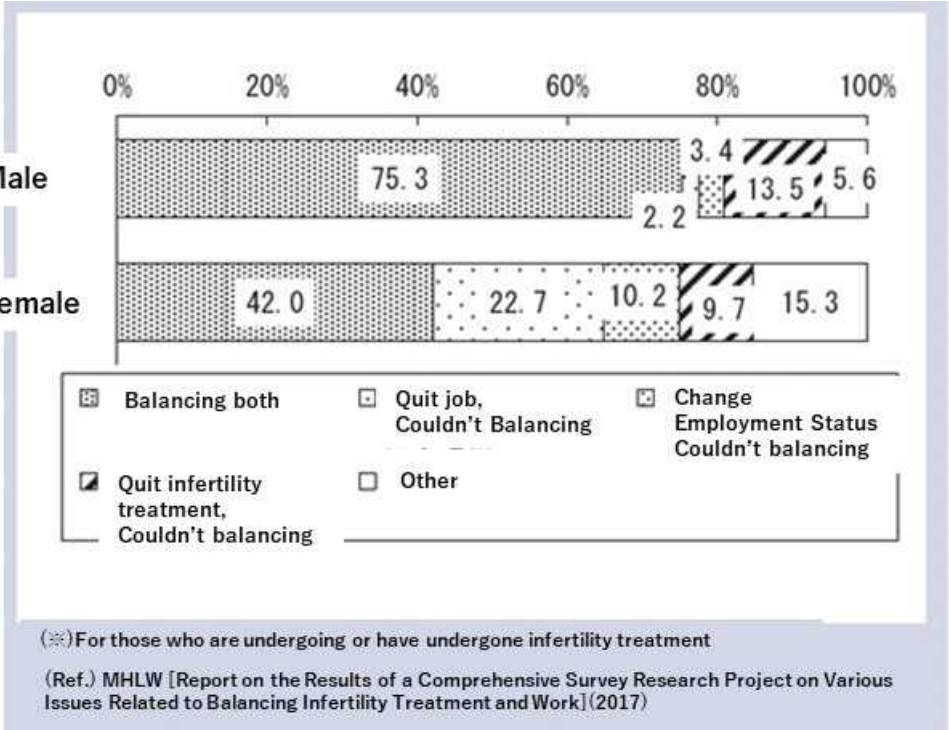


Fig Ⅰ-4 Status of balancing infertility treatment and work[5]

3.1.3【Sexual and reproductive gender inequality, LGBT reproductive rights】

The current situation is that there are irreconcilable differences in biological functions between men and women. At present, reproductive workloads on women's bodies are unavoidable. During pregnancy, which lasts about ten months, a woman's activities are greatly restricted. Now and then, childbirth is a life-threatening act. It imposes a variety of physical and social burdens. The surrogate mother business in developing countries is also a problem（Fig. I-5）. Wealthy people who cannot afford to have children pay women in developing countries such as India, Vietnam, and Thailand to become surrogate mothers. Complications arise when the birth mother refuses to hand over the child, or when the client refuses to take the child back when it is born with a disability.

In addition, the promotion of diversity for sexual minorities, known as LGBT, has begun around the world. In Japan, it is said that LGBT people make up 3-10% of the total population. Currently in Japan, same-sex couples are not legally guaranteed the same rights as heterosexual couples. For example, they are not legally allowed to share property, have children, inherit inheritance, receive pensions and insurance benefits, and so on. Recently, discriminatory remarks about LGBT couples not being able to have children have been taken up and criticized, and we believe that by 2050, there should be an option to realize 'a society where LGBT people can choose to have children as a matter of course. However, reproducing through third parties (sperm donor banks, surrogate mothers, egg donation, etc.) raises a number of complex issues, including the legal definition of parenthood. Above all, we believe that LGBT people have the desire to have children with their beloved partners, and that there should be technology that allows them to do so.

Fig. I-3　Press coverage on the issue of surrogate mother business in developing countries [6]

3.1.4 【Despair about the child-rearing environment in our country】

According to an international survey of attitudes toward declining birthrates, more than 40% of respondents in Japan answered "No" to the question, "Do you think your country is a good place to have and raise children? (Fig. I-6) This is a very high percentage of that internationally. In the latest edition of the World Happiness Report, which shows the happiness rankings of countries around the world, Japan ranks 56th in terms of happiness, 77th in terms of freedom of life choices, and 148th in terms of generosity, by far the lowest among developed countries. In terms of nominal GDP (gross domestic product), Japan ranks third in the world after the major powers, the United States and China. There are so many things in abundance that the applicant himself cannot think of many things he wants to buy anymore. However, in reality, we feel very cramped and suffocated. This feeling may be one of the reasons why people do not feel like having and raising children. First of all, there is a lot of room for improvement in the fertility and child-rearing environment in order to raise the level of happiness of the people.

Fig. 3-1-2-4 Do you think it's an easy country to have and raise children?

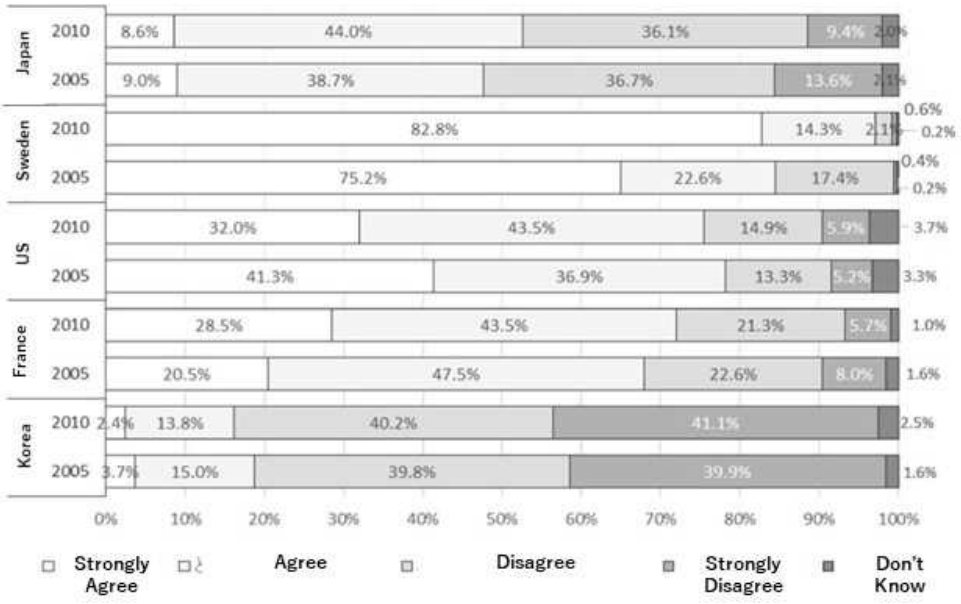


Fig. I-6 International Survey on Fertility and Society [7]

3.1.5 【Loneliness, isolation】

A detailed analysis of the psychological aspects of the childcare environment revealed that

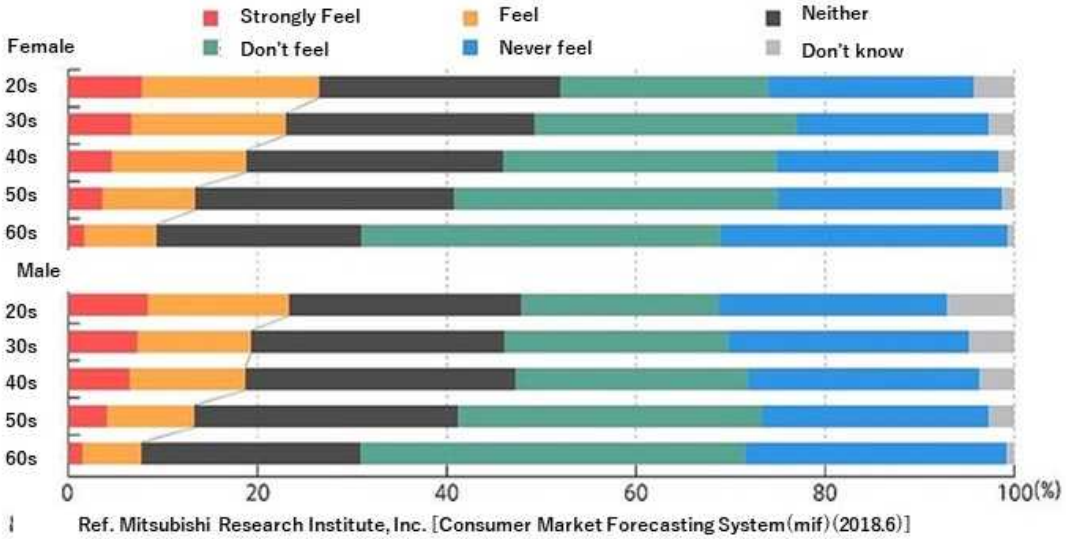


Fig. I-7 Loneliness by age groupm [8]

many people are tormented by loneliness and anxiety. In particular, many young people who are digitally savvy feel lonely (Fig. I-7). This is in spite of the fact that we live in an age where we can easily connect with others through the Internet and SNS. We believe that this is the root cause of today's suffocating social structure. The details will be described in the next chapter. To begin with, humans are social animals and have evolved by forming communities. Now, however, as a result of the development of capitalism and the pursuit of convenience, individualization is rapidly advancing. We can turn on the faucet at home and water will come out. There is no need to go to the well to get water anymore. In exchange, there are no more well meetings. There are no more opportunities to meet by chance and talk about trivial things. If you look pale, there's no chance to ask what's wrong. In the case of the Corona disaster, the development of online meetings has made it more and more difficult to observe and intervene in the lives of others. The reason seems to be the "total lack of contingency and semi-transparency in communication. But would you build a well again? Would you go to the river to wash your clothes? Do we want to create a closed village society? This is the question. It would be unacceptable to do something that would go against the times. We need to make some kind of move that is appropriate for the future.

There are various factors behind this, including the increase in the number of elderly people and people living alone, the deterioration of public finances, and the growing recognition of the value of so-called social capital to well-being, community revitalization, and the economy, as will be discussed later.

The benefits and impact of having more friends and acquaintances in the area where you live cannot be overlooked. A number of epidemiological studies have already shown that social ties predict death from almost all causes of death.[7,8,9,10]。There is also a large body of research in the area of connections between neighborhood residents.[11] People who have more connections with their neighbors are healthier than those who do not, People who live close to their neighbors are more likely to experience mental well-being[12], increase life satisfaction[13], live a long and healthy life[14].

Holt-Lunstad et al. conducted a meta-analysis of the effects of both structural and functional aspects of social ties on mortality, and found that mortality was 5% higher among those with fewer than more structural ties, and 16% higher among those with fewer than more functional ties.[15] Another meta-analysis found that living alone increased mortality by 32%, social isolation by 29%, and loneliness by 26%.[16]

The impact is not limited to individual well-being and health. Community connections have also been shown to lower the cost of social security.[17] In the Great Hanshin Earthquake, almost 70% of the victims were rescued by "self-help" including family members, and 30% by "mutual-help" with neighbors[18]. Especially in Japan, where disasters are common, connections among neighbors can be a life-threatening issue.

Turning to the data on connections among neighbors, we see that the number of respondents who say they keep close ties with their neighbors has shrunk sharply, from 49.0% in 1986 to 17.0% in 2018, a decrease of 32.0%.[19,20] (Fig I -8). According to the Ministry of Health, Labor and Welfare, 84.5% of people consider it ideal to have a good relationship with their neighbors, while 65.7% of people do not have neighbors to help them in their daily lives.[21]。

There is also a generational gap here. According to the Cabinet Office, only 16.0% of the total number of "connected people" in the community, and more than 70% of them are in their 50s or older (as of 2007). (Fig. I-9) he survey also points out that "the characteristics of people who have neighborhood relationships and those who participate in community activities are generally consistent. In other words, people who are married, have children, are older, are not employed, live in rural areas, or live in single-family homes tend to participate in one type of community activity or another, and have more ties to the community, while those who do not participate in community activities tend to be more isolated. On the other hand, those who do not participate in community activities tend to be isolated.

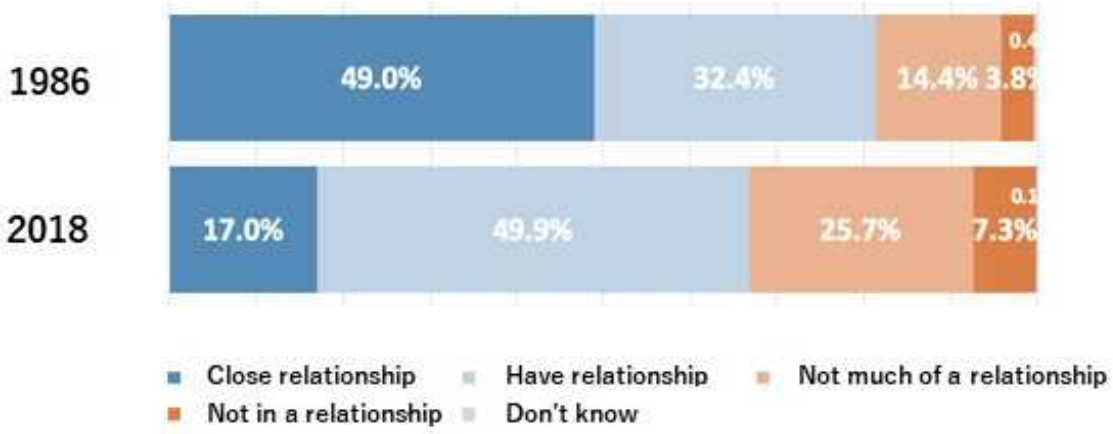


Fig. I-8 Changes in the degree of neighborly relations [9]

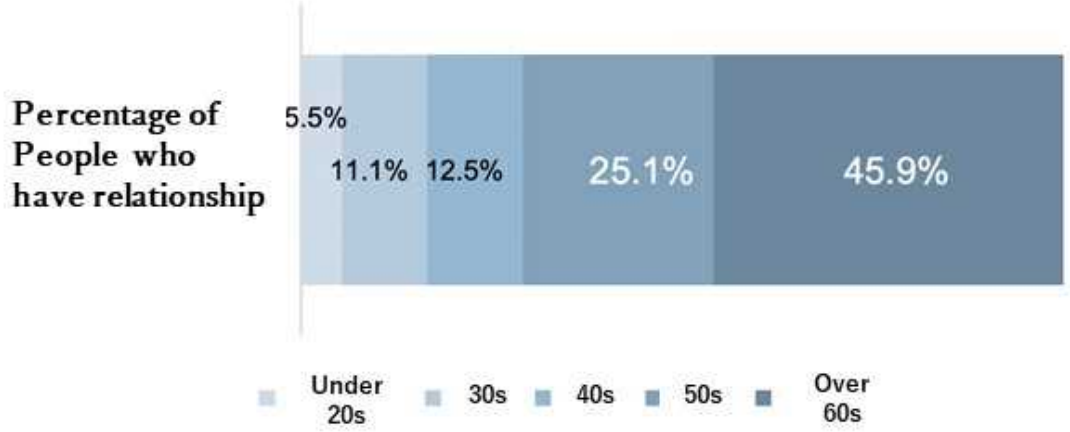


Fig. I-9 Trends in (relationship) by age group and region [10]

In this survey, community activities were divided into four areas: (1) neighborhood associations, (2) other local activities, (3) sports, hobbies, and recreational activities, and (4) volunteer and civic activities such as NPOs. According to the data, in 1968, 70.2% of people in towns and villages and 49.1% of people in cities participated in neighborhood association activities; 15.6% of people in towns and villages and 19.6% of people in cities participated occasionally; and 14.2% of people in towns and villages and 31.5% of people in cities did not participate (including those who did not join). The percentage of those who did not

participate (including those who did not join) was 14.2% in townships and 31.5% in cities. On the other hand, in the 2007 survey, 12.7% of respondents participated in community activities "at least one day a month," 35.8% participated several times a year, and 51.5% did not participate.

In just 25 years, from 2015 to 2040, the population will decline by 12.7%, from about 130 million to 110 million.[22] Meanwhile, the number of elderly people will increase from 33.87 million to 39.21 million over the same period, an increase of 15.9% (the aging rate will rise to 35.4%)(Fig I -10). By 2040, all of the so-called junior baby boomers will be 65 years old or older, and according to estimates, 39.3% of all households will be one-person households in that year[23]. Of these, 55.0% are expected to be elderly.[24] (Fig. I-11)。

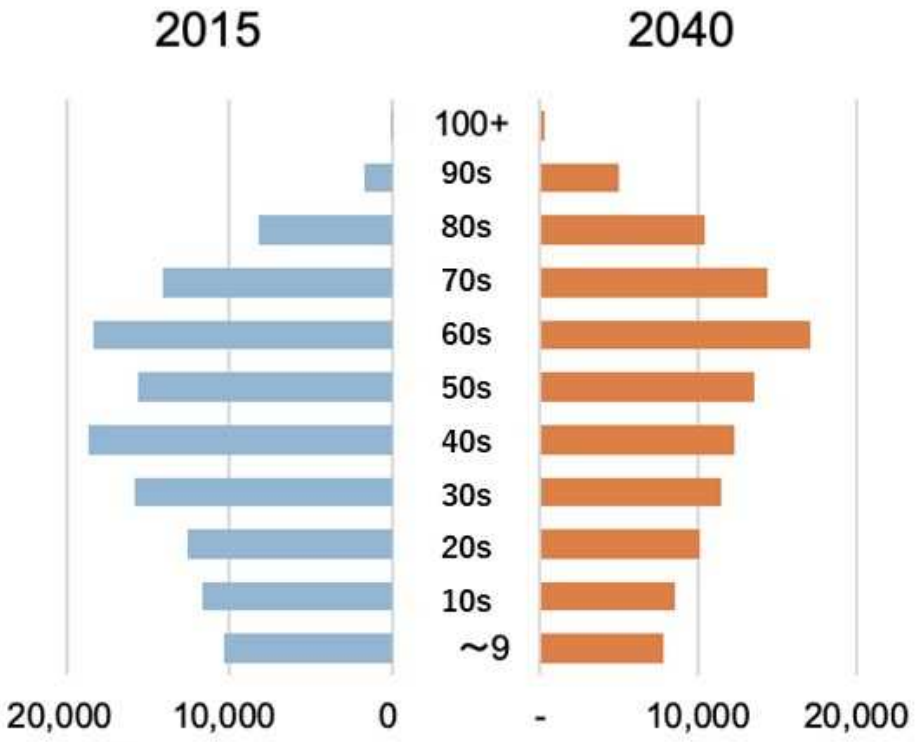


Fig I -10 Demographic change from 2015 to 2040. [11]

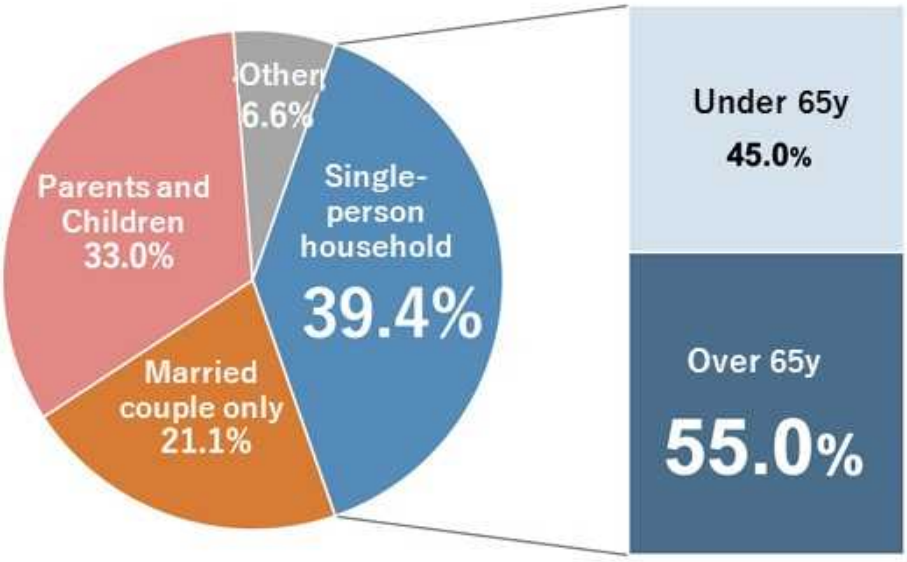


Fig. I-11 Household composition in Japan in 2040 and the percentage of households headed by one person aged 65 or older [12]

3.1.6 【Child abuse and poverty】

In recent years, child abuse and poverty have been on the rise (Fig. I -12). The number of cases of abuse and the number of consultations with child guidance centers continue to increase, but no improvements have been made even though the problem has been recognized[25]. In addition, there are children in Japan who, due to the environment in which they were born and raised, do not have access to a nutritionally balanced diet or to educational opportunities. The relative poverty rate for children under the age of 17 in Japan is 13.5%[26], and there are approximately 1.37 million elementary and junior high school students who receive schooling assistance for economic reasons (according to the Ministry of Education, Culture, Sports, Science and Technology, 2018). However, even if children and their parents are aware of poverty, they do not seek support because they are concerned about the eyes of those around them, making child poverty less visible. Child poverty and abuse have become even more difficult to see from the outside due to the disintegration of communities and over-individualization. There is a high risk of these problems spreading in a chain reaction in the future, and they need to be solved immediately. Against this background, our society needs to shift to a society where children are watched over and nurtured by society as a whole.

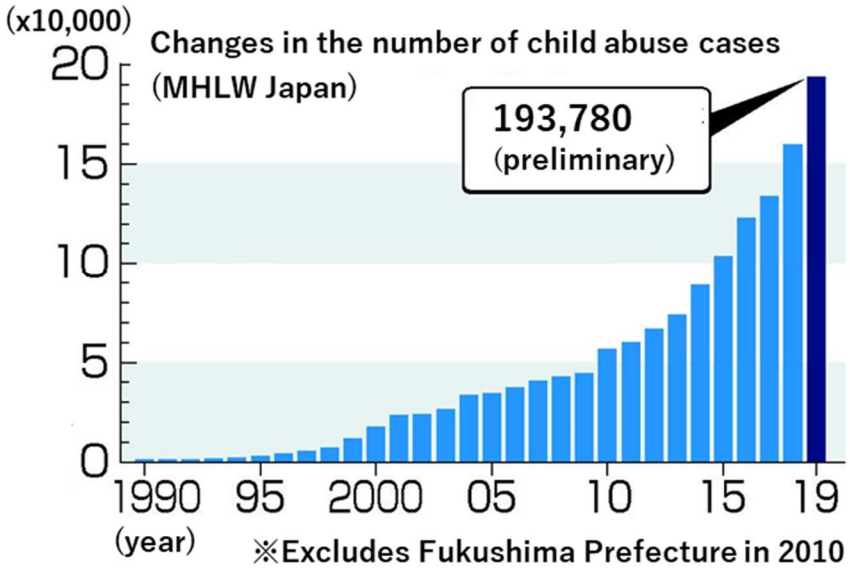


Fig I-12 Changes in the number of child abuse cases [13]

3.1.7 Necessity of setting and working on this MS target proposal

(Scientific and technological requirements)

・From the perspective of the academic world, the issue of declining birthrate has been overlooked. For example, four of the seven Moonshot proposals are based on the idea of opening up the way to a society with declining birthrates and an aging population through radical innovation. However, if you carefully read the proposals, you will find that they include "freedom from physical limitations," "prevention of diseases," "robots that coexist with people," and "health until age 100. In other words, even if all seven moonshot goals are achieved by 2050, the problem of declining birthrates and aging society will not be solved. The same seems to be true for Society 5.0, the vision of the academic world. I am concerned that if this trend continues, Japanese academia will not be able to fundamentally solve the problem of declining birthrates and aging society. From the perspective of the academic world, I believe that proposing a fundamental solution to the problem of declining birthrates in setting this goal will have a unique and significant impact.

・Although the number of children a couple can have is decreasing due to biological limitations caused by late marriages, it has become possible to discuss age-independent pregnancies and other issues due to major developmental modalities such as assisted reproductive medicine and iPS cells. It is no exaggeration to say that we have already stepped into the "realm of God," so to speak, as progress in the field of life science is extremely rapid, due in part to international competition. It is important to focus on the fields of reproductive medicine and women's health care, while also discussing the ethical aspects.

・In order to realize the society we propose, it is necessary to change social systems, institutions, and laws, and this is a problem that deals with complex systems. What kind of society we will create in the future is currently the subject of active debate, and we are now in the demonstration stage. There are probably countless correct answers to this question, and it will be difficult to draw a clear-cut blueprint like the Grand Unified Theory. This is just our personal opinion, but the recent Smart City concept and Society 5.0, which emphasize efficiency by pushing digital technology and AI to the forefront, seem to be "inorganic" evolution. We should work together with social scientists, social system designers and other experts from various fields, citizens, and local governments to create a society where digital and analog technologies are in harmony, and where the evolutionary process of humans and our genetic instincts are taken into consideration.

・The further development of assisted reproductive medicine and life science is a field that must be advanced through discussions on ethics, religion, culture, and other issues, and cannot be solved by short-term efforts. To begin with, the mechanisms of development and differentiation of living organisms are not clear at this point, and a vast amount of basic research is needed. In addition, it will take at least 10 years or more to reach the stage of social implementation, if we estimate the approval process of non-clinical and clinical trials.

・Social system transformation is also not easy in the short term. Individual mindsets, cultures, laws, and economic systems will need to be changed simultaneously, and countless and long-term empirical studies will be needed. It will take countless, long-term empirical studies, and we will have to wait for a generational shift to change these things. Therefore, there are many initiatives that can be started immediately, but they need to be implemented continuously and persistently until they become effective.

Recently, as a big step towards creating a child-centered society, it has been proposed to establish a "Children's Agency" which is a governmental organization that will deal with the administration of children. In addition, the subsidies for infertility treatment have been expanded from January 2021. The government is becoming more and more aware of issues related to fertility, childbirth, and childcare, and now is the time for science and technology to focus on these areas for solutions.

3.2. Social significance

The aim of this proposal is to design and build a "society where people can hope for a child with hope" and to develop "technology that enables people to have a child when they want one (Fig I -13). It is also to eliminate the suffering and pain of those who are responsible for pregnancy and child rearing, as well as young children. Parents and children can grow up healthy and sound, with enough physical and mental space, without giving up what they want

to do and learn, and with the kindness and care of society as a whole. They can grow up healthy and sound, cared for by society as a whole, without giving up what they want to do or learn. This is the "society of prosperous offspring" that we are aiming for.

As a side note, this is not a suggestion from the top, "Have more children, have more children. I would like to make it clear that this is not a proposal from the top. There is nothing wrong with a childless life or a single life, as long as you are happy. It is also perfectly fine to take in a child as an adoptive or foster parent and lead a good life together. The ultimate vision of the future is a society where each individual can pursue happiness in a society with various choices and values.

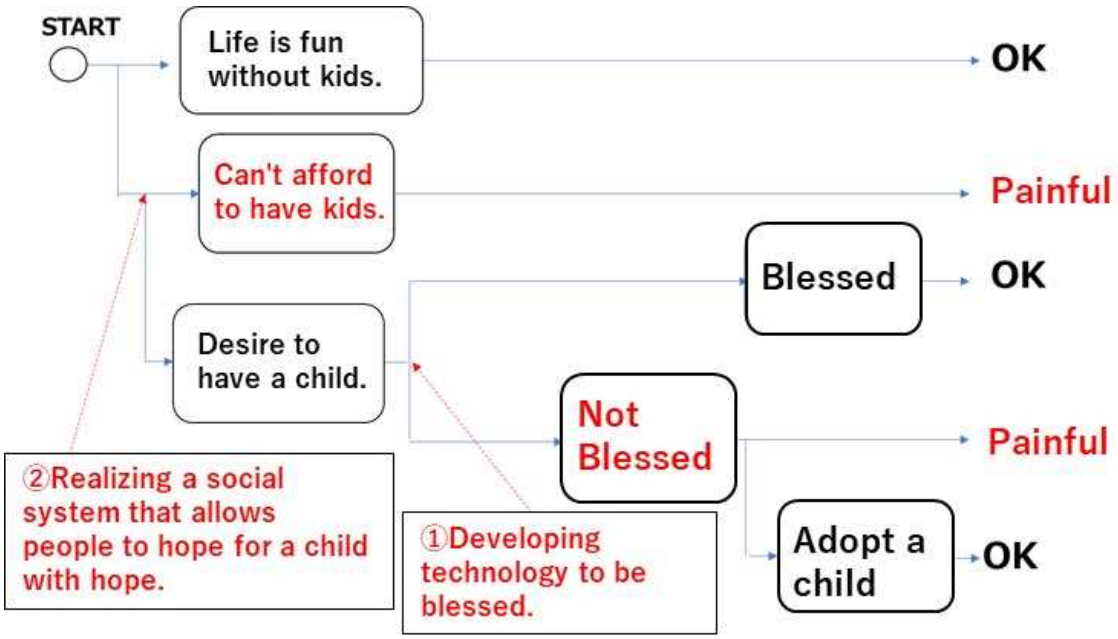


Fig I -13　Overhead view of the targets and objectives of this

3.3. Action outline

3.3.1 Vision①

Education and awareness: Preconception care and sex education should be provided in schools. While the number of infertile patients is increasing, the number of cases of unwanted pregnancies is also on the rise.

Companies: An increasing number of companies are providing support to their employees for fertility treatment. Specifically, these include "leave of absence for fertility treatment," "subsidies for treatment costs," "interest-free or low-interest loans for treatment costs," and "counseling. Although this will increase the burden on companies in the short term, there

are many advantages in the long run, as creating an environment where employees can work with peace of mind will increase the possibility of securing or hiring excellent employees. Efforts should be made to foster a system and culture that is understanding of the burden of women.

Medical institutions: The success rate of fertility treatment varies greatly from clinic to clinic, and the lack of guidelines is one of the problems. Efforts are needed to accumulate evidence

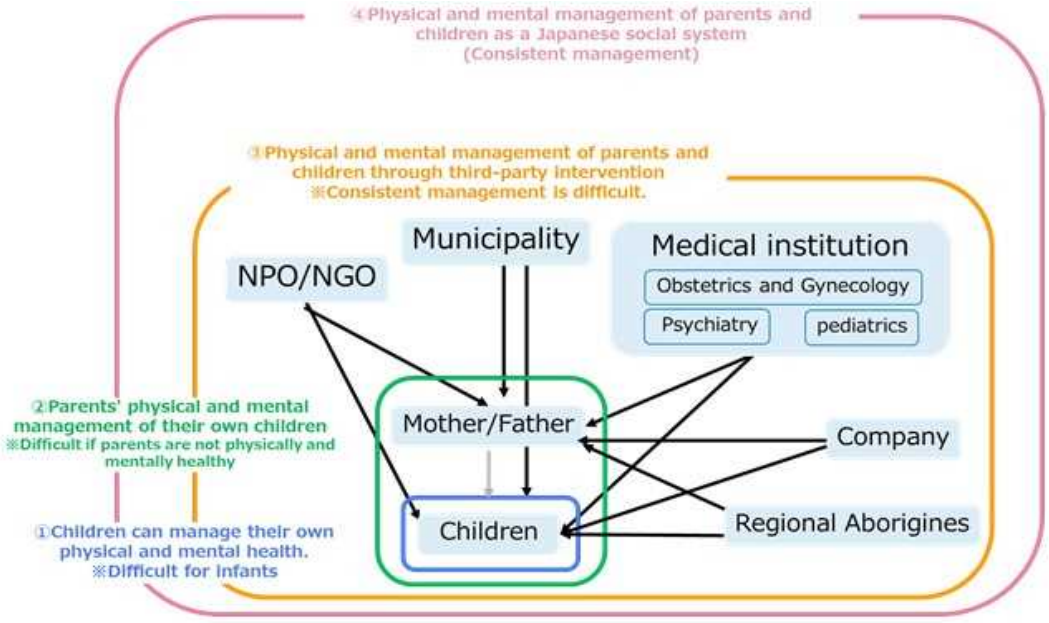


Fig I -14　Inclusive support from various sectors and networks

in basic research and to provide scientific fertility treatment.

Insurance system and costs, etc.: Advanced infertility treatment requires extremely high costs, and this has become a major burden for the people involved. It is hoped that the burden on patients will be reduced by shifting to outcome-based medical costs, for example, paying the full amount when a child is born.

3.3.2 Vision②

It is necessary for stakeholders involved in supporting parents and children to share their opinions and create an inclusive system of oversight (Fig I -14).

People involved in supporting parents and children: local government, child guidance centers, various NPOs and NGOs (poverty support, free tutoring, food banks, children's cafeterias,) medical care (obstetrics and gynecology, obstetrics, pediatrics, psychiatry),

nursery schools and kindergartens, elementary schools, welfare commissioners, social welfare councils, police

Researchers (all research topics related to parents and children; labor issues, poverty, social systems, history, abuse, education, and research topics related to building a watchdog system; information systems, society, ethics, politics, law,)

There are already various governmental supports and organizations in the society to help with childcare and livelihood. As for the issue of poverty, the Corona disaster since last year has caused poverty to increase. In today's society, there are systems in place to support people with life challenges, but with the increase in the number of supporters, there is no connection or coordination for the proper use of the various support systems, which depends on the abilities of the supporters and the field, and is critically lacking in resources. It would be desirable to update the functions and efficiency of the support organizations themselves, and to strengthen the connections between organizations and institutions through ICT, AI, and other scientific technologies. However, collaboration among sectors such as government (differences in the temperature of efforts by each municipality), the private sector, research organizations, and medical institutions is difficult because it does not lead to social and economic benefits, not to mention legal restrictions. Furthermore, from the perspective of personal information, it is necessary to consider a social infrastructure system with excellent security that can be used with peace of mind, as well as ethics and regulations, such as the extent to which the system should be watched over and the extent to which it should be monitored.

4. Benefits for industry and society

・Advances in reproductive technology will create a society with a variety of options. In particular, the difficulties and problems unique to women's lives will be scientifically and socially eliminated. In the era of 100 years of life, life events will be concentrated in the first half of the century, and women will no longer be forced to make decisions of choice. In addition, even if they change their mind about the decision they made at that time, they will be able to "take it back," which will lead to a wider range of life for the people concerned. Transcending "sex" as defined by sex chromosomes will also bring gospel to sexual minorities.

・Cities, regions, and towns will be built across the country from the perspective of "national wellbeing. It is a social system that is sustainable and allows people to interact and create communities naturally. Residents will be able to connect with their neighbors in a way that suits their individuality. It will be a society in which the mechanisms that trigger these connections are implemented everywhere, and in which the people have enough time to participate in them. In addition, people's innate needs (social needs, biological needs, self-actualization, etc.) will be satisfied.

・The sense of anxiety, burden, and loneliness regarding childbirth and childcare will be greatly reduced. At the same time, social systems and technologies are implemented that allow both parents and children to obtain adequate oversight and support. Environments and technologies (perhaps utilizing AI, IoT, data science, etc.) that make it easy to obtain support as needed are in place. Through these systems, the government, NPOs, and public institutions themselves (child guidance centers, etc.) are able to understand the social and economic status as well as the status of parents and children, and provide more effective and efficient administrative support without leaks.

・In a society where the responsibility for the upbringing of a child does not fall solely on the genetically related parents, there is no room for unhealthy upbringing in closed rooms. Parents are human beings, and of course they are not perfect. They may have illnesses and other problems. In addition to strengthening support for such cases, we need to develop human rights-conscious behavior change techniques for parents who are dependent or unable to control their emotions. If we can achieve these goals, the cycle of poverty and abuse will be stopped and the number of crimes will be reduced. We can also expect to give back to society by working hard. The administrative and social burdens placed on these problems will be reduced, and society as a whole will be stabilized.

・Well-being is also known to be correlated with productivity and creativity. A society in which everyone can feel secure in their desire to have and raise children is a well-being society in which people are optimistic and feel that they can "make it work," and a society in which productivity and creativity are high.

・In order to achieve the society described in this moonshot, the science and technology to be introduced into society, its contents and effects must be understood by society in general. In other words, the relationship between science and technology and society has become a social structure where the understanding of society has increased.

II. Analysis

1. Essential scientific/social components

1.1. Vision① Issues for “Anyone can have a genetically related child at any time if they wish.”

The treatment of infertility-related diseases is still a challenging task. In the first place, there is still much that is unknown about the human development and growth process. Therefore, there is a lot of variation in the effectiveness of treatment in clinics, which is one of the reasons why infertility patients are troubled. When a rescue treatment, such as a third party (sperm donor or surrogate mother) is involved, many ethical and social issues arise. Bioethical and regulatory considerations must also be taken into account, such as those related to the identity of the unborn child (the right to know one's origins). The surrogate mother business is rampant in developing countries. The dignity of women is being lost, and it is essential to consider this issue within an international framework.

1.2. Vision ② Issues for “We can look forward to our children with hope, and all parents and children can grow up healthy and safe.”

1.2.1 About causal loop diagrams

First, I will briefly explain the causal loop diagram used in the analysis of social systems, and the systems thinking on which it is based. Systems thinking is a conceptual framework for uncovering overall patterns of change and finding ways to change them effectively by capturing the interconnections and invisible structures among the elements of a system[27]. The causal loop diagram (CLD) is a tool used in systems thinking to decompose a system into variables, analyze the causal relationships among the variables, and visualize the results. In CLD, the structure of the system is explicitly derived by connecting variables with arrows[28].

In a system where multiple elements are intricately intertwined, it is difficult to see the overall picture and the impact of individual interventions on the whole when communication only cuts to one aspect. On the other hand, it is difficult to find concrete and effective intervention points and measures by simply discussing at a high level of abstraction. Systems thinking and causal loop diagrams are effective analytical methods for considering intervention points and methods while grasping the overall picture when improving a system in which multiple elements are intricately intertwined, and they have already produced results in many cases of social change[29]. It is also expected to be further utilized

in science and technology communication[30].

Therefore, this study will use a causal loop diagram based on systems thinking as a tool for analysis and depiction of the results to highlight the social structure related to "childbearing and childrearing," organize the issues facing Japanese society, and examine the points of intervention and the direction of future research themes.

The basic description rules of a causal loop diagram are shown in Fig. II-1

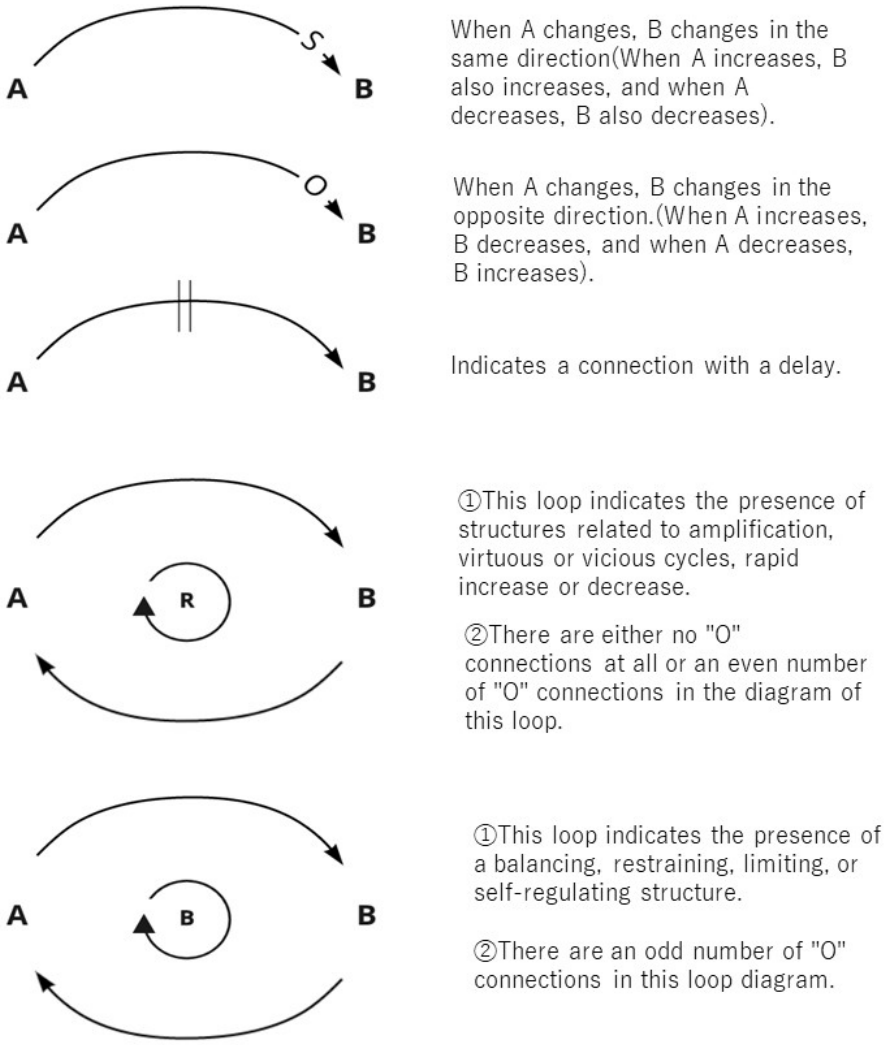


Fig. II-1 Basic description rules for causal loop diagrams [14]

Source:Modified from David Peter Stroud, "A Practical Guide to Systems Thinking for Social Change" (2018).

1.2.1 Overview of the social structure analyzed in this study

As a result of six months of research and analysis, the team has developed the following picture of the social structure surrounding child-rearing in Japan.

The right hand side shows the social structure of couples/partners of the right age, and the right hand side shows the social structure of poor families and their supporters. The right hand side shows the social structure surrounding poor families and their supporters. The details will be discussed in turn, but it is obvious that the two structures, while separate from each other, are closely related and linked. (Fig. II-2)。

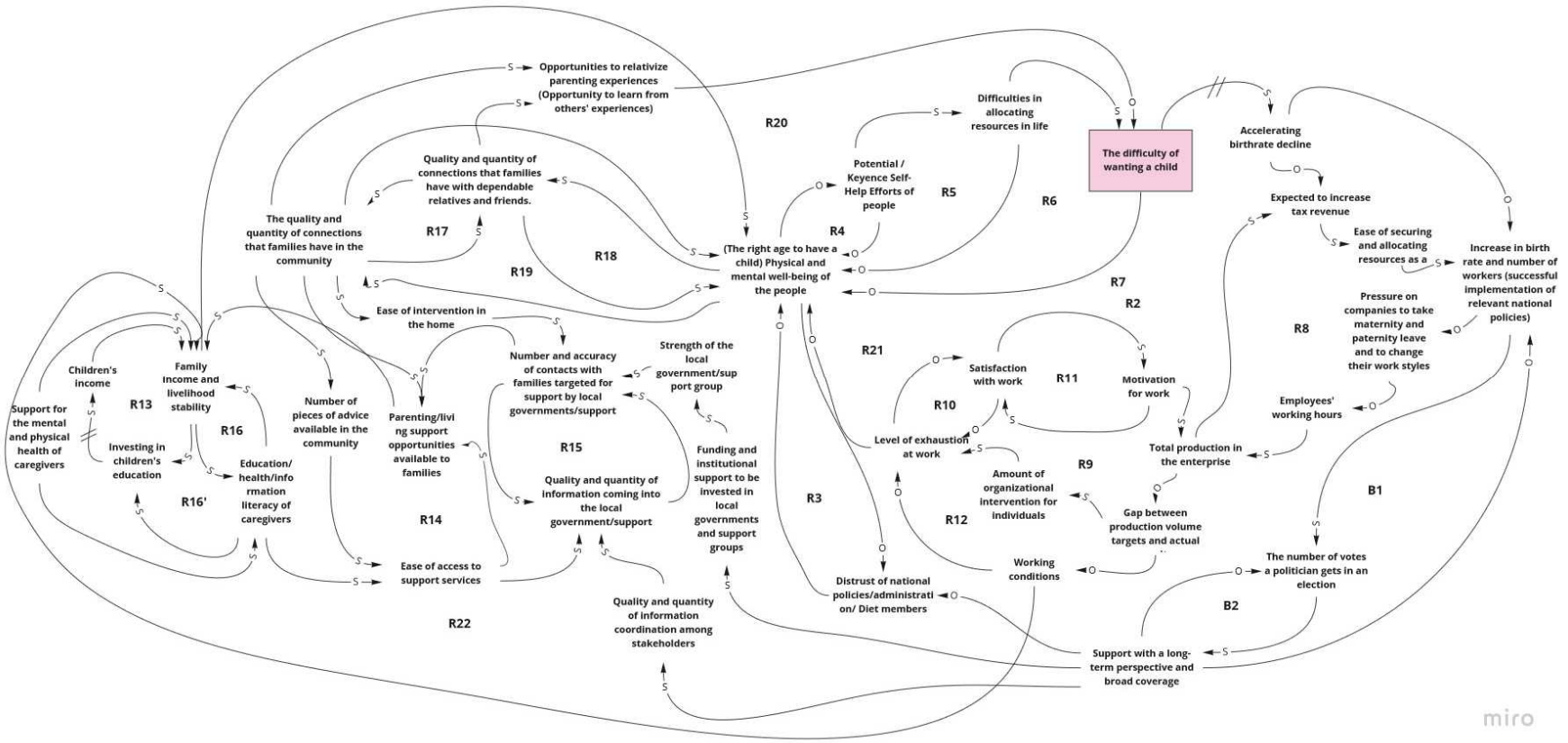


Fig. II-2 A cause-and-effect loop diagram showing the social structure that makes it increasingly difficult for people to have children as an inherent desire, as they lose their sense of marginality (amplifying their sense of anxiety and loneliness). (Provided by: General Incorporated Association Tamani)

In particular, the team found that a particularly significant factor in the context of this period was "the physical and mental well-being of the population (of the appropriate age) (Fig. II-2 center). This can also be expressed as a self-reinforcing loop of "anxiety" and "loneliness (Fig. II-3）. And, that is accelerating as a result of a variety of factors.

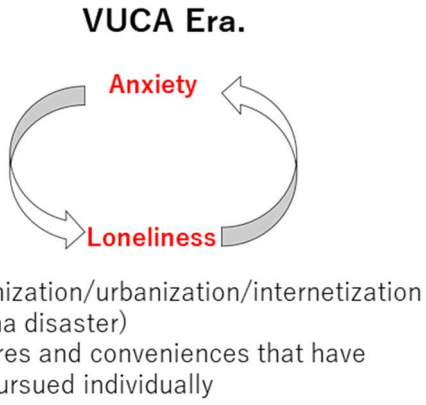


Fig. II-3 Self-reinforcing loops of loneliness and anxiety

For example, against the backdrop of modernization/urbanization/internetization/corona disaster, individually pursued pleasures and conveniences have accelerated isolation and loneliness. This reduces the opportunity to relativize the self and increases "anxiety". In addition, we are in the so-called VUCA era with the acceleration of the new acceleration of technology (VUCA is an acronym for Volatility, Uncertainty, Complexity, and Ambiguity. These four elements are intertwined in a multilayered manner in today's social environment, causing people more anxiety and stress than they can imagine. In order to relieve this anxiety, we consume time and money for short-term gains and to improve our abilities, which further deepens our isolation and loneliness, creating a vicious cycle.

For example, in terms of the employment environment, lifelong employment is collapsing, and non-regular employment is increasing. We live in a social environment where each individual must assume that if they do not improve their performance or acquire skills, they have no future. We live in a compulsive age where we are "driven" to do something, which leaves us with little time or mental space.（Fig. II-2 R9-12)

In terms of the child-rearing environment, kinship networks are collapsing, and regional and neighborhood networks are also becoming more fragile. Anthropologically speaking, humans have not evolved to be able to raise children alone or in nuclear families. In such a situation, it is unnatural to raise children in isolation, and it is natural to feel strong anxiety. In addition, in this age of uncertainty, we are inundated with information and have no opportunity to learn from other people's experiences in child rearing, so it is easy to assume that there is a right answer to child rearing.（R17-20)

Furthermore, while the promotion of "solitude for each person" has encouraged a free way of life, it has also instilled a sense of self-responsibility if something goes wrong. There is also a culture of shame in Japan, and an atmosphere of not being able to say, "Help me," even when backed into a corner is prevalent in the world. Furthermore, the corona disaster has

increasingly eliminated opportunities for accidental encounters and interventions, making it impossible to detect signs of a crisis situation. In terms of technology, the development of ICT technology makes it easy to form "connection-like" things with people. However, we believe that we are no longer able to build trustworthy human relationships.

Based on the above understanding of the overall picture, the results of the analysis will be explained in detail in the following sections.

1.2.2 Basic social structure of couples/partners of appropriate age

Fig. II-4 is a right side part of Fig. II-2. This is a causal loop diagram depicting the basic social structure of men and women of the appropriate age for childbearing and childrearing in Japan from two perspectives: ideal and reality.

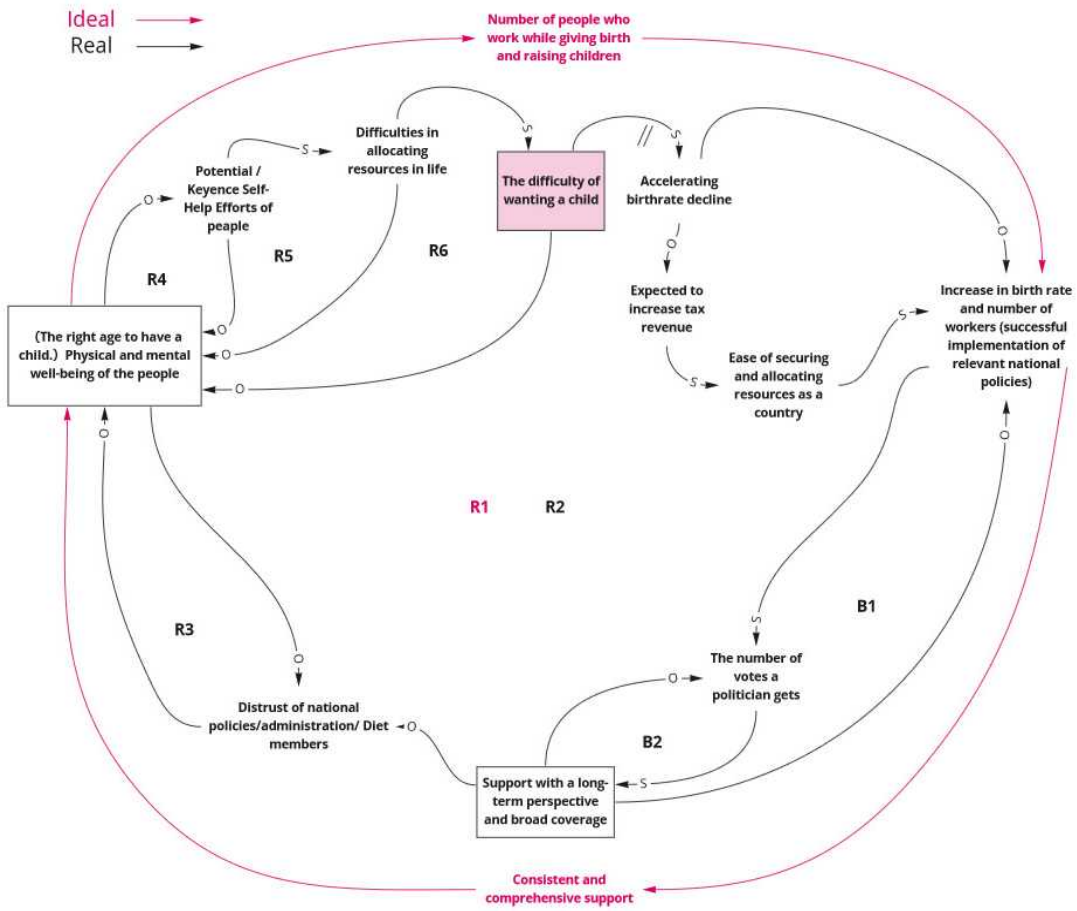


Fig. II-4 Basic social structure of couples/partners of appropriate age (causal loop diagram) (Provided by: General Incorporated Association Tamani)

The cycle indicated by the red arrows (R1) shows the ideal cycle that the country and its people originally aim for each other.

The country wants to increase the birth rate and the number of workers, and achieving both of them indicates the success of the related measures. If such measures are able to provide consistent and comprehensive support to the public, the public will be able to gain physical and mental well-being, which in turn will increase the number of people working alongside childbirth and childcare, and the success of these measures as a national policy will enable further support. This self-reinforcing feedback loop is the ideal story that both sides are aiming for.

However, reality doesn't always go according to the ideal. R2 represents the story of reality that circulates between the country and its people. Contrary to the ideal, the structure of the system prototype is that of an "unexpected adversary," where the short-term self-help efforts of the country and its people result in interfering with each other's long-term success. This system archetype is a story that shows how two parties, as a result of their respective efforts, can unintentionally fall into a structure that sabotages each other's success.[31]

The government tries to develop a variety of measures to increase both the birth rate and the number of workers, but in the short term, it is difficult to come up with long-term and essentially effective measures because they have to be driven by politicians' election strategies. This is because the current demographics of Japan make it difficult for politicians to set policy goals that are not relevant to the generation that gives birth to and raises children, such as fighting for policies for the elderly in their manifestos, in other words, to win votes. The measures that will be realized as a result are perceived by the public as such, both internationally and by the public, as they lack long-term vision and broad coverage[32]. With such limited support measures, many people are worried not only about raising their children but also about their own future, which naturally erodes the "mental and physical well-being of the people. At the same time, the lack of marginality and low level of satisfaction with life makes people more likely to be dissatisfied with the government and politics (R3).

As a result, people are forced to rely on "self-help," and money and time for other things become tight (e.g., caregivers who think that public schooling will not make their children happy send their children to cram schools, send them to private schools from an early age, save money to finance their own children, etc.). This is the case for many people. In this way, having a child becomes a life event with a very high cost.

In addition, the difficulty of people's self-help efforts and resource allocation in their daily lives, as well as the situation that forces people to view having children as difficult, all form a self-reinforcing loop that erodes people's physical and mental well-being (R4, R5, R6). This

multi-layered and overlapping vicious cycle (negative self-reinforcing loop) ultimately makes it difficult for the public to desire to have children themselves[33]. As a result, the birthrate is declining at an accelerating pace, which can be seen as the current situation in Japan. As a result, the prospects for increased tax revenue will decrease. At the same time, the national burden ratio will increase, and people will have even less hope for the country[34]. In the long run, the budget for effective measures for this generation will be further reduced. Politicians will be less likely to focus on the child-rearing generation as a way to win elections.

What this self-reinforcing loop shows is the story of a vicious circle in which, as mentioned earlier, the self-help, well-meaning actions of each country and its people ultimately hinder the success of the entire system. We need to update the entire system with effective interventions in this structure as early as possible in the future, up to the year 2050. This study considers not the "acceleration of declining birthrates" per se, but the "difficulty of wanting children" as the key variable for solving the problem, and examines what kind of research can reverse the trend to a "society where everyone who wants to can have children and raise them with dreams and hopes for the future.

1.2.3 Brake structure of measures to reduce the birthrate by increasing the number of workers (employment rate)

Fig. II-5 shows the pattern of the impact on employees of the measures taken by the government to increase the number of workers (the employment rate) and the response of companies to these measures.

What these loops show is a structure and mechanism that makes it even more difficult for people of the right age to feel comfortable and, in turn, to desire children, and the reality of Japanese society that it is only negatively turning a cycle that has room to turn positively.

The large loop around the periphery (R7) shows how the government's intention to maintain and improve the labor force, including women who are raising children, does not necessarily benefit the public, but instead contributes to the declining birthrate. In order to increase both the birth rate and the number of workers, the government is forcing companies to provide maternity leave to their employees (especially to male employees these days), and is forcing (legal system) and pressuring (numerical targets) companies to shorten working hours. This will reduce the apparent working hours of employees. However, on the other hand, productivity does not increase so easily, and as a result, the total output of the company tends to decrease. According to a survey of 277 companies[35], Only 16% of all companies have started

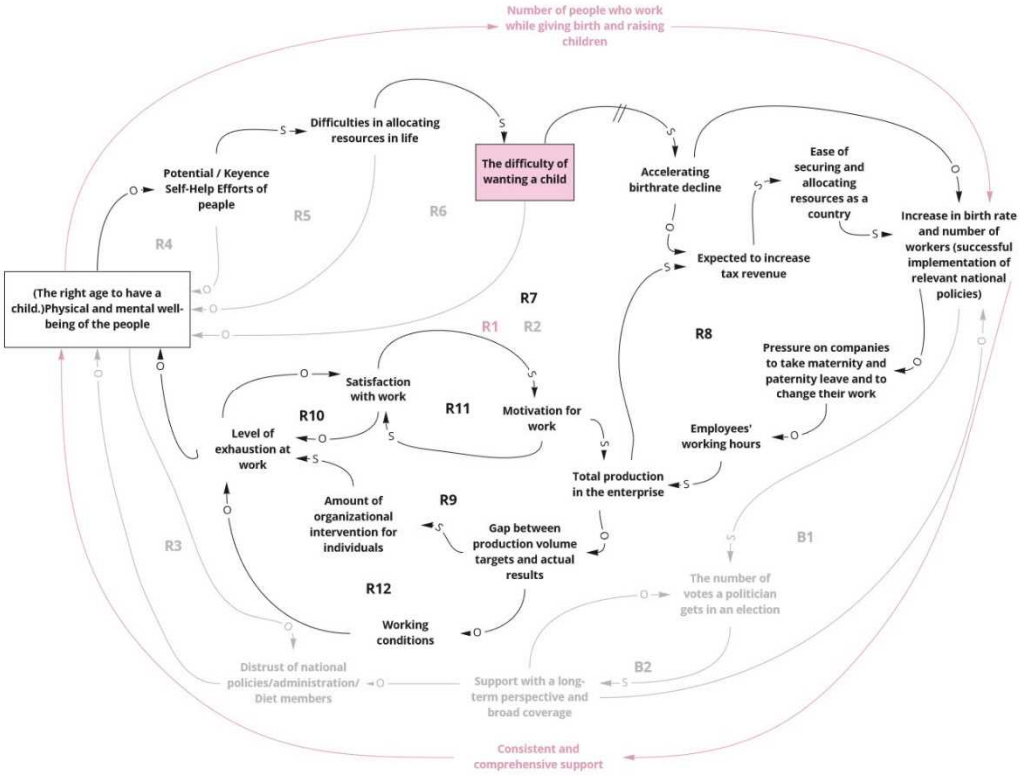


Fig. II-5 A social structure in which measures to increase the employment rate lead to a loss of physical and mental well-being, accelerating the decline in the birthrate (causal loop diagram) (Provided by: General Incorporated Association Tamani)

to improve the efficiency of existing operations through a series of work style reforms. In other words, in most companies, the reduction in employee working hours is directly related to the decline in total corporate productivity. （Many companies cite a "shortage of staff" as an issue that has arisen as a result of the work style reform.[36]）

One of the most important keys to whether this loop (R7) will fall into a negative reinforcing loop or settle into a stable balanced loop is, as is obvious to all, "productivity. Companies and organizations that succeed in increasing productivity do not lose productivity even if their employees' working hours are reduced; on the contrary, they can also motivate their employees, resulting in the creation of a virtuous cycle. However, the percentage of such companies is only 16% of the total, based on the aforementioned survey. As seen in Fig. II-5, In most companies, the working hours of employees directly and positively affect the total productivity in the company. As a result, the company is unable to maintain its production volume at the same human cost as before.

Although this is a slight departure from the main purpose of this analysis, as an incidental result of the analysis, it is possible to conclude that the government should have promoted

measures to improve productivity before putting a cap on "working hours," which is the "result" of the work style reform. Reducing working hours is only a goal and an outcome, and it is clear from the structure that the key drive to reduce working hours is to increase productivity. In addition, when considering the productivity of society as a whole, it is important to keep in mind that, at the same time as considering productivity within companies, we should also seek productivity in government and administration as well. It is not only general companies that need to improve their productivity. Time loss and low productivity in the operation of government parliaments and administrations can be a life-threatening issue for the people, as they hold the key to the formulation and operation of institutional policies. It is important to point out that those who are involved in this process have a great responsibility to create measures that will increase the productivity of society as a whole in a productive manner, although this is self-evident. (It is outside the scope of this research, but when considering what kind of society Japan will have in 2050, the design of institutional policies and the development of social/organizational designs and technologies to make these processes productive and conducive to the wellbeing of the people will be an area of great demand.

After "total output in the firm" in R7, it is as follows.

When the total production volume in a company falls, the gap between the target (or forecast) and actual production volume (sales) in the company becomes larger. As a result, the company will have to intervene in the field to provide guidance, etc., and working conditions will deteriorate. Contracts are often switched from full-time to part-time, and personnel are often downsized. While some teams and individuals who are able to produce results may not face any problems, those who are not are under severe pressure. （How companies communicate with them is again key, and the details of this individual loop (R9, R10, R11, and R12) will be presented later.） And a work-weary populace will find it harder to afford, which at the same time will lead to an increase in the number of poor families. This reinforces the story of the "unexpected adversary" described in R2.

Next, we will discuss the R8-12.

R8 shows a mechanism that makes it difficult for a government to formulate policies from a long-term and comprehensive perspective, because a simple reduction in working hours without an increase in productivity is expected to result in a decrease in tax revenue. Actual tax revenue is affected by a variety of other factors, so productivity is not simply directly related to tax revenue, but it is important to keep in mind that these basic dynamics are at work as a base in the system.

R9 indicates the existence of a self-reinforcing loop due to the gap between total production

Table II-1Target of questionnaire on childbearing and trust in the government

Gender/No children/ Yes	n	%
Female: No children	225	25.0%
Female: With child	225	25.0%
Male: No children	225	25.0%
Male: With child	225	25.0%
Others	0	0.0%
Sum	1100	100.0%

Average age
35.26 years

Not married/married	n	%
Not married (including separation and bereavement)	436	39.6%
Married	664	60.4%
Sum	1100	100.0%

Administrative divisions of Japan	n	%
Saitama	224	20.4%
Chiba	189	17.2%
Tokyo	431	39.2%
Kanagawa	256	23.3%
Sum	1100	100.0%

and productivity targets and actual performance in the company, the amount of organizational intervention for individuals, and job satisfaction and motivation. Work exhaustion, satisfaction, and motivation form a self-reinforcing loop with each other[37,38] (R10, R11) . Hence, each company needs to turn these loops in a positive direction by increasing productivity to achieve its production targets and above. Alternatively, organizations need to convert R12 into a balanced model by intervening with individuals in a way that reduces individual exhaustion.

In fact, as mentioned above, from an international perspective, countries with generous support for childbirth and childcare, such as France and Sweden, tend to have higher rates of women in the workforce. In Japan, some companies are making positive changes to reduce working hours while increasing employee satisfaction and motivation, which in turn increases productivity. However, such companies account for less than 20% of all companies. In the remaining 80% or so of companies, these self-reinforcing loops create a vicious cycle, with structures and mechanisms that easily exhaust individual employees.

1.2.4 Questionnaire survey of 1,100 men and women of childbearing and childrearing age in Tokyo and three prefectures

In this study, in addition to previous research and social surveys, we conducted a survey of 1,100 people aged 20-44 (excluding males and females/students) living in Tokyo and the three prefectures in order to investigate some of the points that previous research and social surveys have failed to provide clues about the relationship between the variables and the actual psychology of the people as described in this section, The survey was conducted on 1,100 people aged 20-44 (male and female, excluding students) living in Tokyo and three prefectures.

①Attributes of the survey targets

The attributes of the survey targets are shown in **エラー! 参照元が見つかりません。** and Fig. II-6.

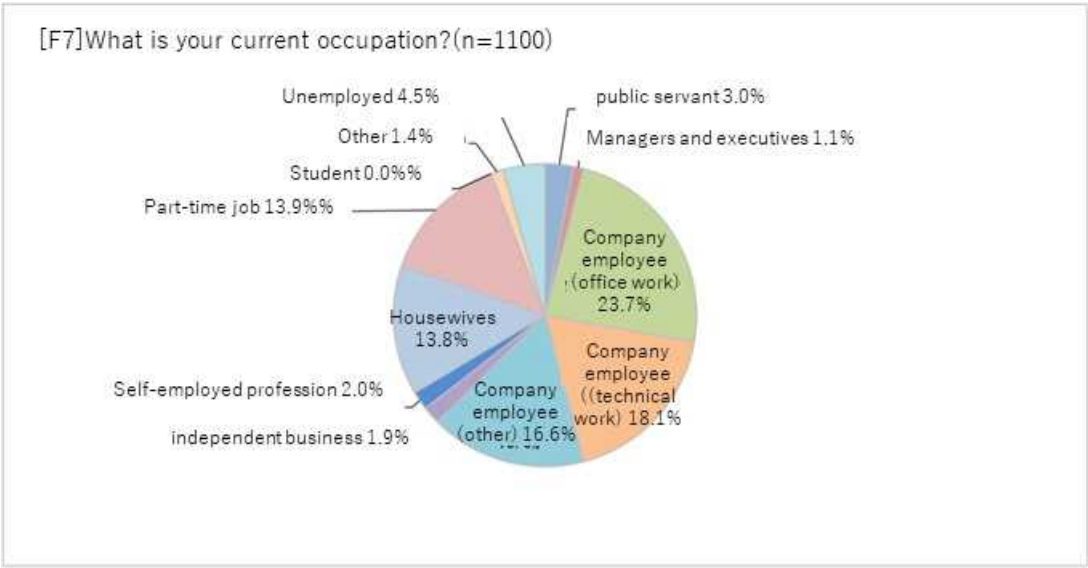


Fig. II-6 Subject's occupation (n=1,100)

The annual household income is also shown in Fig. II-7. The data provided by the government is mostly secondary data, and it was not possible to calculate the distribution of annual income in Tokyo and the three prefectures in this survey, but according to a private survey, the average annual income in Kanto is 4.29 million yen[39]. The high range of annual income in this sample is probably due to the fact that there was a relatively large sample from Tokyo, a city with high annual income.

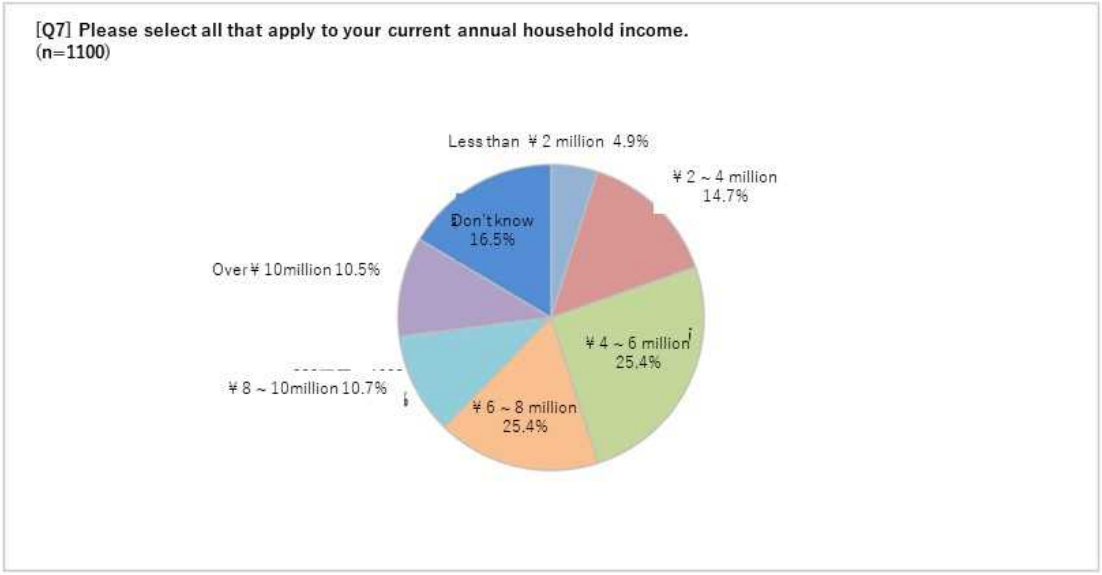


Fig. II-7 7Annual household income of the subject (n=1,100)

②Survey results and their analysis

Fig. II-8 shows the responses of the previous survey participants to the question "How many children are you currently hoping to have? Figure II 8 shows the responses of the previous survey participants to the question "How many children do you currently wish to have? A little less than 40% of the respondents, both those who have children and those who do not have children, want to have two children, while 23.3% of the respondents do not want children.

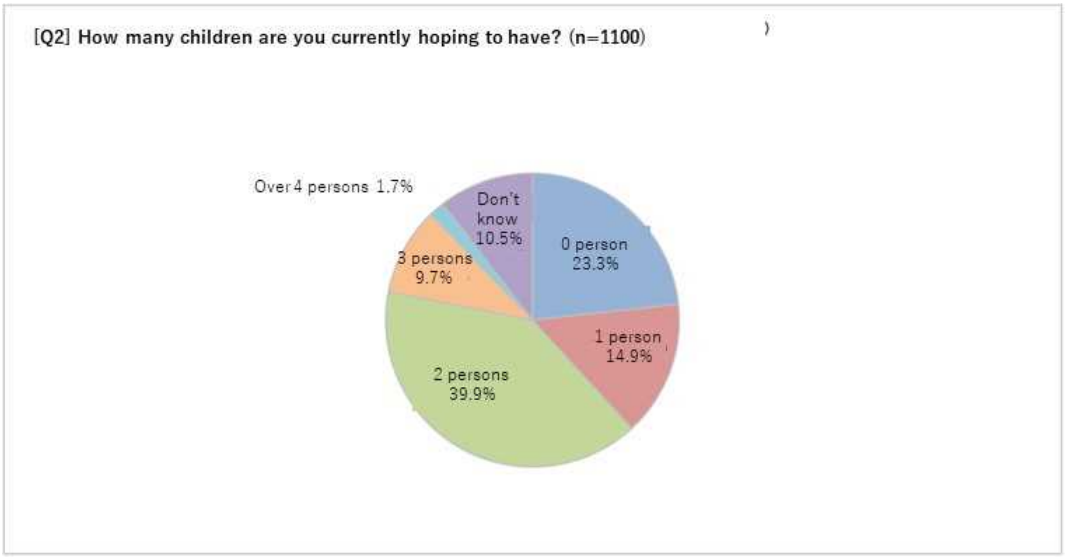


Fig. II-8 Number of desired children (n=1,100)

Fig. II-9 shows the responses of 225 men and women with children (550 respondents in total) to the question "How many children do you currently have? Fig. II-10 indicates the number of children a married person wishes to have. Although this includes cases where people want to (and are able to) have and raise children in the future, the fact that the total fertility rate is 1.36 (2019) shows that there is a gap between the actual number of children and the desired number of children.

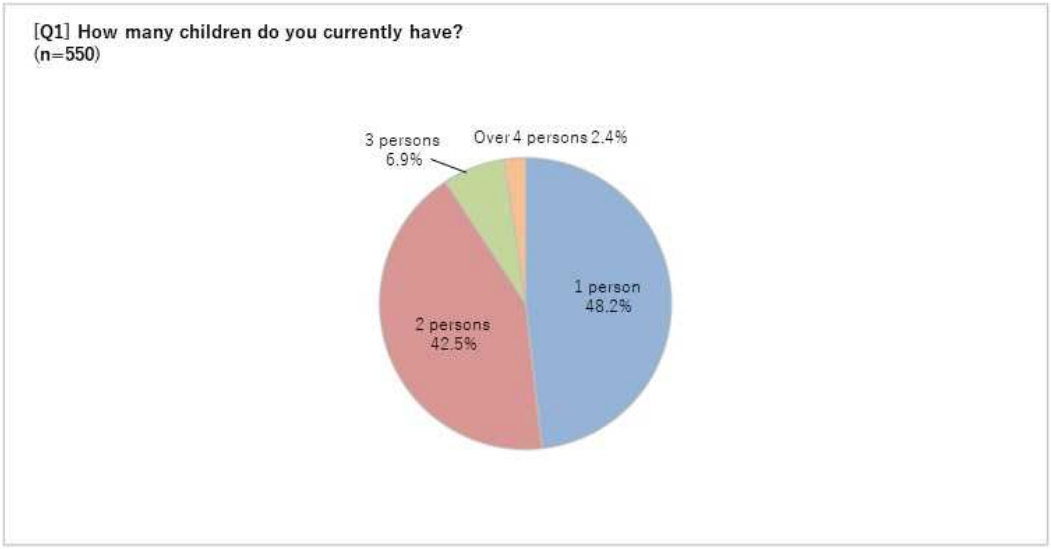


Fig. II-9 Current number of children (n=550)

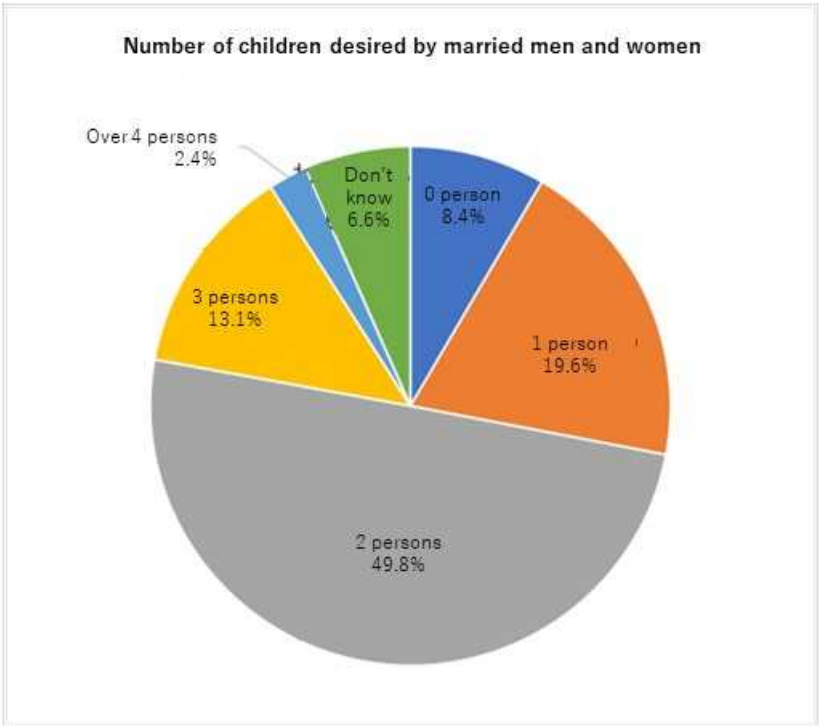


Fig. II-10 Number of children desired by married men and women (n=664)

Fig. II-11 is the response to the question, "If you were to have one more child than you currently want, what do you think you would need? This is the answer to the question, "If you were to raise one more child than you currently want, what do you think you would need? More income is the most desperately needed by 77.1% of the respondents, and they are also worried about their health and physical strength (50.1%), balancing work and family (37.5%), finding time to have and raise children (35.7%), and not having a network to turn to in times of need (29.5%).

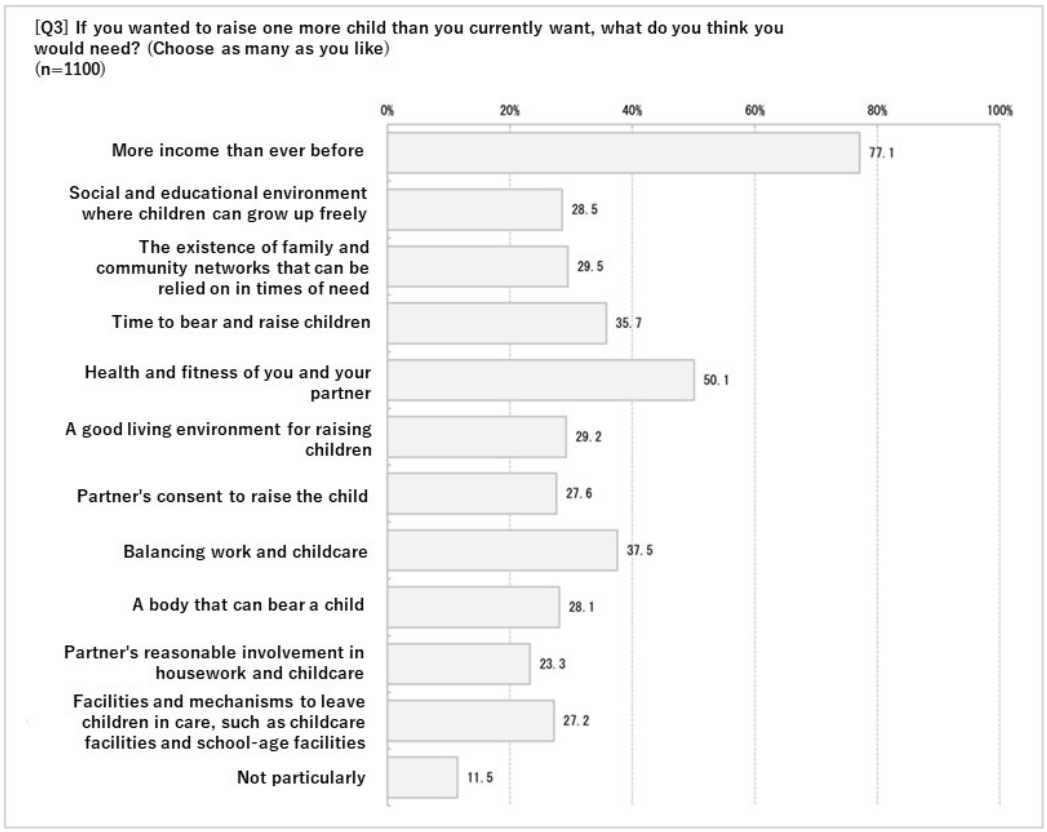


Fig. II-11 What you need to do if you want to have and raise one more child. (n=1,100)

On the other hand, when asked, "What do you currently do or plan to do that is necessary to have and raise children? On the other hand, "What do you currently do or plan to do to have and raise a child?" was the top answer at 45.4% (Fig. II-12). In Fig. II-11, Considering the fact that 77.1% of the respondents need more income, we can see that there are those who want to increase their income but cannot find a way to make a concrete effort to do so, and those who are resigned to the fact that they will never reach an amount of income that they consider sufficient to have and raise children. Compared to Fig. II-11, the items with the largest gaps were "formation of family and community networks that can be relied on in times of emergency" and "development of a work environment that allows for both child rearing and work.

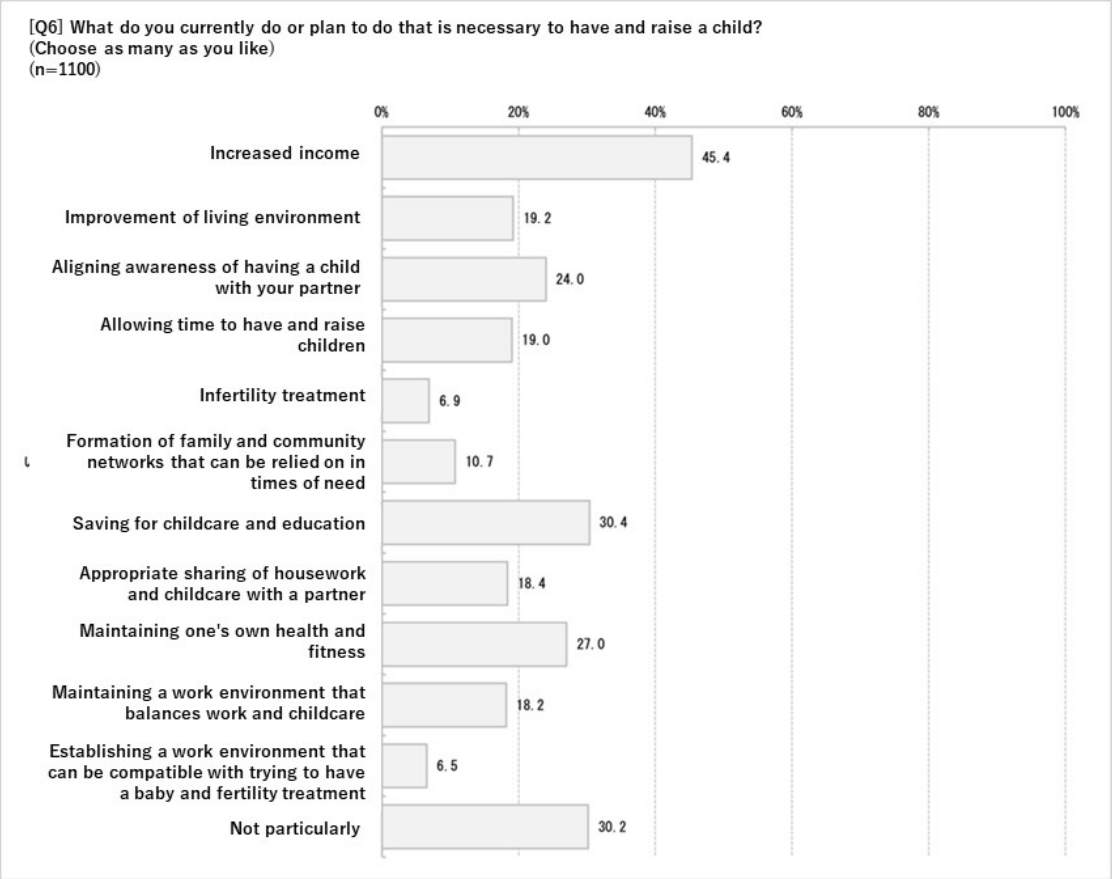


Fig. II-12 What you do to have and raise your children. (n=1,100)

In response to the question, "What do you want the government to do to help you raise your children? In response to the question, "What do you want the government to do to help you raise your children?", the following responses stood out: "Elimination of income disparity through taxation and various allowances" (52.7%), "Greater subsidies for expenses related to childbirth, childcare, and infertility treatment" (51.2%), "Facilities and systems where children can be left, such as day-care facilities and school-age facilities" (47.2%), and "Social and educational environments where children can grow up freely" (46.3%). On the other hand, "strong intervention by companies and organizations to encourage employees to take maternity and childcare leave" (35.2%), "improvement of the working environment" (35.1%), and "creation of networks and systems that can be relied on in case of emergencies" (33.5%) were also common. (Fig. II-13)

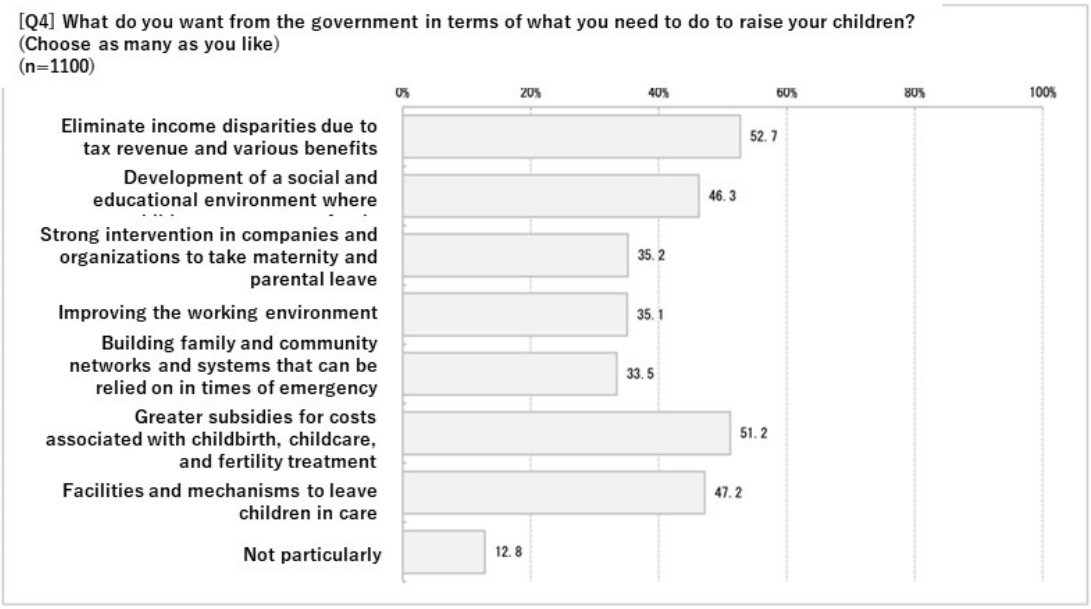


Fig. II-13 What you want from the government to help us have and raise children (n=1,100)

In Q5 shown in Fig. II-14, 959 respondents, excluding those who answered "not particularly" in Q4 shown in Fig. II-13, were asked to indicate how much they trusted the government's support measures for the selected items and the families considering them. The total of "I trust them" and "I trust them fairly well" was 16.7%, which is very low.

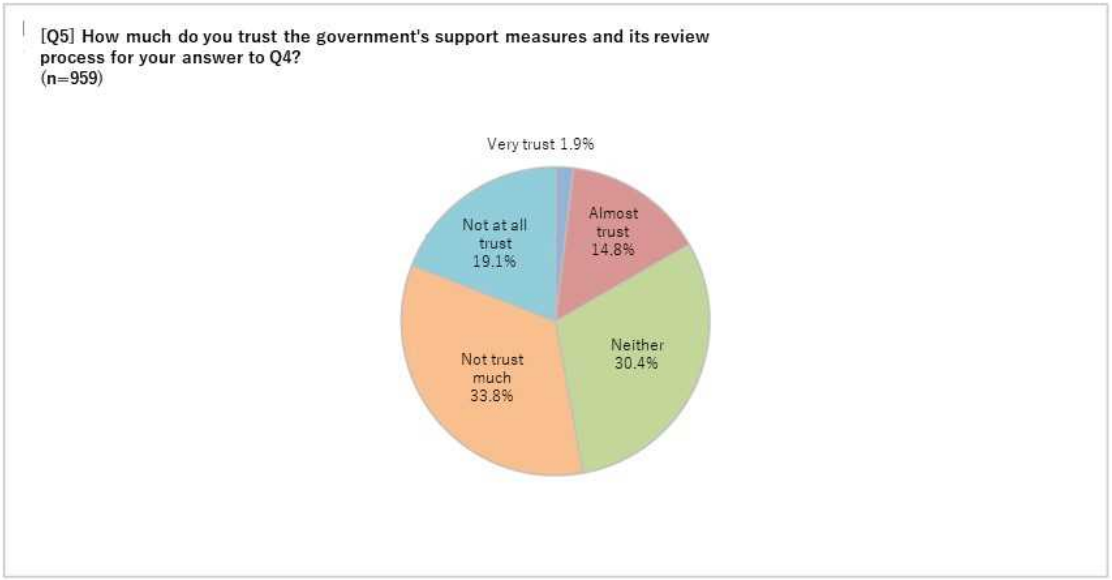


Fig. II-14 How much do you trust the government's support measures for having and raising children? (n=959)

We will look at the responses to the same questions as in Fig. II-14, broken down by segment. Fig. II-15 shows a graph of the responses to Q4, segmented by whether or not the child has a preference. Although these figures are very low, with less than 20% of respondents saying they trust the government's support measures for childbirth and child care and the process of considering such measures, it is clear that men and women who wish to have children have more trust in the government's support measures for childbirth and child care and the process of considering such measures. In other words, trust in the government's support measures for childbirth and childcare, as well as in the process of considering such measures, has a significant impact on whether or not a person wishes to have children. More over As seen in Fi. II-16, Those who actually have children clearly have a higher level of trust in the government's childbirth and childcare support measures and review process. Again, this suggests that trust in the government's childbirth and childrearing support measures and review process has a strong influence.

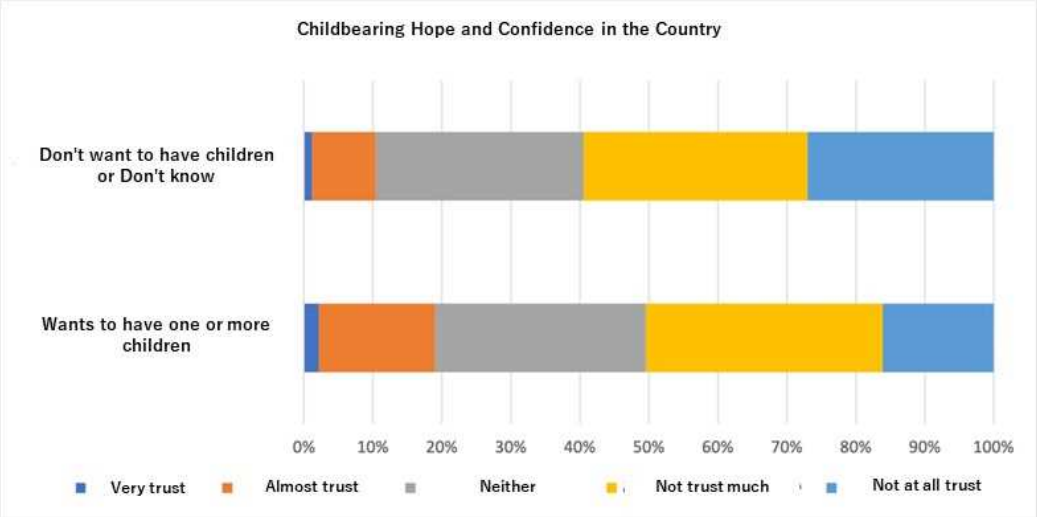
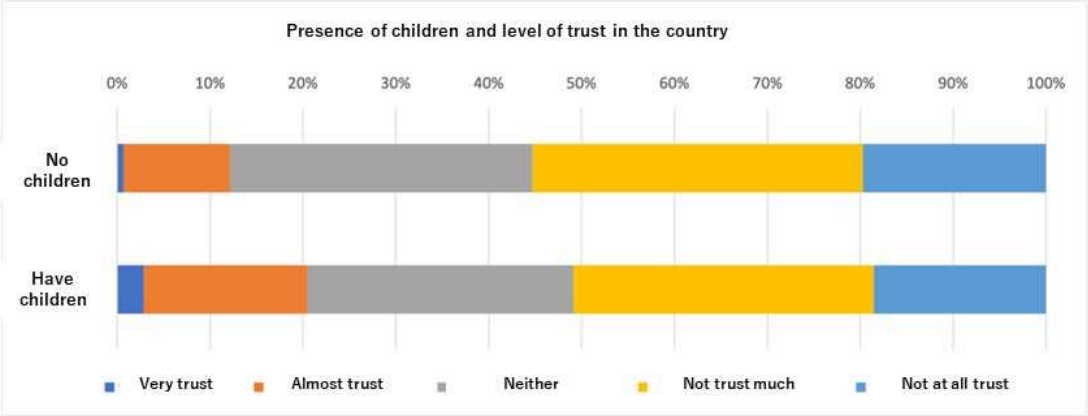


Fig. II-15 Desire for children and trust in national childbirth and childrearing policies (n=959)



Fi. II-16 Presence of children and level of trust in national childbirth and childrearing policies (n=959)

In addition, we will consider segments by gender and by whether or not they have children.（Fig. II-17）。Relatively speaking, men and women who "have children" have a higher level of trust than those who "do not have children. On the other hand, it should be noted that the level of trust among women, who are thought to actually bear much of the burden of raising children, is clearly lower.

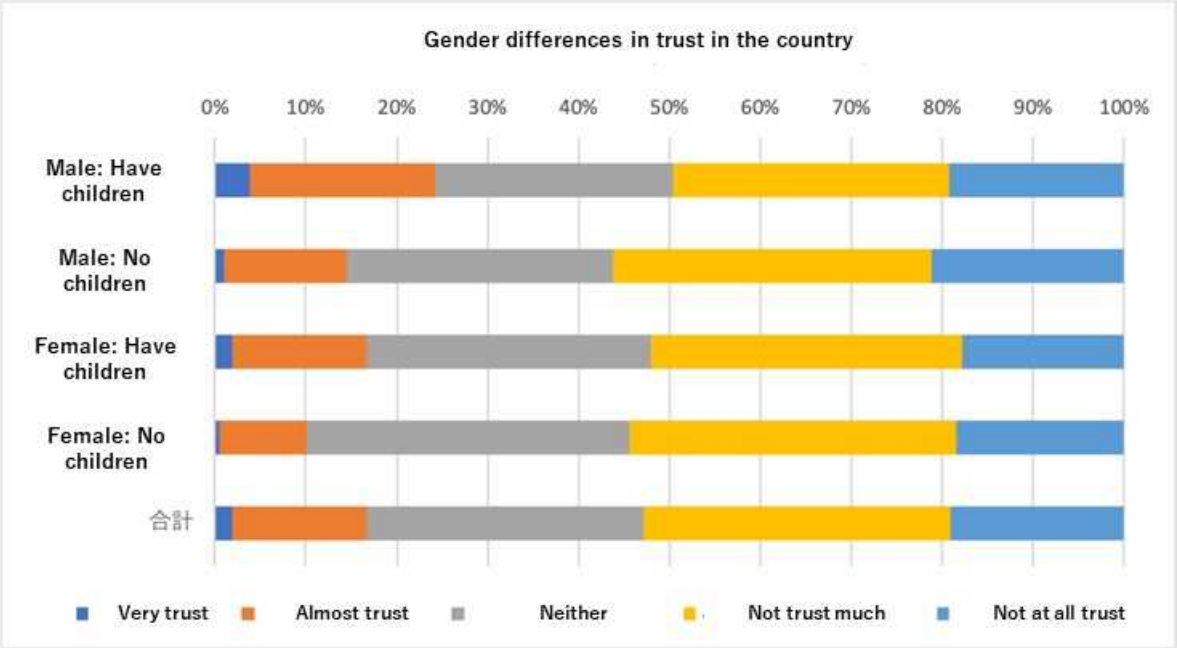


Fig. II-17Level of trust in the government for childbirth and childrearing support by target (n=959)

Fig. II-18 shows the responses to the question, "Do you have parents, relatives, friends, etc.

within easy reach that you can rely on when having and raising children? Figure II 18 shows the responses to the question, "Do you have parents, relatives, friends, etc. within easy reach that you can rely on when having and raising children? Fig. II-19 shows a graph of the number of children among respondents who have children and their responses to the same question.

One interesting finding was that although there was no effect of parental presence on the number of children, the more children there were, the more they relied on their "friends".

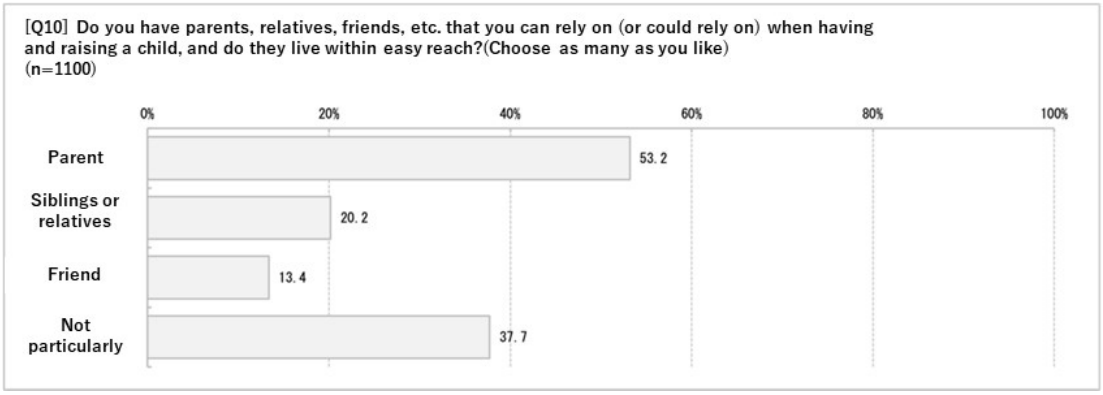


Fig. II-18 Existence and type of dependable person who is within easy reach (n=1,100)

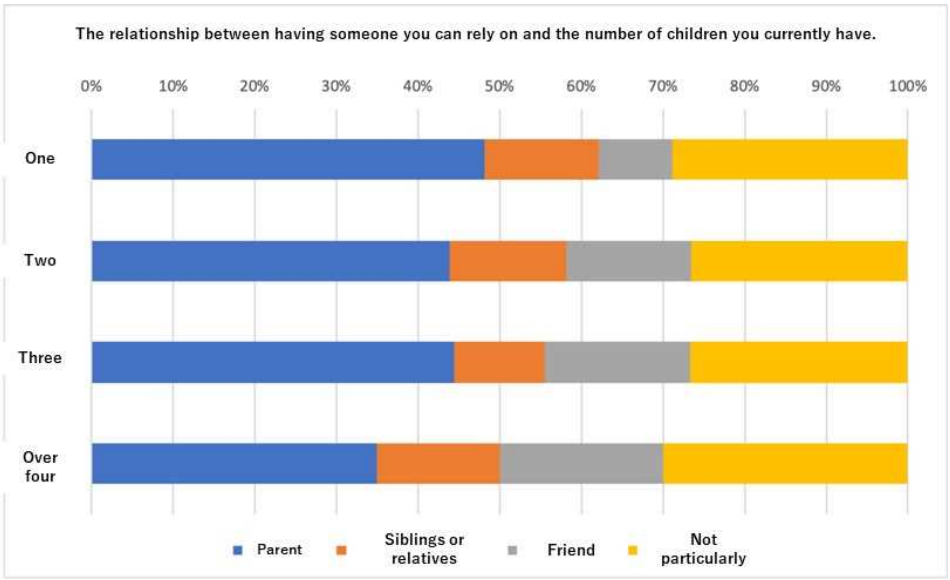


Fig. II-19The relationship between the number of children and having someone you can rely on within easy reach (n=550)

③Summary of Analysis Results

From this survey of 1,100 respondents, the following points were revealed as trends.

1. Most people want to have about two children (while the total fertility rate is 1.36).
2. As for the factors needed to have and raise a child, "more income" (77.1%) was the most desperately needed, followed by health and physical fitness (50.1%), balancing work (37.5%), time to have and raise a child (35.7%), and a network to rely on in case of emergency (29.5%).
3. When asked what they would like the government to do to help them have and raise their children, the most common responses were "Eliminate income disparities through taxation and various allowances" (52.7%), "Greater subsidies for expenses related to childbirth, childcare, and infertility treatment" (51.2%), "Facilities and systems for leaving children at home, such as childcare facilities and school facilities" (47.2%), and "Social and educational environments where children can grow up freely" (46.3%). On the other hand, "strong intervention by companies and organizations to encourage employees to take maternity and childcare leave" (35.2%), "improvement of the working environment" (35.1%), and "creation of networks and systems that can be relied on in case of emergencies" (33.5%) were also common.
4. 4. Although the presence of parents had no effect on the number of children, the more children there were, the more they relied on their "friends".
5. Men and women who want children actually have generally low trust in the national childbirth and childrearing support policies of the people, and in the process of considering them.
6. Among them, those who are relatively trustworthy tend to have hopes of having and raising children, and actually do so.

1.2.5 Social structure of poor families

Fig. II-20 shows each part of the social structure surrounding poor families.

R13 is a basic causal loop diagram in which family income and livelihood stability leads to increased income for children. If we can break this loop (chain), we can pave the way to save children from its negative impact even if their caregivers are poor.

During the period of high economic growth, fathers worked for stable companies (seniority-based, lifetime employment), mothers raised their children at home as housewives, and there were large families of three or four generations. Even in that era, there were probably a certain number of cases of poverty and abuse, but social welfare was able to cope with them. However, the so-called "lost 20 years" from the early 1990s to the bursting of the bubble economy saw a transformation of society, and from 2001 the Koizumi administration's policy of structural

reform without sanctuary led to a small government and neo-liberal economy, and the spread of a labor environment (non-regular labor) that was more convenient for business owners. Many middle class people have moved down to the lower class, and the society has changed into one of disparity between a few upper class people and many lower class people (the percentage of non-regular employment doubled from 19.1% in 1989 to 37.2% in 2020 according to data from the Ministry of Health, Labor and Welfare.

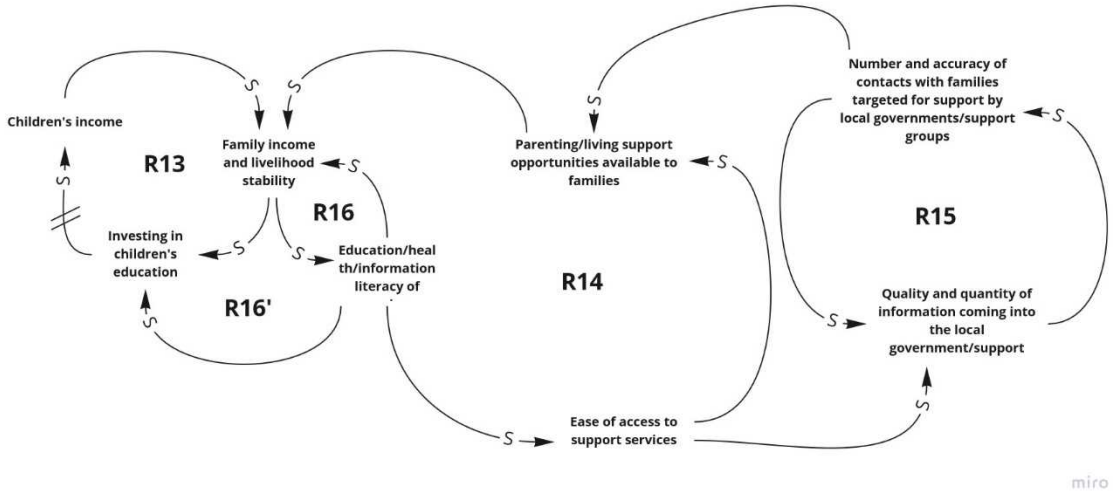


Fig. II-20 Causal loop diagram of the basic structure of reproduction in the economic situation of families and the social structure of support for poor families (Provided by: General Incorporated Association Tamani)

R14 and R15 are the support loops for R13.

Local governments and local NPOs have prepared various (whether sufficient or not) menus of support, but being prepared does not mean that the support will be delivered to those who need it. Furthermore, the poverty rate has remained high due to changes in the social structure, where economic growth has stagnated and accelerated into a society of inequality.[40] And the burden on the supporters to deal with the increasing abuse problem is also increasing.[41]

R14 indicates that in order for families to reach support, there is a need on the part of caregivers to access support services through a minimum level of literacy in education, health, information, etc., and the ability to make decisions based on the knowledge and information they learn and the time they devote (or can devote) to doing so (R14). These are the first hurdles in bringing access to support to families in need, as well as having a significant impact

on the quality and quantity of information coming into local governments and support groups (R15). If the quality and quantity of information coming to local governments and support groups can be increased, and horizontal cooperation among supporters can be promoted, it will be possible to increase the number of contacts with families who are eligible for support. This will make it easier to build a comprehensive support system (a social safety net) and, as a result, increase the number of families that can be saved.

Another key here is the aforementioned "education/health/information literacy of caregivers"; as shown in R14, this variable is a hurdle that cannot be cracked in order to achieve support. As shown in R14, this variable is a hurdle that must be overcome in order to achieve support, but it is also a factor that drives all actions toward family income and livelihood security (R16). It also has a significant impact on the mechanisms used to determine the appropriate (or necessary as a basis for) investment in education for children (R16').

1.2.6 A set of variables that affect multiple variables in the loop surrounding poor families

Variables that have a significant impact on these loops were identified and plotted through research and interviews (Fig. II-21）.

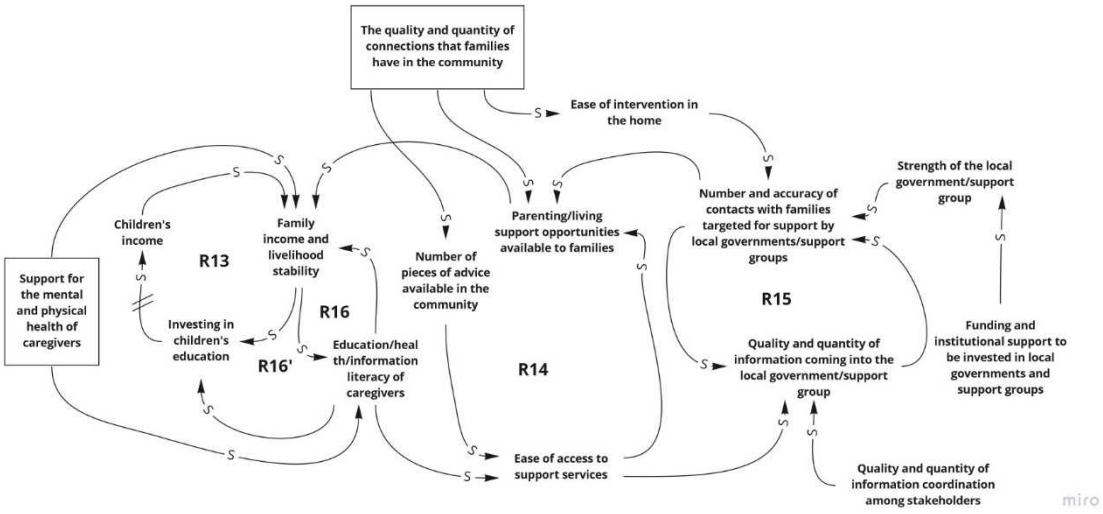


Fig. II-21 A set of variables that affect multiple variables in the loop surrounding poor families. (Provided by: General Incorporated Association Tamani)

Ultimately, it is "support for the mental and physical health of caregivers" and "the quality

and quantity of family connections in the community" that will have the greatest impact on "family income and livelihood security.

First, support for the mental and physical health of caregivers is a very important factor in preventing the reproduction of poverty[42,43,44]. As a background, caregivers who fall into extreme poverty or abuse their children often have (1) mental illness, (2) intellectual disabilities, (3) experiences of abuse and neglect by the caregivers themselves, and (4) other potentially traumatic experiences by the caregivers. Children from poor and abusive families become less educated due to the mental illness of their caregivers, poverty and abuse as children, mental illness of their parents, experiences such as rape, and bad working conditions, and this leads to a cycle of poverty. Therefore, if caregivers can be supported to get out of poverty and abuse, the poor education of children can be improved and the cycle of poverty can be prevented.

Giving appropriate support to these caregivers can have a significant secondary effect. Support for the mental and physical health of caregivers contributes to the stability of family income and livelihoods, and at the same time improves the educational, health, and information literacy of caregivers. Because these two variables are related to multiple other variables, the size of the support for the mental and physical health of caregivers has a large leverage and impact on the whole, but the current support for caregivers in poor families is very limited.

The "quality and quantity of household ties in the community" is another important variable mentioned in several literatures and interviews. We will look at the arrows extending from the "quality and quantity of household connections in the community" from right to left. In the actual field of supporting poor families, even if information about abuse is received, it is not easy to go into the home. One of the reasons for this is the difficulty in making individual judgments on how far to go into a case, as well as the judgment of the support group in terms of personal information, human rights protection, authority of the person in charge, and communication issues. This difficulty is exacerbated when the information that the local government or support group has is from a single or limited perspective. In order to make appropriate judgments and take appropriate actions, it is essential to create an environment where multifaceted information from multiple sources is available.

The arrow extending from "the quality and quantity of connections that families have in the community" to "the opportunities for parenting/living support that families can receive" refers to the support that families can receive directly from their neighbors. The type of support may be an object or a small call. The existence of such connections should not be overlooked in order to mitigate the negative impact of isolation and loneliness, which will be discussed later.

The "number of advice available in the community" was originally a variable that was part of the "opportunities for parenting/lifestyle support available to families," but it was isolated because it is directly related to the "ease of access to support services" that follows. In order to take some kind of action to deal with the problem, we need information that can be used as a concrete starting point. In order to get a concrete clue, the information will only work if it is as specific and scene-specific as possible, not general. It has long been known and research is accumulating that connections with neighbors have a dominant effect on health, longevity, and life satisfaction[10,45,46,47,48,49,50,51]. In the area of poverty alleviation, it is important to have connections with distant relatives, experts, and the Internet, which are not sufficient. In addition, it has been shown that these "connections" can greatly reduce social costs[17]. The health of the individual and the health of society as a whole are deeply intertwined, even in economic terms.

In this section, we have discussed two variables that have a significant impact on the overall mechanism: "support for the mental and physical health of caregivers" and "the quality and quantity of the family's ties in the community. Fig. II-21 is added with other factors such asThe quality and quantity of funding and institutional support provided to local governments and support groups, and the quality and quantity of information coordination among local governments and stakeholder groups. Each municipality has different methods and temperatures for childcare support. It is recognized that there is currently not enough collaboration at all among each support group and among stakeholders including support groups. These variables will be discussed later in the paper with explanations of related variables and loops.

1.2.7 Connecting the declining birthrate loop between the state and families (right) and the loop of supporting poor families (left) to capture the overall structure of society

So far, we have analyzed separately the fertility loop between the state and families, "the social structure in which couples, families, and partners of the right age are placed" (right), and the loop of support for poor families, "the social structure surrounding poor families" (left). From here, I would like to turn my attention to the connections and dynamics of both structures.

Fig. II-22 shows the presence of a group of loops in Fig. II-21 that connect the "quality and quantity of connections in the community that families have" and the "social structure in which couples, families, and partners of the right age are placed" that have a significant impact on the dynamics of supporting poor families.

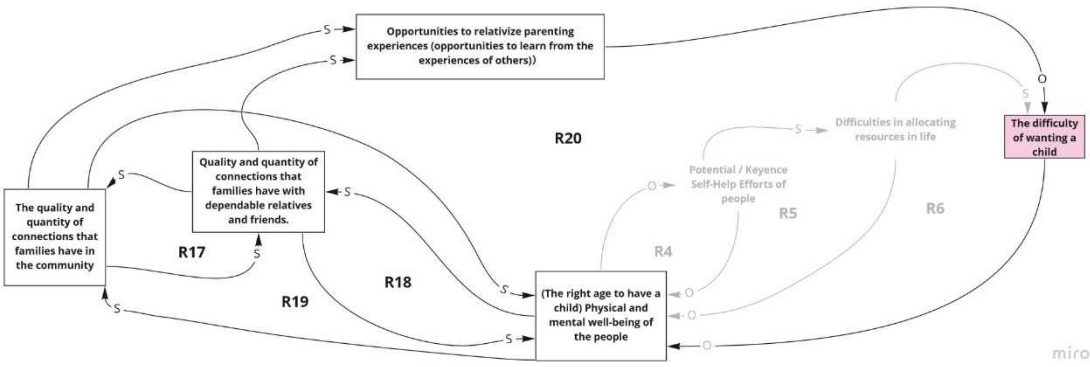


Fig. II-22 A loop formed by connections in the community and the difficulty of wanting a child (Provided by: General Incorporated Association Tamani)

R17, 18, and 19 show the following self-reinforcing loops.

R17：”The quality and quantity of the household's connections in the community and “the quality and “quantity of the household's connections with dependable relatives and friends”.

R18：”The quality and quantity of the family's connections with dependable relatives and friends”, and “the physical and mental well-being of the population at the appropriate age”.

R19：”The quality and quantity of family connections in the community” and “the physical and mental well-being of the population of the appropriate age”.

Here, the variables "the quality and quantity of the household's connections in the community" and "the quality and quantity of the household's connections with dependable relatives/friends" have a mutually reinforcing (or weakening) relationship. It is important to note that the "amount (number) of relatives a family can rely on" is set to decrease.[52]

R20 is a self-reinforcing loop, which is a virtuous cycle in which the hurdle to having children is lowered by being blessed with "opportunities to relativize the child-rearing experience" through "the family's connections in the community" and "the family's connections with dependable relatives and friends. Alternatively, it is a vicious circle loop in which the hurdle to having children cannot be lowered because of the lack of such connections and the inability to learn from the child-rearing experiences of others. This "relativization of the child-rearing experience" was provided by relatives until the generation before the junior baby boomers (the second demographic generation). In the later generations, the nuclearization of the family progressed rapidly, and the number of siblings living far away from home decreased.

Based on the above structure, as well as the current situation and future projections, we

can once again see that what we need to do in order to build a "society where people can have and raise children with hope" is to shift the design of society so that people can increase their connections with others in the community.

1.2.8 Weak Safety Nets Accelerate Fertility Decline

Next, I would like to expand the scope of this article and look at the simplest loop of the entire structure, which involves both the "social structure of couples, families, and partners of the right age" (right) and the "social structure surrounding poor families" (left), which is the fertility loop between the state and families. (Fig. II-23)

R21 indicates the next loop.

The government, which is trying to increase the birth rate and the number of workers, has not been able to come up with a long-term vision and a broad coverage of support measures → Insufficient measures to support poor families, i.e., lack of "quality and quantity of information coordination among stakeholders" and "funds and institutional support invested in local governments and support groups" → Families receive less support Even non-poor households become aware that they will face great hardship if they fail to help themselves and fall into poverty. As a result, their physical and mental well-being will be undermined, leading to a decline in birthrate.

The loop of R22 is as follows

Government measures to increase the birth rate and the number of workers will worsen working conditions -> loss of family income and livelihood stability, which will impair the physical and mental well-being of the people. As with R21, the problem with this loop is not limited to increasing poverty and the so-called "inequality society," but it also triggers a vicious cycle that makes it difficult for families that are not in poverty to have children.

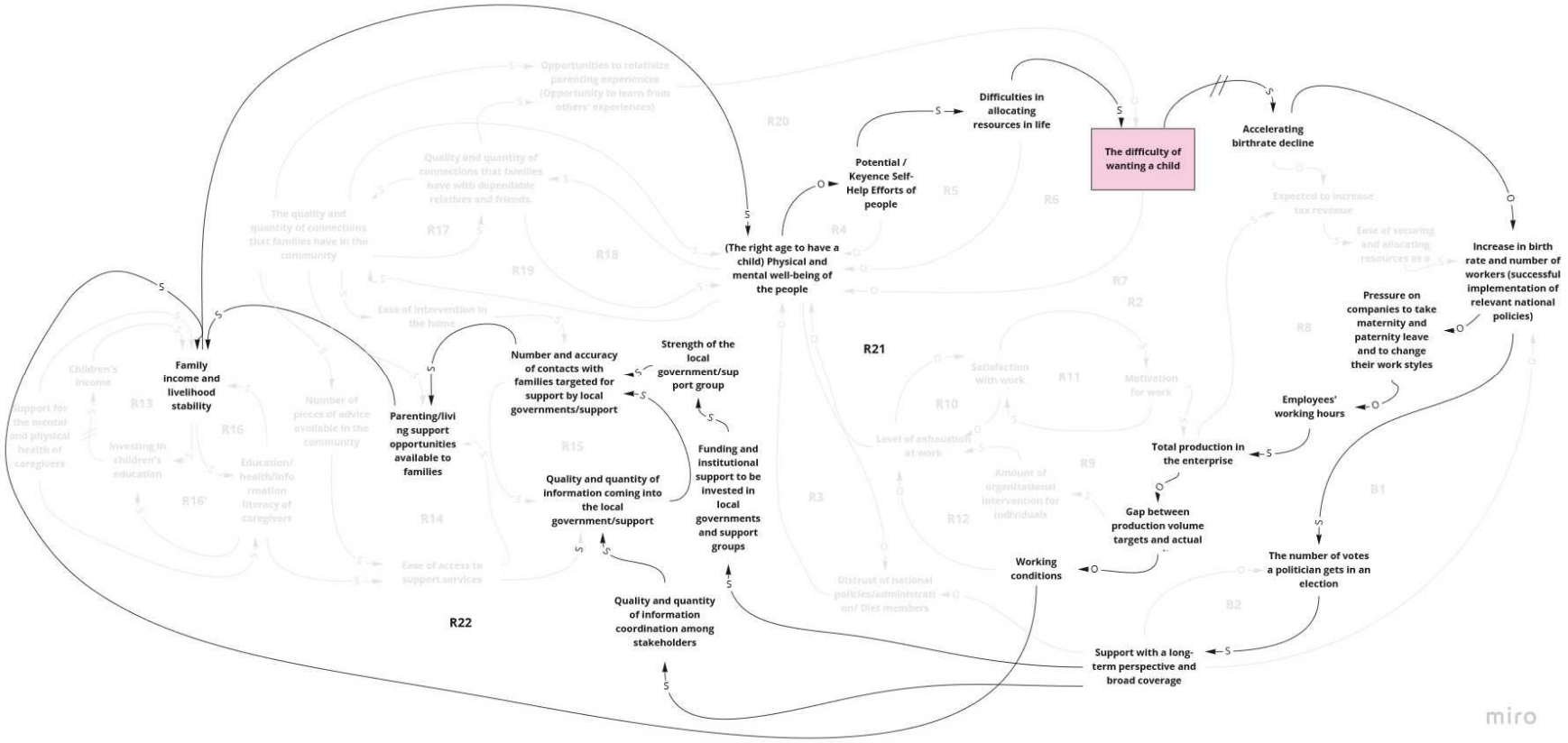


Fig. II-23 A causal loop showing how weak safety nets accelerate the decline in birthrates in a social structure (Provided by: General Incorporated Association Tamani)

1.2.9 Social structure assumed in this study and summary of this section

In this section, we have looked at the results of analysis using literature, Internet research, interviews, causal loop diagrams, and questionnaires. Considering them, this proposal regards the structure shown in Fig. II -24, as Social structures involved in bearing and raising children, and proposes research issues.

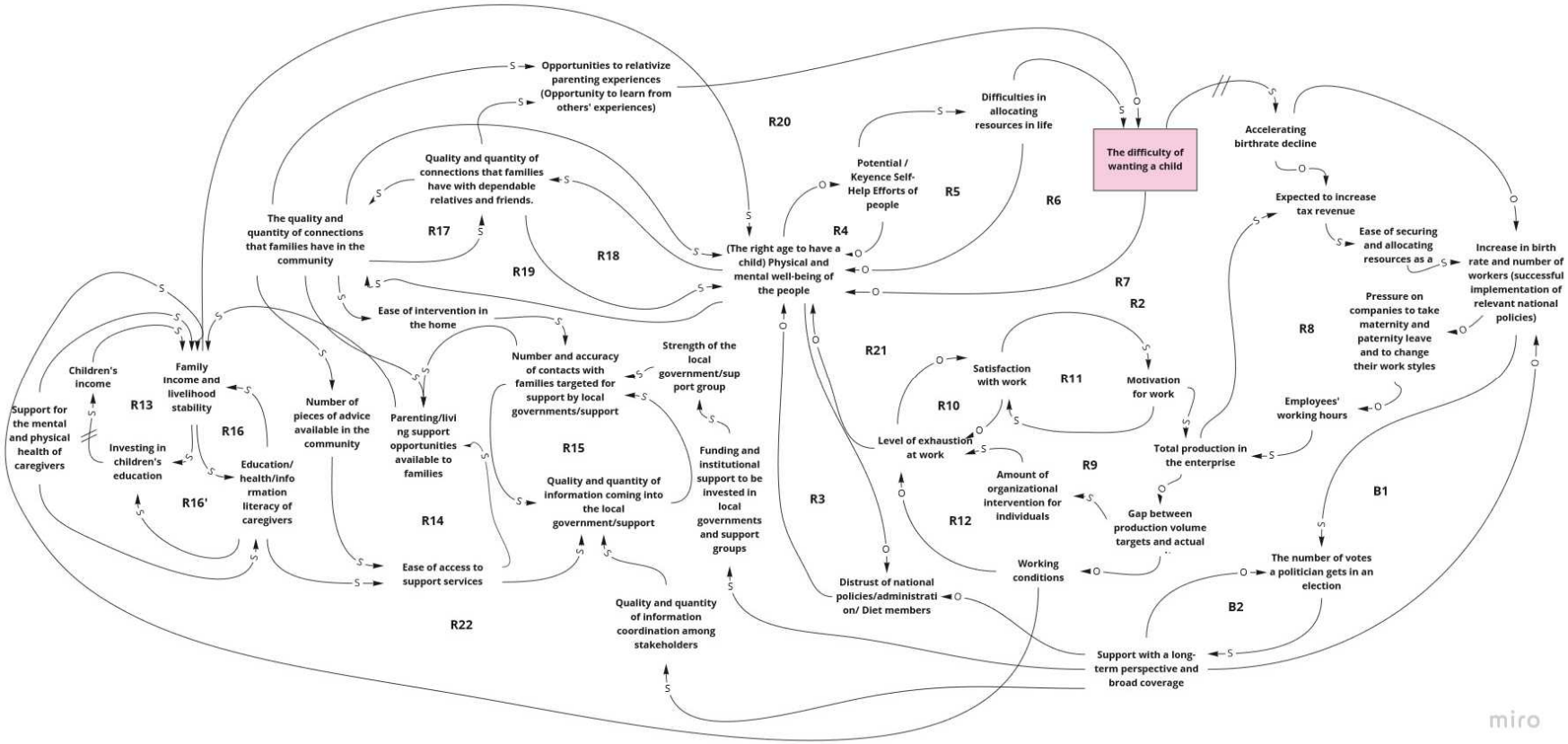


Fig. II-24【Again show】A cause-and-effect loop diagram showing the overall picture of a social structure in which people are losing their marginality and finding it increasingly difficult to have children as a desire that they should be able to have. (Provided by: General Incorporated Association Tamani)

2. Overview of research and development to be conducted to achieve the relevant MS goals

In this proposal, the entire discussion has been divided into two visions for convenience. The following is a bird's eye view of the areas of research and development that should be addressed as a whole (Fig. II-25).

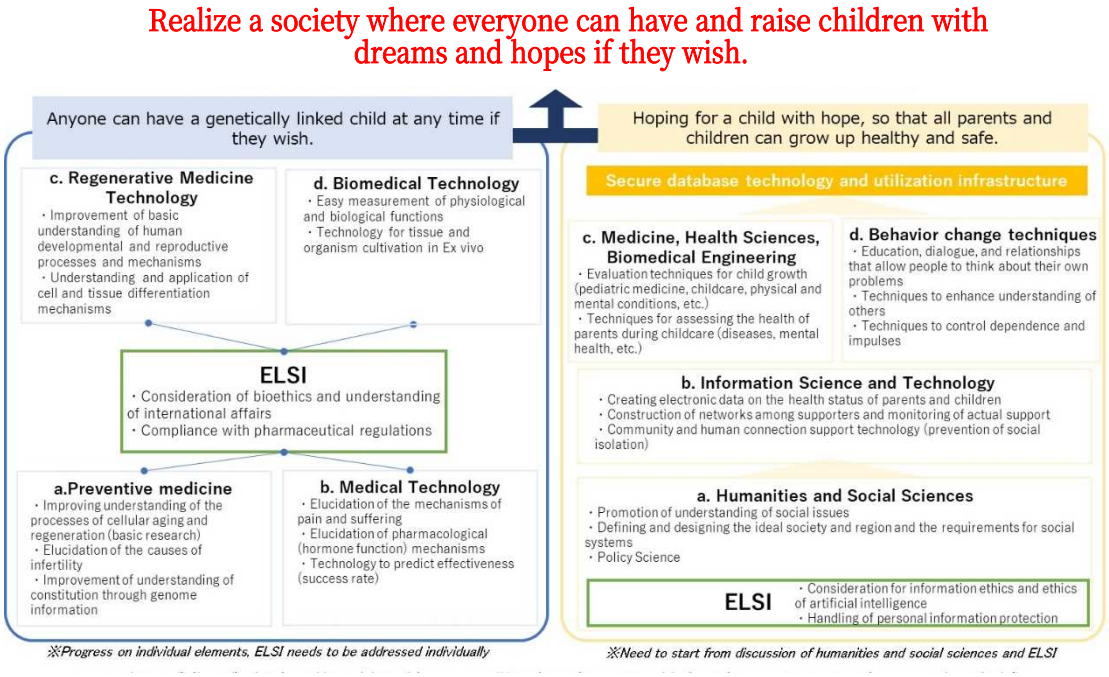


Fig. II-25　Research and development required and main areas for the ultimate vision of this proposal.

2.1. Vision①Anyone can have a genetically related child at any time if they wish.

① Develop preventive methods against the causes of infertility and technologies that can dramatically reduce the burden of infertility treatment.

(Issues) In many cases, the cause of infertility is not known in the first place. The physical and mental burden of infertility treatment is so great that it interferes with daily life and working life.

(Example of research and development) Understanding the relationship between genome, lifestyle, and reproductive function. Medical technology that can maintain or maximize each person's fertility. Technology to quantify fertility. Elucidation of human developmental

mechanisms and development of control technologies. Technology to determine the maturity level of follicles even at home. Development of drugs with fewer side effects, etc.

② Do not become infertile. Develop technology to restore or regenerate fertility even if it is lost.

(Issue) The number of diseases that can cure the causes of infertility is still limited. The aging of the spouse and uterus cannot be stopped. Those who have lost their uterus due to cancer treatment, etc., or those who were born without a uterus, cannot conceive. Some people are born with non-functioning gametes, and there is no cure for this. Pregnancy is probabilistic, even though it can only be attempted once a month or less, and the swings of expectation and disappointment are large enough to cause depression.

(Example of research and development) Regenerative medicine using universal stem cells, gene therapy, and transplantation to cure infertility. Technology to restore or increase fertility.

③ Develop technology that can produce children without depending on the human female body.

(Issue) In the first place, there is a difference in biological functions between men and women, and there is no choice regarding reproduction (only biological women can have children, etc.), resulting in various problems as described in Chapter I.

(Example of research and development) Ex-vivo reproduction through a complete artificial womb. Technology that allows biological males to become pregnant.

2.2. Vision②We can look forward to our children with hope, and all parents and children can grow up healthy and safe.

Fig. II-25 shows the research targets for each research area. On the other hand, for Vision 2), as shown in the results of the analysis using the loop diagram, it is necessary to solve the problems of the social system. Fig. II-26 shows research targets and intervention area according to the system of society.

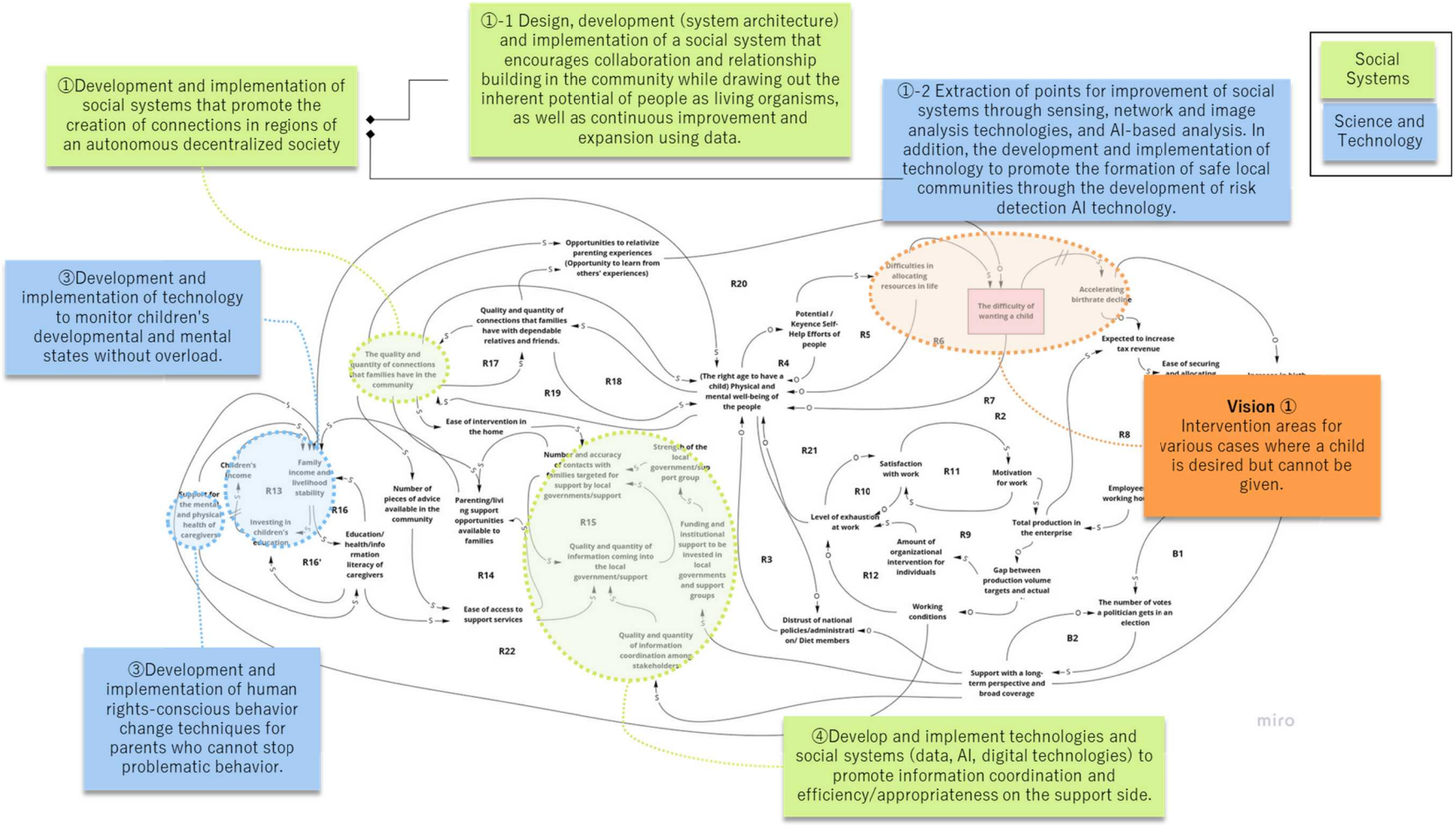


Fig. II-26 Social structure and R&D targets

The research targets are listed as follows.

① Development and implementation of social systems that promote the creation of connections in regions of an autonomous decentralized society.

①-1 Design and development of a social system (system architecture) that encourages collaboration and connection building in the community while drawing out the inherent potential of people as living organisms. Continuous improvement and expansion using data.

①-2 Technology for extracting points for improvement in social systems through sensing, network and image analysis technology, and AI-based analysis. Development of technology to promote the formation of safe local communities through the development of risk detection AI technology.

② Development and implementation of technology to monitor children's developmental and mental states without burdens

③ Development and implementation of human rights-conscious behavior change techniques for parents who cannot stop problematic behavior.

④ Development and implementation of technology and social systems (data, AI, digital technology) to promote information coordination and efficiency/appropriateness on the support side.

In the next section, each item is described in detail.

3. Japan’s position in overseas trends

3.1. Vision① Anyone can have a genetically related child at any time if they wish.

・Research groups in the U.S., Canada, and Japan (especially, a research group of Tohoku University) are leading the world in the research of artificial uterus and placenta. However, there are still many hurdles that need to be overcome for practical use. In the basic research stage, experiments have been conducted using sheep, but for practical use, primates are needed. First of all, the current issue is which research group will be able to announce its success with primates. Another challenging issue is how to create a device that can be safely and accurately handled by anyone technically. In other words, there are many issues that need to be resolved in order to realize a device, operability, and size that can be used in general clinical practice, rather than a technology that can be used only by a few specialists.

One of Japan's strengths is the proximity of medical device manufacturers to research and clinical sites. Japanese medical device manufacturers tend to value the domestic market relatively more, and there is a trend to make products that can be sold to domestic doctors. This has led to the immediate modification and commercialization of products based on the usage experience of clinical doctors. Medical device manufacturers in the U.S. and elsewhere, being large corporations, take a considerable amount of time to make a single modification, going through extensive meetings, modifying the production line, and so on, while small requests from the field tend to be ignored.

Artificial umbilical cord catheters and artificial uterus/placenta, which are being researched and developed at Tohoku University in Japan, are being developed in close collaboration between domestic medical device manufacturers and researchers in the field. This speed, accuracy, and diligence are the strengths of Japan, and this is why we are able to stay at the forefront of the world.

・Research using iPS cells and other pluripotent stem cells is one of the fields in which Japan is a world leader. There is a good chance that Japan can lead the world in research on regenerative medicine using these cells to combat the decline in fertility. As described in the chapter on ELSI, the so-called "14-day rule" for embryonic research using fertilized eggs has been abolished, and it is now up to each country to decide how many days it is permissible to culture fertilized eggs. As described in the ELSI chapter, the so-called "14-day rule" for embryonic research using fertilized eggs has been abolished, and it is now up to each country to decide how many days of culture are allowed. It is extremely difficult to culture fertilized mammalian eggs for a long period of time, but the culture period is being extended every year. The competition for future technological development will depend on the constraints of the culture period.

・As for uterus transplantation technology, there are no examples of uterus transplants in

Japan, but overseas, transplants of uteruses donated by mothers, sisters, and deceased people have been attempted since 2000, and a group in Sweden succeeded in giving birth for the first time in 2002. Nearly 40 babies have been reported to have been born in more than 10 countries including the U.S., Czech Republic, and China. In Japan, a research group led by Keio University has successfully performed uterus transplantation using crab-eating macaques, and became the first non-human primate in the world to give birth after uterus transplantation, thus achieving a high level of technology.

・A questionnaire survey on the proposed science and technology was conducted among 144 men and women who had experienced infertility treatment for investigating the acceptability of this vison.

Question 1: "Please select "all" of the future scenarios that you feel are "rather favorable/desirable. The following were the responses with relatively low approval ratings for (Fig. Ⅱ-27)

Option 3) A future in which the choice of surrogate motherhood ("having the baby born" by a voluntary third party) is commonplace (36.8%)

Option 5) A future in which multiple men and women can become the genetic parents of a single baby (13.9%) (Note: This means that sperm and egg donors can become parents to the child born.

This suggests that many of those who have experienced infertility treatment do not want a fertility treatment in which a third party participates.

The reason for the large number of votes for option "(2) A future where future women can freeze their eggs in their twenties to ensure that they can conceive when they want" is probably dissatisfaction with the biological age limit.

The reason for the large number of votes for option "6) A future in which single women can easily choose to give birth and raise their children alone" is not because they want to reproduce alone, but because they hope for a society in which single mothers can choose to divorce with peace of mind and plenty of support from society.

Surprisingly, many respondents agreed with option (4), "A future where the choice to have children without blood relations, such as through adoption, is more common. Where the desire for genetic connection and the obsession and bias toward blood relatives comes from needs to be investigated, but it is desirable as the ideal form of society.

As seen in Fig. Ⅱ-28, Fig. Ⅱ-29, many people agreed that "technology that allows men to conceive and give birth to children" and "technology that completely eliminates the burden of pregnancy and childbirth on the female body, such as artificial wombs" should be developed as options. However, there were also opinions that the application of these technologies

should be limited, for example, to those who have unavoidably lost their fertility due to illness or to LGBT people. In response to the former question, some women expressed their desire for empathy, saying that they wanted men to understand the pain of menstruation and childbirth. Perhaps what they truly want is not the technology itself, which allows men to give birth, but the understanding and sympathy of men, the people around them, and society for the unique suffering of women. In this sense, the goal is not only to develop reproductive technologies, but also to innovate social systems.

Question 1 : Please select "All" for the future that you feel "rather favorable/desirable" about.

① A future where the success rate of fertility treatment is much higher and everyone can achieve pregnancy in the shortest possible time through treatment.
② A future where freezing eggs in your 20s will ensure that future women can get pregnant when they want to.
③ Surrogate motherhood (having the baby born by a voluntary third party) is becoming a common choice in the future.
④ A future where the choice to have children without blood relations, such as adoption, is becoming more common.
⑤ A future in which multiple men and women can be the genetic parents of a single baby.
⑥ A future where single women can choose to give birth and raise their children alone without difficulty.
⑦ A future where same-sex partners can have genetically linked children without the need for a third party.

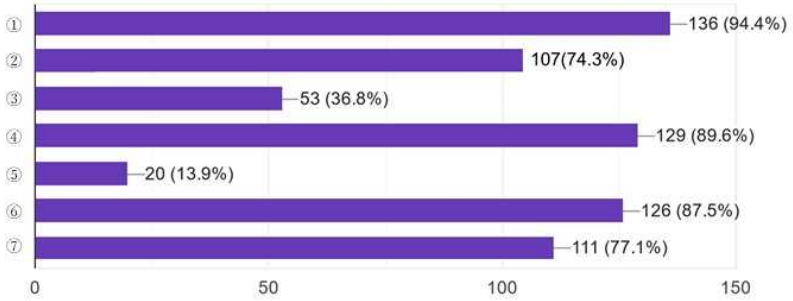


Fig. Ⅱ-27 Questionnaire survey of infertile people（1）

Question 2: About "technology that allows men to conceive and give birth to children" (i.e., to have the male partner do the conceiving and giving birth)

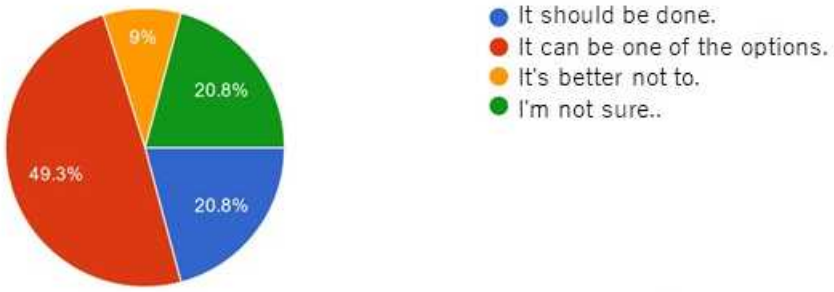


Fig. Ⅱ-28 Questionnaire survey of infertile people（2）

Question 3: "Artificial wombs and other technologies that completely eliminate the burden of pregnancy and childbirth on women's bodies.

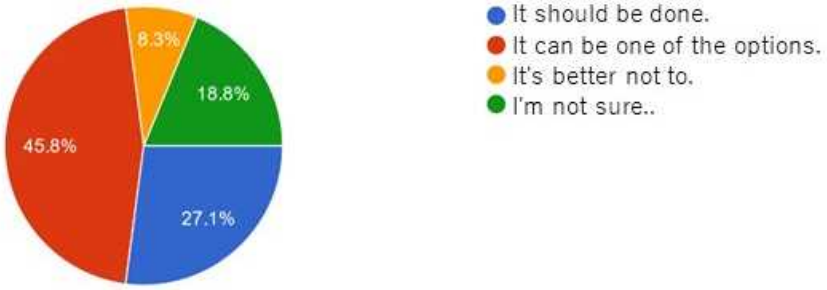
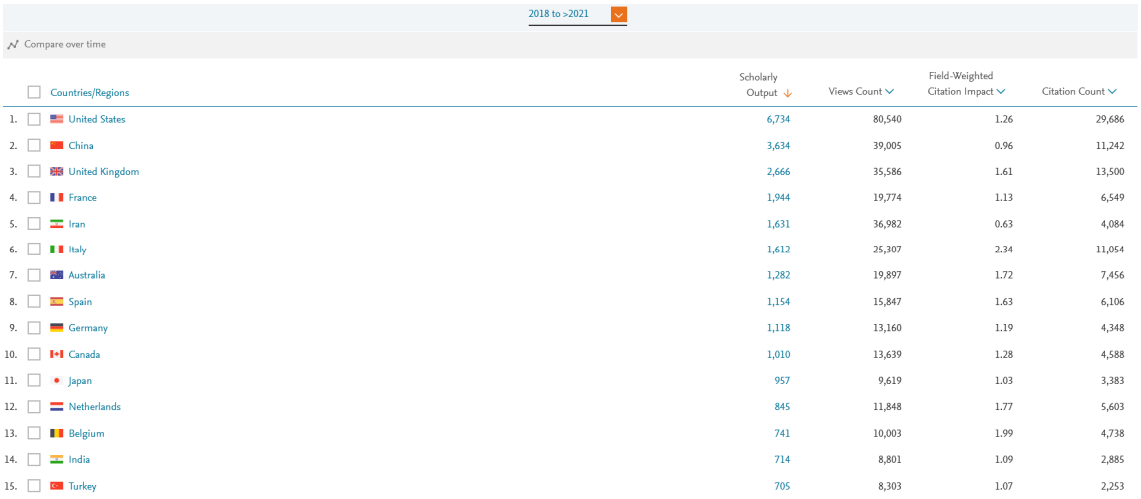


Fig. Ⅱ-29 Questionnaire survey of infertile people（3）

・An analysis of Japan's research capabilities by Elsevier Scival

Japan ranks 11th in the world in terms of the number of papers in the research area "Reproductive Medicine," lagging behind the United States, China, and European countries. Although we cannot draw conclusions from the number of papers alone, we cannot deny the possibility that Japan's research capacity is low compared to other fields. It is also possible that ethical or institutional constraints are hindering the promotion of research in Japan. This is an area that should be leveraged by moonshots.



2018 to >2021

Compare over time

	Countries/Regions	Scholarly Output	Views Count	Field-Weighted Citation Impact	Citation Count
1.	United States	6,734	80,540	1.26	29,686
2.	China	3,634	39,005	0.96	11,242
3.	United Kingdom	2,666	35,586	1.61	13,500
4.	France	1,944	19,774	1.13	6,549
5.	Iran	1,631	36,982	0.63	4,084
6.	Italy	1,612	25,307	2.34	11,054
7.	Australia	1,282	19,897	1.72	7,456
8.	Spain	1,154	15,847	1.63	6,106
9.	Germany	1,118	13,160	1.19	4,348
10.	Canada	1,010	13,639	1.28	4,588
11.	Japan	957	9,619	1.03	3,383
12.	Netherlands	845	11,848	1.77	5,603
13.	Belgium	741	10,003	1.99	4,738
14.	India	714	8,801	1.09	2,885
15.	Turkey	705	8,303	1.07	2,253

Fig. II-27 Analysis of research power by Scival in the research area "Reproductive Medicine

3.2. Vision② We can look forward to our children with hope, and all parents and children can grow up healthy and safe.

In turn, we will summarize the domestic and international trends and issues of research in each target.

3.2.1 About Target ① and ②

① Autonomous and decentralized regional social systems

The research that has helped drive the most impactful local (autonomous) decentralized social system in recent years is the AI future predictions of Hitachi Kyoto University Lab. The question is: "Will Japan be sustainable in 2050?" The project sought to find a design for a society with a declining population in Japan.[1]

In order for Japan to avoid catastrophe (financial collapse, accelerating population decline (declining birth rate, youth poverty), widening inequality and poverty, growing number of shopping refugees (currently 6-7 million), and hollowing out of agriculture) and remain sustainable as a nation, it is necessary to (1) steer the country toward a decentralized regional economy by 8-10 years from now as the biggest turning point, and (2) push back the trend of (1) by implementing policies continuously until FY2005-20. In order to avoid these problems and to remain sustainable as a nation, it is necessary to (1) shift to a decentralized economy by the end of the next 8 to 10 years as the biggest turning point, and (2) push back the trend of (1) through continuous policy implementation from FY2005 to FY2008. [53]

In this proposal, we refer to the above project as the result of the most sophisticated and technologically advanced simulation of the future, and aim to research, develop, and implement social systems and science and technology to enhance the sustainability and wellbeing of our society in 2050. The goal of this project is to develop and implement social systems and science and technology that will enable our society to enhance sustainability and the wellbeing of its residents in 2050.

② Solitary measures

In recent years, the government and local governments have begun to recognize the importance of "mutual aid," or connections among residents in the community, including neighbors, in various contexts such as comprehensive regional cooperation and disaster prevention. The Cabinet Office alone has conducted various large-scale surveys and analyses, starting with the publication of the report "Social Capital: Seeking a Virtuous Circle of Rich Human Relations and Citizen Activities"[54] and continuing with the "Research Survey Report on Community Function Revitalization and Social Capital"[55]. It is thought that they are trying to understand the "connections" between people from all aspects, structural, functional, quantitative and qualitative, and apply them to their policies.

If you look around overseas, you will see that more and more countries than Japan have governments with clear policies that aim to revitalize human connections in the community, measure them, and then reflect them in their policies. (Table II-2)。

The United Kingdom appointed a Minister for Loneliness in 2018, and is taking national measures to increase connectivity throughout society, with local communities as one of the main players. In October 2018, the 84-page strategy paper "A connected society - a strategy for loneliness" was released, and as of January 2019, more than 126 organizations have been supported and are working under this strategy.[56]

Table II-2 An overview of the implementation of major measures, including the revitalization of neighborhood relations, by governments.

Country Name	Overview
Bhutan	Since 1971, improving Gross National Happiness (GNH) has been a pillar of national policy. An important index includes "Community vitality".[57]
UAE	In February 2016, he appointed a Minister of State for Happiness to address Social Relations as a key driver of Wellbeing and Happiness.[58]
United Kingdom	In January 2018, cross-governmental collaboration and compilation of A Strategy for Loneliness, including 13 charities and two universities, was undertaken by The Digital, Culture, Media and Sport Minister (known as the In October 2018, A connected society -A strategy for loneliness was developed.
New Zealand	On December 13, 2018, the Budget Policy Statement 2019 listed social capital as a key indicator and announced that the budget would be invested in revitalizing local communities to improve life satisfaction and mental health.In May 2019, a long-term plan, the " Wellbeing Budget 2019" was released in May 2019.

Table II-3 UK government's A connected society: a strategy for loneliness overview and main points

Overview
• - Effective October 15, 2018. • - A comprehensive strategy to tackle loneliness across society has been set out with the aim of building a society where people who are lonely are connected to services and residents are connected to residents • - Ministers and Under Secretaries from 9 ministries, 13 charities, and 2 universities participated in the development of the strategy.
Points
• - Social relationships are important for people's health and wellbeing. • - The concept of social wellbeing implies that personal relationships and social support networks enhance wellbeing, comfort, and resilience. The vision is for governments and all sectors to recognize the social importance of wellbeing and to encourage its improvement. • - Distinguish between physical isolation and subjective loneliness, and approach subjective loneliness.

The Japanese people and the Japanese government have not been sitting on their hands about the problem of loneliness or the lack of connection in the community. There are many diverse and attractive activities that try to connect people within the community.

e.g.) Creation of community cafes and other places to live[59], children's cafeteria[60], activities that seek to bring people together to stimulate the economy within the community[61], Community revitalization activities and share houses in tower apartments, Activities by companies and others to bring neighbors together with an eye to some benefit, An attempt by an individual or group to connect with community members on a volunteer basis or as a service. A regional version of SNS that encourages information sharing and event implementation in the region.

In recent years, children's cafeterias and community cafeterias have been attracting particular attention. Children's cafeterias are free or low-cost cafeterias where children can go alone, and are held once or twice a month at community halls, etc. Many of these cafeterias are open to the community without limiting the target group.[62] Community cafeterias are children's cafeterias that are also accessible to adults without children. The number of community cafeterias has increased 12-fold in the past three years, reaching 3,700 by June 2019 (one in every six elementary schools).[63]

Previous research has shown that shared mealtime, co-eating, and commensality play an important role in mental health[64]. Food brings people together, whether in daily life or at celebrations[65]. In addition, the meal itself has the meaning of a gift that can be shared with those who sit together[66]. Therefore, it is suggested that these activities are effective not only in addressing child poverty, but also for the purpose of connecting neighborhood residents.

As you can see, there are many individuals and corporations that are engaged in attractive activities, but the interaction between neighbors continues to wane, and the need for further measures is obvious.

As for the government's community policy, in 1969, the then Economic Planning Agency published a report entitled "Community: Restoring Humanity in Daily Life" with the aim of building a "local community" involving "citizen-type residents" who are not actively participating in neighborhood association activities.[67] It is close to the "busy generation living in cities," which is the target of this proposal.

Although the national and local governments continued to invest money in the development of facilities and human resources, it was reported that 90% of the recipients of the activities were neighborhood associations (54.5% were women's associations such as neighborhood associations and senior citizens' clubs, and 32.8% were neighborhood associations themselves).[68] In other words, most of the investments in the series of community policies did not reach the busy generation (younger generation), but rather

invested in the elderly and other groups that were already involved in local activities.

As we have seen above, although efforts are being made by various players in the formation and promotion of human connections in the community, community policies by the government and local governments have unfortunately not yielded sufficient return on investment in terms of their results. There is a need to design systems and policies that will make it easier to involve thoughtful players in the community, and that will make the currently unconnected segments of the population want or need to participate.

③ Improving wellbeing and becoming smarter in the community

As technology continues to evolve, various organizations, countries, and cities around the world are attempting to improve wellbeing through the use of IT. There are several indices from international organizations, such as the World Happiness Report[69], the OECD's Better life index[70], and the EU's Quality of life in European cities. At the national level, there are various indicators and initiatives, including the aforementioned measures against loneliness, and technology, including sensors, is steadily being incorporated in R&D and social implementation.

For example, the Liveability Indicator framework has been adopted by major Australian cities, such as Melbourne, as a policy tool for urban design and management. This is based on the framework of the WHO's Social Determinants of Health, which aims to improve the livability of cities through the items shown in Fig. II-31.[71] These data are made public as open data, encouraging each city to make use of its unique characteristics to create a livable city that contributes to the wellbeing of its residents.

Fig. Ⅱ-31 Example of Australian Urban Observatory / RMIT [15]

One of the leading organizations driving this trend in Japan is the Smart City Institute Japan[3]. They are actively working with industry, academia, and government to develop and implement indicators for a Liveable Well-Being City based on objective and subjective indicators unique to Japan, in collaboration with local governments, while incorporating the trends of Society 5.0, Smart City, and Super City.

Thus, in the context of IT-based smart cities, safety and security are also being actively discussed. In the context of smart cities, the case of Kakogawa City's watchdog camera is known as one of the outstanding examples[72]. With the development of science and technology in the future, it is certain that sensors and other devices will be actively considered and introduced. On the other hand, a data-driven society cannot bring happiness to people without more sensitive consideration of privacy. In Japan as well, the government and the Data Distribution Promotion Council have been studying the issue. Keeping a close eye on these developments, it is desirable to design social systems that contribute to the wellbeing of the people.

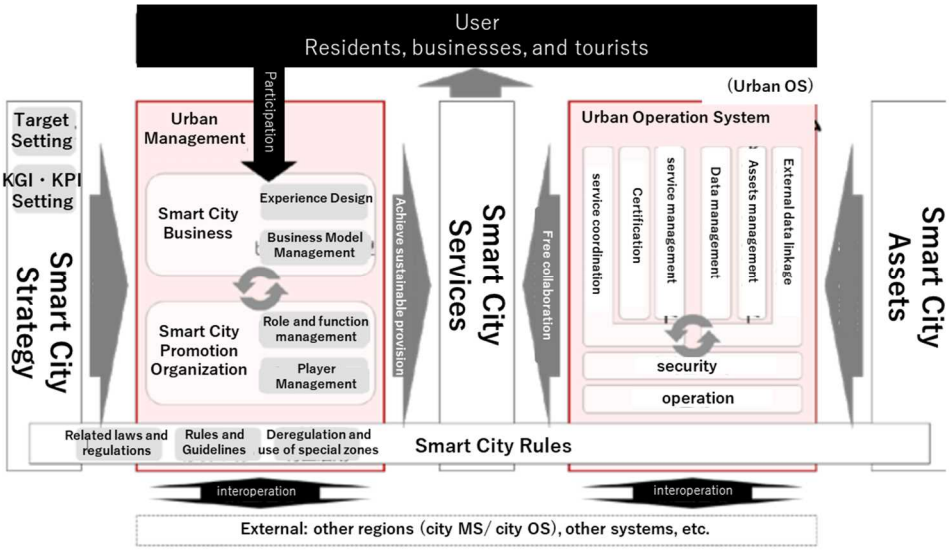


Fig. Ⅱ-32 Reference Architecture for Smart Cities [16]

④ Current trends in the design of social systems using the concept and methodology of architecting

Another trend that should not be overlooked, both domestically and internationally, is the increasing importance of architecting (design) and architects (systems engineers) who follow the methodology of Systems Engineering in the design and implementation of social systems.

The term "systems engineering" refers to "the multi-disciplinary approaches and methods that enable the successful realization of systems" and has been used and developed in large-scale complex systems development such as military and space development in Europe and the United States. A "system" is defined here as "a combination of interacting elements (elements) to accomplish a defined purpose. It includes hardware, software, firmware, people, information, technology, facilities, services, and other supporting elements. Today, they are used in the development of a wide range of social systems, including social infrastructure and smart technologies.[73]

INCOSE, the International Conference on Systems Engineering, has created a working group on Social Systems in 2019. In 2020, Japan's Society 5.0 was introduced as an attempt to develop cities using technology in a human-centered way.

In 2020, the Digital Architecture Design Center (DADC) will be established under the Information-technology Promotion Agency, Japan (IPA), with the aim of further promoting the use of systems engineering. In 2020, the Digital Architecture Design Center (DADC) [74] will be established under the Information-technology Promotion Agency, Japan (IPA), aiming for further dissemination and utilization.Examples of reference architectures have been reviewed and presented (Fig. Ⅱ-32).

3.2.2 About Target ②, ③ and ④

Research and development of social systems is being conducted as a project of the Research and Development Center for Social Technology (RISTEX) of JST to address the problems of poverty and abuse, which is related with Target ②, ③ and ④. We interviewed the related researchers with the project.

In terms of research, there has been no survey of the people involved or the parents involved in problems such as abuse in Japan, and the realities of these issues have not been fully understood by society and used as a basis for social measures. A solid sociological study is needed. The first thing that is important is how to support parents, and if parents do not change, reaching out to their children will not lead to a solution. He also pointed out that even if the technology is developed, there are other hurdles to overcome before it can be widely used in society. It is still necessary to look at the issues on the frontline of support. It is necessary to connect supporters, but the problem is that many of them are not digitized in the first place. Another issue is that it is difficult to share the decision-making process and rationale for dealing with cases. Furthermore, dialogue is necessary to draw out, support, and encourage problems from people. It was also pointed out that not everything can be solved by AI or digital technology.

We interviewed an NPO, which actually supports poor families, about the situation of consultation and support. The feedback from the interview was that in Japan, research has not been able to fully grasp the reality of these social issues, and that there is no secure social infrastructure such as social systems and welfare.

One overseas example is Finland's Neuvola. This is also a model for the activities of the "Child-rearing Generation Comprehensive Support Center" in Japan, which provides comprehensive support from pregnancy to child-rearing, but it is feared that it will not function in Japan, where the person in charge as a supporter is supposed to be transferred. If the government system cannot be changed, it will be necessary to use this data in the context of a data-driven society such as Society 5.0 and smart cities, to support childcare and prevent poverty and abuse.

III. Plan for Realization

1. Area and field of challenging R&D, research subject for realization of the Goals

1.1. Vision①Anyone can have a genetically related child at any time if they wish.

Fields and areas to be promoted:

Life science and medicine (reproduction, clarification of developmental mechanism of life, regenerative medicine, application to reproductive medicine, genome medicine, etc.), cell analysis technology (understanding the status of eggs and sperm, identification of influencing factors and prediction of future), medical engineering (artificial womb, etc.), ethics (bioethics, religious studies), law

Research issues to be addressed in achieving the goals：

・Research of the relationship between an individual's constitution and fertility, lifestyle, and reproductive function through genomic and epidemiological research. Research on lifestyle habits and preventive methods to maintain each person's fertility.

・Medical and pharmaceutical research into medical technologies and drugs that can assist, maximize, and restore fertility.

・Fertility quantification and prediction technology through medical and biomedical engineering research.

・Elucidation of the mechanism of human development and research on control technology through research in medicine, developmental engineering, and medical engineering.

・Research in medicine, engineering, and other fields to measure and determine the maturity of follicles at home.

・Pharmaceutical research into drugs with fewer side effects, such as hormone therapy during fertility treatment

・Research in medicine, regenerative medicine, gene therapy, and other fields to find a cure for infertility through regenerative medicine, gene therapy, and transplantation using pluripotent stem cells, etc.

・Ex-vivo reproduction with a complete artificial uterus, based on research in medicine, medical engineering, and developmental engineering. Technology that allows biologically male women to become pregnant.

1.2. Vision② We can look forward to our children with hope, and all parents and children can grow up healthy and safe.

Fields and areas to be promoted:

ICT technology (semi-transparent communication that allows us to see what is going on even when we are online, physical intervention), social science (how communities are and can

be created in the digital age), architecture (housing structures and towns that encourage community building, psychiatry (parent-child relationships, illness and parenting), information technology, medicine (indicators of physical abuse, secure information infrastructure), social science. Parent-child relationship, diseases and childcare), biomedical engineering (usable even for infants, non-invasive/small sensors), information technology, medicine (indicators of physical abuse, secure information infrastructure), social science (the state of social systems), economics (poverty and wealth distribution), ethics (social ethics, acceptability of interventions, human rights), law (personal information handling methods, security)

Research issues to be addressed in achieving the goals：

・Research in the humanities, medicine, psychiatry, etc. on the impact of essential human functions and values (joy, anxiety, security, etc.) on collaboration and connection with others in the community.

・Research on social systems that promote the creation of connections in regions of an autonomous decentralized society through the study of systems architecture in the humanities and social sciences, engineering, and information science.

・Sensor, network, and image analysis technologies for sensing biological information, environmental information, and social environment, based on research in engineering and information science. In addition, technologies that make it possible to extract points for improvement in social systems through AI analysis, detect risks in society and intervene appropriately, and support collaboration among supporters and improve efficiency.

・Development of human rights-conscious behavioral change techniques for the treatment of mental illnesses that affect parental background, childbirth and childcare, and problematic behaviors such as abuse due to dependence on drugs, alcohol, gambling, and poor control of heightened emotions, through research in medicine, engineering, medical engineering, pharmacy, law, humanities, and social sciences. We will also develop techniques such as brain electrode stimulation and social care.

2. Direction of R&D for realization of Goals

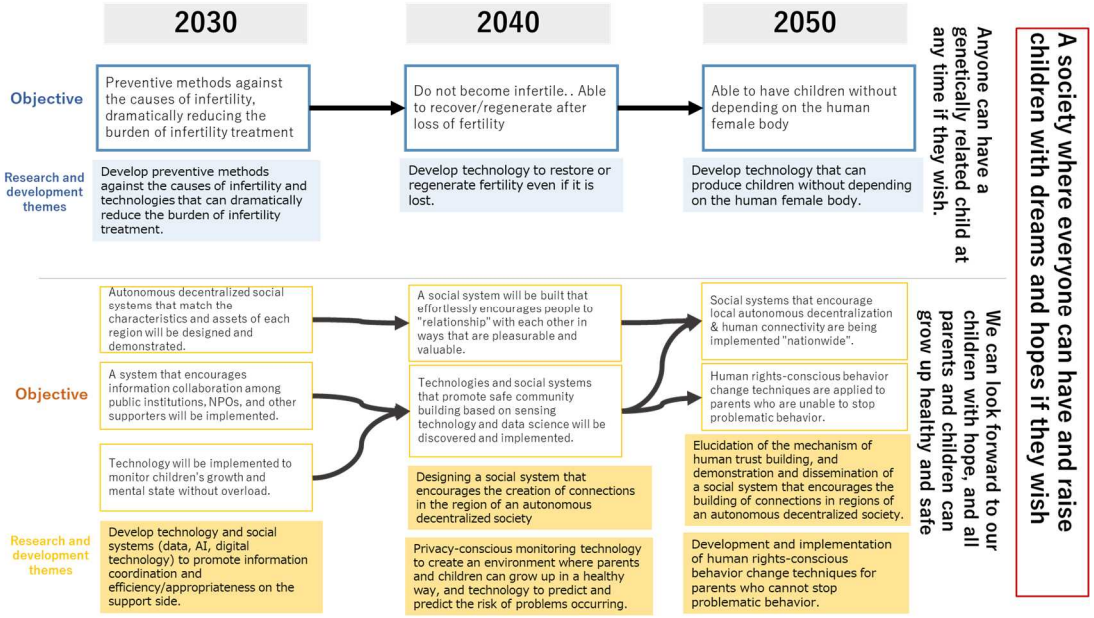


Fig. II -33 Targets (milestones) to be achieved in 2030, 2040, and 2050, research and development aimed at achieving the milestones, and ripple effects of this.

2.1. Vision①Anyone can have a genetically related child at any time if they wish.

In 2030, Develop preventive methods against the causes of infertility and technologies that dramatically reduce the maternal burden of infertility treatment. The number of women suffering from infertility will be reduced and the burden of treatment will be lessened, reducing the impact on their real lives and careers.

In 2040, Develop a curative treatment for the causes of infertility. No more giving up on childbirth due to infertility with a clear cause.

In 2050, Develop reproductive technologies that do not rely on the human female body. Abandonment of infertility due to gender or biological reasons will be eliminated.

2.2. Vision② We can look forward to our children with hope, and all parents and children can grow up healthy and safe.

In 2030, Develop technology and social systems (data, AI, digital technology) to promote information coordination and efficiency/appropriateness on the support side. The increase in abuse and poverty issues will stop.

In 2040, Design a social system that encourages the creation of connections in regions of an autonomous decentralized society. Technology to watch over parents and children with

consideration for privacy and technology to predict and predict the risk of problems occurring will be developed in order to create an environment in which parents and children can grow up in a healthy manner. Abuse and poverty problems will be reduced by half.

In 2050, To elucidate the mechanism of human trust building, and to demonstrate a social system that encourages the building of connections in regions of an autonomous decentralized society, and to spread it throughout Japan. Develop human rights-conscious behavior change technology for parents who are dependent or unable to control their emotions. We aim to create a society in which there is no abuse or poverty.

3. International cooperation

In the research and development of the so-called reproduction field, it will be necessary to keep pace with the international community in terms of ethics.

International comparisons will be important for the construction of an ideal social system. While referring to the efforts of various regions, such as Europe, America, Asia, the Middle East, and Africa, it is desirable to tune and implement the system according to Japanese culture and history. For example, there is no need to excessively demean our country by comparing only the good parts of Europe with the bad parts of Japan. We need to take a more bird's eye view and steadily implement realistic initiatives.

4. Interdisciplinary cooperation

Regarding vision 1), close collaboration between life science and medical researchers and ethicists is essential. Furthermore, when taking the approach of developing an artificial uterus, it is also important to collaborate with the fields of materials engineering, mechanical engineering, and biomedical engineering.

For social transformation, such as human networks and community building, which are mainly related to vision 2), it will be necessary to involve various stakeholders, such as experts in social sciences and social engineering, local governments, NPOs, and citizens, and build them in a co-creative manner.

Any technology that can be used as a means to achieve the vision of the society we are aiming for should be used, and this could include AI, ICT technology, robots, sensors, and many other things. It would be desirable to promote this project in strong collaboration with existing MS Objective 3 and others.

5. ELSI (Ethical, Legal, Social Issues)

Introduction.

The purpose of this section is to clarify what ethical, legal, and social issues exist in order to realize the society that we are aiming for, to organize the structure of the issues, and to prospect a path to their solution. This study sets the society it aims to achieve as the MS goal, defines the vision that must be realized to achieve the goal, and identifies scenarios and R&D issues to realize the vision. Here, we can see the hierarchical nature of carrying out R&D tasks in order to realize the society. In this section, the ethical, legal, and social issues are organized for each of the goals, visions, scenarios, and R&D tasks. After that, we will try to discuss the idea of changing society.

Our MS goal is "to realize a society by 2050 in which everyone can have children and raise them with dreams and hopes for the future, if they wish. This is a society in which free will choices are respected. At first glance, this is correct from the standpoint of utilitarianism, but there are a few points that need to be considered.

First of all, what is the nature of free will choice? In contrast to choices made by non-free will, such as those made under duress by others, it would be obvious that we should respect free will choices. However, it is necessary to consider whether it is possible to make free will choices without being influenced by others.

Then there is the scope of influence of the consequences of free will choices. Free will choices are respected on the premise that we take on the consequences of our own choices, that is, that we do not interfere with the free will choices of others. By the way, our MS goal is to realize a society where everyone can have children and raise them. The term "everyone" here refers to those who wish to become parents, and does not include unborn children. The possibility that the free will choices of parents may influence the free will choices of their children should be considered as a matter of intergenerational ethics.

About Vision

Organize the structure of the visions and show what past discussions can be used as a reference for each.

Vision ① is to use technology to overcome the biological limitations of pregnancy and childbirth.

Think about the "everyone". In everyday life, it is between a man and a woman that a genetically related child is born, and the woman becomes pregnant and gives birth. However, this is only a part of "everyone". But this is only a part of "everyone". "Everyone" does not exclude a single person, a man or a woman, or three or more people. In the case of one person,

the child is a clone of himself. The creation of cloned humans is prohibited by law (Law Concerning the Regulation of Human Cloning Technology, etc., Law No. 146 of 2000).

In the case of two people, a man and a woman, if both sexes have germ cells and the woman is able to conceive and give birth, the results of assisted reproductive medicine can be expected. In the case of a man and a woman, if both sexes have germ cells and the woman is capable of conception and childbirth, then assisted reproductive medicine can be used. If a woman is unable to carry a child to term, a surrogate mother may be an option. However, surrogate mothers are not allowed in Japan.[75]

In the case of homosexual couples, it is possible to conceive if iPS cells are created from somatic cells, germ cells are induced, and then artificial insemination is performed. In the case of same-sex couples, it is necessary to clarify how their relationship is legally positioned. The Constitution of Japan states that "Marriage shall be formed solely on the basis of the consent of both sexes" (Article 24). On the other hand, Article 14, which states that "All citizens are equal under the law and shall not be discriminated against in political, economic, or social relations on the basis of race, creed, sex, social status, or family origin. This is also the text of Article 14. There is a difference of opinion as to what is meant by "both sexes," whether it is a man and a woman or the parties to a marriage, and whether the decision is consistent with the concept of equality under the law.

In the case of three or more, no embryos can be created through fertilization. The use of genome editing may be theoretically possible, but it has no ethical justification at this time.[76] Therefore, it is not a socially acceptable option at this time.

The Assisted Reproductive Treatment Law states that the mother of a child born through assisted reproductive treatment using the eggs of another person shall be the woman who gave birth to the child (Chapter 3).[77] This law also stipulates that a husband who consents to assisted reproduction using another man's sperm cannot deny the legitimacy of a child conceived through such medical treatment, i.e., the husband becomes the father (Chapter 3). As mentioned earlier, pregnancy and childbirth by a surrogate mother is not permitted in Japan. These current laws and the views of the academic community differ from our position, which emphasizes the importance of genetic connection. If we stick to our position, it will lead to the acceptance of surrogate mothers and beyond. However, our goal is to create a society where people can have children with genetic ties if they wish, and we do not exclude others. Therefore, we believe that it is possible to coexist. It will have to be clarified in the future whether the genetic link or the actual birth mother is more powerful in recognizing the parent-child relationship.

Next, consider the point about “anytime”. As stated in the goal of realizing a society where children can be born and raised, pregnancy, childbirth, and child rearing are considered to be

one and the same thing. The question is, what age does "anytime" mean, and what age does it have to be after reaching the age of majority? If we were to draw a uniform line based on age, wouldn't we be depriving those who are older than that of their free will to choose? Currently, even if a person wants to have a child, if the germ cells are not available, she may give up the pregnancy because she cannot have a child with a genetic link or because of the high health risk to the mother and child. If germ cells can be generated from stem cells and made available, these limitations will disappear. If we respect the free will of everyone who wants to have a child with a genetic link, then age is not the appropriate dividing line. It may be practical to set certain conditions in the light of common sense and custom. However, the question remains whether free will influenced by common sense and custom is truly free will, and whether the free will choices of those who do not wish to follow them should be respected.

Vision ② is the question of how society should be involved in individual child rearing. There are two problems. First, if society is viewed as a collection of individuals, this vision, which requires involvement in the children of others, so to speak, may deny free will choices to those who do not agree with the vision. If so, the assumption of respect for free will choices only apply to those who share the vision. Even if everyone agrees on the vision, it is essential to reach a consensus on how much of the society's overall resources should be allocated.

About Research and Development

Ethical, legal, and social issues of research and development that should be addressed to achieve MS goals

We will try to organize the issues according to the R&D items indicated in each vision. It is assumed that the problems pointed out for the vision have been resolved for the goals.

Vision ① is to make innovative advances in fertility prevention and treatment methods. It is the research and development of new assisted reproductive medicine. In the basic research stage, the Act on Securing the Safety of Regenerative Medicine and Other Related Matters (Act No. 85 of 1950) and the Ethical Guidelines for Life Science and Medical Research Involving Human Subjects must be observed.[78] In addition to the above, the Law Concerning the Quality, Efficacy and Safety of Drugs and Medical Devices (Law No. 145 of 1960) must be observed during the development phase and the conduct of clinical trials. In all cases, the plan must be implemented with the approval of the Ethical Review Committee or the Clinical Trial Review Committee in accordance with the regulations of the respective research institution.

The question is whether it is permissible to conduct research and development that is not permitted by law or guideline but has the potential to bring about innovative results. Examples of research and development related to pregnancy and childbirth include the use of germ cells

derived from stem cells, the use of genome-edited germ cells, the generation and culture of human embryos by cloning or nuclear transfer, the continued culture of human embryos, and the completion of pregnancy in an environment other than the human womb. Generating human embryos by nuclear transfer and using them for research has not been approved in the past. However, in May 2021, a revision to the "Guidelines for the Handling of Specified Embryos" and other guidelines was approved, allowing basic research using nuclear replacement technology on human fertilized embryos, which was previously not allowed, for the purpose of mitochondrial disease research.[79] In addition, human embryos should not be cultured for more than 14 days after fertilization, but the International Society for Stem Cell Research has revised its guidelines to allow culturing for more than 14 days.[80] The change is based on scientific rationality and social relevance. We expect more research to be approved on the same basis in the future. As for scientific rationality, research will be accepted if it meets certain standards of reproducibility and safety. On the other hand, with regard to social validity, we cannot avoid the issue of free will choice, the question of what a parent is and what a child is, and the question of who can and should be a parent of a child.

Vision ② aims to develop technologies that help people interact with each other. This is the use of information technology to alleviate the isolation and loneliness of parents during the child-rearing years, and the issues that have been examined in information ethics and how to deal with them are instructive.[81] Our goal is to develop technology to solve problems by watching over the entire society, predicting risks, extracting signs, and intervening. Risk prediction and prediction technology is necessary to identify the target of support, but it can also be a tool for discrimination and exclusion if used incorrectly. There should be no unethical research and development and use of artificial intelligence.[82,83]

Summary of ELSI

Although this section contains many negative statements about our vision, the author wishes to improve the current child-rearing environment and would like to see a society in which our vision is realized. However, it cannot be "I want it, so everyone else must want it, too. As long as we take respect for free will as our starting point, our own free will and respect for the free will of others should be equal.

There is an issue that could not be examined in this survey. This is the issue of social acceptance of technologies that support pregnancy, childbirth, and child rearing.

Vision 1 is to eliminate the burden on parents in child rearing mainly through technology. On the other hand, in pregnancy and childbirth, there are terms such as "natural pregnancy" and "natural childbirth" that emphasize the naturalness of the process. In child rearing, some believe that the burden and hardship of parents, especially mothers, is desirable. In the past,

it was television, and today, relying on smartphones to raise children is condemned. If we can clarify what kind of value is expressed by the term "nature" in this context, and what is behind the exclusion of technology in favor of nature, it will be easier to accept technology. Both visions (2) seek to free the burden of child-rearing from the problems of parents alone. In addition to the aforementioned friction between placing value on nature and the use of science and technology, parents of the child-rearing generation may have negative opinions about this. In addition to the aforementioned friction between the value placed on nature and the use of science and technology, there are also negative opinions from parents of the child-rearing generation: "My father (mother) went through a lot of hardship, so you should go through the same hardship.

These are just some of the things I have personally seen and heard, and I could not survey how many people actually experience this. Therefore, it is necessary to start by understanding the current situation to see if it is a problem in the first place.

Is having a child an extremely private matter, and is there no room for the involvement of others or society? Since the 1990s, Japan has been taking measures to reduce the birthrate by improving the working environment for parents and the childcare environment. What can be said from the results of examining the vision is that 'in order to realize the vision, it is necessary to rethink the system at the level of the constitution as well as the development of medical technology related to pregnancy and childbirth. This is a problem that cannot be trivialized into a problem involving only parents and children[84].

Thinking about ethical, legal, and social issues in research and development is not only about the merits and demerits of the technology being used, but also about the kind of society we want to create. In particular, in terms of our responsibility to the next generation, we should have in-depth discussions about what kind of society we want to create for the future generations who will live in the next era, and how we will use science and technology to realize that society.

IV. Conclusion

We began our research by first imagining the "ideal society" and then analyzing the gap between that image and contemporary society. Through interviews with experts, fieldwork, literature research, workshops with experts, and questionnaire surveys, we analyzed the problems and issues that are currently occurring. We used the design thinking method to comprehensively extract the pains and needs of the field, while attempting to structure the issues and causes using the systems thinking method.

Then, the goals to be addressed in the moonshot, i.e., the R&D items to be addressed as solutions to the above problems, were set as described above. The R&D items are not expected to overlap with other moonshot goals. We are also convinced that they have sufficient academic and social significance. The scientific and technological challenges do not exceed the laws of physics, and although they are challenging, we believe they are feasible.

Science and technology can contribute a great deal to "the realization of a society where everyone can have children and raise them with dreams and hopes for the future", which is the wish of the "Team for Building a Prosperous Society". On the other hand, it is not something that can be achieved simply by perfecting the technology. It is also not something that can be dramatically transformed or achieved in a single moment. We need interdisciplinary research and development, and we need to change our social systems, institutions, cultures, and customs. Each one of us must be aware that we are complicit in the creation of the current society. In other words, the gap between our vision and the current situation can surely be bridged through the efforts and collective wisdom of each and every one of us. I hope that the setting of this proposal as a moonshot goal will inspire the various stakeholders, each and every one of us, to share in this vision and to make sustained attempts and efforts to realize it. I also hope that by 2050, the world will be a place worth living in, where everyone can enjoy life with hope and pass on the future to the next generation and the generation after that.

V. References

[1] 毎日新聞 2020/6/6　東京朝刊
[2] 医療政策 vol 1, 政策提言：少子化と女性の健康, 国立社会保障・人口問題研究所第 12 回出生動向基本調査　結婚と出産に関する全国調査 2002
[3] 内閣府 選択する未来 2.0 参考資料、https://www5.cao.go.jp/keizai2/keizai-syakai/future2/20200409/shiryou2.pdf
[4] 「ＡＲＴデータブック」の「２０１３年ＰＰＴＸ版
[5] 第一生命経済研レポート 2021.2
[6] https://www.cnn.co.jp/photo/l/525850.html
[7] https://www5.cao.go.jp/keizai-shimon/kaigi/special/future/sentaku/s3_1_2.html
[8] https://www.mri.co.jp/knowledge/mreview/201812-6.html、三菱総合研究所「生活者市場予測システム(mif)」2018 年 6 月調査
[9] 内閣府大臣官房政府広報室 社会意識に関する世論調査（1986; 2019)より作成
[10] 内閣府 平成 19 年版国民生活白書（2007)を元に作成
[11] 国立社会保障・人口問題研究所「日本の将来推計人口（平成 29 年推計）」を元に作成
[12] 国土交通省「国土形成計画(全国計画)」(2008)を元に作成
[13] https://www.jiji.com/jc/article?k=2020111800736&g=soc&p=20201118ax04S&rel=pv
[14] ディヴィッド・ピーター・ストロー「社会変革のためのシステム思考実践ガイド」(2018）を元に改変
[15] https://ec.europa.eu/regional_policy/en/information/maps/quality_of_life
[16] https://www8.cao.go.jp/cstp/stmain/20200318siparchitecture.html

---

[1] "日立京大ラボ," (2021), https://www.hitachi.oi.kyoto-u.ac.jp.

[2] "スマートシティ官民連携プラットフォーム," (2021), https://www.mlit.go.jp/scpf.

[3] "一般社団法人スマートシティ・インスティテュート" (2021) https://www.sci-japan.or.jp

[4] "データとデジタル技術でつながる、豊かな未来を確かなものに," (2021), https://www.ipa.go.jp/dadc.

[5] NPO 法人ファイン,「仕事と治療の両立についてのアンケート」調査結果報告　プレスリリース, (2015), https://j-fine.jp/prs/prs/fineprs_ryoritsu1508.pdf.

[6] NPO 法人ファイン,「仕事と不妊治療の両立に関するアンケート Part 2」調査結果報告 プレスリリース, (2017), https://j-fine.jp/prs/prs/fineprs_ryoritsu2_1710.pdf.

[7] Lisa F. Berkman, The Role of Social Relations in Health Promotion, Psychosomatic Medicine 57, no. 3 , (1995) : 245-.

[8] Sheldon Cohen, Psychosocial models of the role of social support in the etiology of physical disease, Health Psychology 7, no. 3 (1988) : 269-.

[9] J. S. House, et al. Social relationships and health, *Science* 241, no. 4865 (1988) : 540-.

[10] Lisa F. Berkman et al.,「社会疫学. 上」, 大修館書店, (2017): 270-.

[11] 近藤克則、他, ソーシャル・キャピタルと健康, 行動計量学, 37, no. 1 (2010): 27-, https://www.jstage.jst.go.jp/article/jbhmk/37/1/37_1_27/_pdf.

[12] 内閣府 「平成 19 年版国民生活白書」, (2007), http://warp.da.ndl.go.jp/info:ndljp/pid/9990748/www5.cao.go.jp/seikatsu/whitepaper/h19/10_pdf/01_honpen/index.html.

[13] Ruca Maass et al., The impact of neighborhood social capital on life satisfaction and

self-rated health: A possible pathway for health promotion?, *Health & Place* 42 (2016) : 120-.

[14] 平山朋、他, 静岡県高齢者コホート調査に基づく運動・栄養・社会参加の死亡に対する影響について, (2012).

[15] Julianne Holt-Lunstad, et al. "Social Relationships and Mortality Risk: A Meta-analytic Review," *PLOS Medicine* 7, no. 7 (2010)

[16] Julianne Holt-Lunstad et al., Loneliness and Social Isolation as Risk Factors for Mortality:A Meta-Analytic Review, Perspectives on Psychological Science 10, no. 2 (2015).

[17] Dustin T. Duncan et al., Neighborhoods and health, Second edition. ed., (New York, NY: Oxford University Press, (2018).

[18] 内閣府 「平成 30 年版 防災白書」, (2018), http://www.bousai.go.jp/kaigirep/hakusho/h30/honbun/1b_1s_01_01.html.

[19] 内閣府大臣官房政府広報室 「社会意識に関する世論調査」, (1986), https://survey.gov-online.go.jp/s61/S61-12-61-15.html.

[20] 内閣府大臣官房政府広報室 「社会意識に関する世論調査」, (2019), https://survey.gov-online.go.jp/h27/h27-shakai/index.html.

[21] 厚生労働省「平成 18 年版厚生労働白書」, (2007), https://www.mhlw.go.jp/wp/hakusyo/kousei/06.

[22] 統計局統計調査部国勢統計課「平成 27 年国勢調査 参考表 年齢・国籍不詳をあん分した人口 年齢・国籍不詳をあん分した人口」, (2015), https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00200521&tstat=000001080615&cycle=0&tclass1=000001090735&tclass2=000001090736&stat_infid=000031496978.

[23] 国立社会保障・人口問題研究所「日本の将来推計人口（平成 29 年推計）出生中位(死亡中位)推計」(2017).

[24] 国土交通省「国土形成計画（全国計画)」(2008).

[25] 厚生労働省「令和 2 年度児童虐待相談対応件数」(2020), https://www.mhlw.go.jp/content/000824359.pdf.

[26] 厚生労働省「相対的貧困率等に関する調査分析結果」(2020), https://www.mhlw.go.jp/seisakunitsuite/soshiki/toukei/dl/tp151218-01_1.pdf.

[27] Peter M. Senge, 淳子 枝廣, 学習する組織 : システム思考で未来を創造する, 東京: 英治出版, (2011).

[28] 冠 中野, 宣明 湊, 経営工学のためのシステムズアプローチ : ビジネスを体系化する考え方・技法 , 講談社, (2012).

[29] David Peter Stroh, Systems thinking for social change : a practical guide to solving complex problems, avoiding unintended consequences, and achieving lasting results, White River Junction, Vt: Chelsea Green Publishing, (2015).

[30] 調麻佐志, 鳥谷真佐子, and 小泉周, "システム思考による新型コロナウイルス感染症

対策の可視化: 政府・専門家会議が検査を増やすことができなかった 「理由」," 科学技術コミュニケーション 27 (2020).

[31] Stroh, Systems thinking for social change : a practical guide to solving complex problems, avoiding unintended consequences, and achieving lasting results. (2015).

[32] "世界的に見ても貧弱な少子化対策　日本は子育て支援増額を　東大・山口慎太郎教授インタビュー," 東京新聞 TOKYO Web, (2020), https://www.tokyo-np.co.jp/article/71331.

[33] 内閣府, 令和 2 年度　年次経済財政報告, (2020).

[34] 内閣府, 平成 15 年度 年次経済財政報告 (2003).

[35] デロイトトーマツコーポレートソリューション合同会社, 働き方改革の実態調査 2020〜デジタル時代のワークスタイル〜｜デロイト トーマツ グループ｜Deloitte Japan (2021), https://www2.deloitte.com/jp/ja/pages/human-capital/articles/hcm/workstyle-survey.html.

[36] 労働時間短縮における課題の第 1 位は「業務量が多く、人員が不足していること」/HR 総研：「働き方改革」への取り組み実態調査【2】労働時間 - HR 総研 ¦ 人事のプロを支援する HR プロ, (2021), https://www.hrpro.co.jp/research_detail.php?r_no=159.

[37] Mark A. Tietjen and Robert M. Myers, Motivation and job satisfaction, Management Decision 36, no. 4 (1998).

[38] Edwin A. Locke and Gary P. Latham, WORK MOTIVATION AND SATISFACTION: Light at the End of the Tunnel, Article, Psychological Science (0956-7976) 1, no. 4 (1990)

[39] 【47 都道府県・地方別】平均年収ランキング 最新版," (2021), https://doda.jp/guide/heikin/area.

[40] 厚生労働省「国民生活基礎調査」(2019) https://www.mhlw.go.jp/toukei/saikin/hw/k-tyosa/k-tyosa19/dl/03.pdf.

[41] 総務省「要保護児童の社会的養護に関する実態調査」(2019) https://www.soumu.go.jp/main_content/000723069.pdf.

[42] お茶の水女子大学, 「平成 25 年度全国学力・学習状況調査の結果を活用した学力に影響を与える要因分析に関する調査研究」(2014).

[43] 厚生労働省「賃金構造基本統計調査（学歴別)」 https://www.mhlw.go.jp/toukei/list/chinginkouzou_a.html.

[44] 日本財団子どもの貧困対策チーム,「子供の貧困が日本を滅ぼす」, 文春新書, (2016).

[45] Lisa F. Berkman, "The Role of Social Relations in Health Promotion," Psychosomatic Medicine 57, no. 3 (1995), https://journals.lww.com/psychosomaticmedicine/Fulltext/1995/05000/The_Role_of_Social_Relations_in_Health_Promotion.6.aspx.

[46] 稲葉陽二, ソーシャル・キャピタル「きずな」の科学とは何か (京都: ミネルヴァ書房, (2014).

[47] 近藤克則・平井寛・竹田徳則・市田行信・相田潤, "ソーシャル・キャピタルと健康," 行動計量学 37, no. 1 (2010),

[48] 内閣府, 平成 19 年版国民生活白書, (2007).

[49] Ruca Maass et al., The impact of neighborhood social capital on life satisfaction and self-rated health: A possible pathway for health promotion?, Health & Place 42 (2016).

[50] 平山朋、他, 静岡県高齢者コホート調査に基づく運動・栄養・社会参加の死亡に対する影響について (2012).

[51] Julianne Holt-Lunstad, et al., Social Relationships and Mortality Risk: A Meta-analytic Review, PLOS Medicine 7, no. 7 (2010).

[52] 落合 恵美子, 21 世紀家族へ, 第四版 ed., 有斐閣選書, (2019).

[53] 広井 良典, 人口減少社会のデザイン, 東洋経済新報社, (2019).

[54] 内閣府 「ソーシャル・キャピタル : 豊かな人間関係と市民活動の好循環を求めて」, (2003).

[55] 内閣府経済社会総合研究所「コミュニティ機能再生とソーシャル・キャピタルに関する研究調査報告書」(2005), http://www.esri.go.jp/jp/prj/hou/hou015/hou015.html.

[56] Culture Department for Digital, the UK Government A connected society: a strategy for tackling loneliness, (2018), https://www.gov.uk/government/publications/a-connected-society-a-strategy-for-tackling-loneliness.

[57] Centre for Bhutan & GNH Studies Centre for Bhutan & GNH Studies, (2020), http://www.grossnationalhappiness.com.

[58] National Program for Happiness Wellbeing, the UAE Government National Program for Happiness & Wellbeing, (2020), https://www.hw.gov.ae.

[59] 大分大学福祉科学研究センター,「コミュニティカフェの実態に関する調査結果」, (2011).

[60] こども食堂ネットワーク, http://kodomoshokudou-network.com, (2019)

[61] 敷田麻実、他, 「中間システムの役割を持つ地域プラットフォームの必要性とその構造分析」『国際広報メディア・観光学ジャーナル= The Journal of International Media, Communication, and Tourism Studies』14 , (2012): 23-.

[62] 「増え続けるこども食堂　過去最大の年間 1,400 ヶ所増で全国 3,718 ヶ所に - Yahoo!ニュース」, https://news.yahoo.co.jp/byline/yuasamakoto/20190626-00131725,

[63] 「こども食堂 1 年で 1.6 倍、過去を上回るペースで増え続け、3700 箇所を超える」, https://musubie.org/news/993, (2020).

[64] Ivan Eisler, The empirical and theoretical base of family therapy and multiple family day therapy for adolescent anorexia nervosa, Journal of Family Therapy 27, no. 2 (2005): 104-.

[65] Lotte Holm, M åtidet som socialt fælleskap, Mad, mennesker og m åtide - samfundsvidenskaplige perspektiver, no. January 2003 (2003) : 21-.

[66] Janet Theophano et al., Sisters, mothers and daughters: food exchange and reciprocity in an Italian-American community, Diet and domestic life in society, (1991): 147-.

[67] 国民生活審議会調査部会コミュニティ問題小委員会報告, 「コミュニティ―生活の場における人間性の回復―」経済企画庁国民生活課, (1969).

[68] 日本都市センター, 「自治的コミュニティの構築と近隣政府の選択 : 市民と都市自治体との新しい関係構築のあり方に関する調査研究最終報告」日本都市センター, (2002).

[69] World Happiness Report 2020, (2020), https://worldhappiness.report/ed/2020.

[70] OECD Better Life Index, https://www.oecdbetterlifeindex.org/#/11111111111.

[71] What we measure - Australian Urban Observatory, (2021), https://auo.org.au/measure.

[72] 見守りサービスの申込みについて（新小学 1 年生以外の方）,加古川市, (2021), https://www.city.kakogawa.lg.jp/soshikikarasagasu/shiminbu/shiminseikatsuanshinka/ICT/30049.html.

[73] 最新システムエンジニアリング情報館, updated (2021), http://se.rdy.jp.

[74] データとデジタル技術でつながる、豊かな未来を確かなものに, (2021), https://www.ipa.go.jp/dadc.

[75] 代理懐胎に関する見解 会告 日本産科婦人科学会（2003 年 4 月 16 日）http://www.jsog.or.jp/kaiin/html/kaikoku/H15_4.html

[76] 日本学術会議哲学委員会いのちと心を考える分科会（2020 年 8 月 4 日）提言 人の生殖にゲノム編集技術を用いることの倫理的正当性について 日本学術会議 http://www.scj.go.jp/ja/info/kohyo/pdf/kohyo-24-t292-5.pdf

[77] 生殖補助医療の提供等及びこれにより出生した子の親子関係に関する民法の特例に関する法律 令和二年法律第七十六号.

[78] 2021 年 3 月 23 日付、文部科学省(2 文科振第 538 号)、厚生労働省（科発 0323 第 1 号、医政発０３２３第１号)、経済産業省（20210323 商局第 5 号）の三省合同通知「「人を対象とする生命科学・医学系研究に関する倫理指針」の制定について（通知)」

[79] 総合科学技術・イノベーション会議（第５４回）(2021) https://www8.cao.go.jp/cstp/siryo/haihui054/haihu-054.html

[80] Guidelines for the Field of Stem Cell Research and Regenerative Medicine, International society for stem cell research, (2021)

[81] 水谷雅彦, 情報の倫理学 「現代社会の倫理を考える」15,丸善, (2004).

[82] 人工知能学会の倫理指針, (2017), http://ai-elsi.org/wp-content/uploads/2017/02/%E4%BA%BA%E5%B7%A5%E7%9F%A5%E8%83%BD%E5%AD%A6%E4%BC%9A%E5%80%AB%E7%90%86%E6%8C%87%E9%87%9D.pdf.

[83] 村上 祐子, 人工知能の倫理の現在 ―研究開発における技術哲学・倫理の意義―, 電子情報通信学会 基礎・境界ソサイエティ Fundamentals Review, (2018): 155-.

[84] 白波瀬 佐和子, 少子化対策のいま, 学術の動向, (2008): 35-.