Modeling a Policy for Managing Polio Vaccine in Japan: Scenario Planning based on System Dynamics

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Abstract

This research is to provide a methodology for making policy scenarios based on the system dynamics. The authors deem this new methodology would be a useful tool for policymakers to make policy scenarios. As for the case study, this research deals with the policy scenarios for managing polioviruses in Japan as an example. This methodology includes both the simulation part of using System Dynamics and the conversation part related to Scenario Planning. Through using this methodology, we had structural understanding of the problem with the visible simulation results and conversation with member which was focusing on the parameters that would be a part of suggested scenarios. This methodology is expected to improve the public deliberations for making policy scenario based on data.

1 Introduction

This research is to propose a methodology using system dynamics with scenario planning in a case of making policy scenarios for managing polioviruses in Japan. And we validated the usefulness of the methodology.

Polio is known as an acute infection which arises when the poliovirus is infected to central-nerves tissue. Currently, the only Oral Polio Vaccine can be used as the polioviruses prevention depends on the law in Japan. It is known that Oral Polio Vaccine rarely causes symptoms of paralysis and secondary infection. In 2011, the parents who have infants worried about the side effects of the Oral Polio Vaccine, the movement which kept from polio vaccination have occurred in Japan.

According to an investigation for polio vaccination rate, which is conducted by the Government of Japan, the number of Oral Polio Vaccine inoculation rate from April to June in 2011 was decreased by 17.5% as the national average comparing with the corresponding-period-of-last-year in Japan (MHLW, 2011).

There is an Inactivated Polio Vaccine as a substitute of Oral Polio Vaccine. It is known

that it has very little possibility of appearance of symptoms of the paralysis which is the side effects that Oral Polio Vaccine has. However, the clinical trials for introducing Inactivated Polio Vaccine are currently on-going in Japan.

Besides, the wild polio viruses are decreasing in the world, but they continued to circulate in some countries (Nigeria, India, Pakistan, Afghanistan, etc.) in 2010. And there are much traffic between the countries and Japan. Therefore, the possibility of infection to Japan from the area where wild polio viruses circulate cannot be denied. And since the curative drug to polio does not exist, the prevention of polioviruses using a vaccine is still an important policy countermeasure.

2 Literature Review

System dynamics is known as an effective systematic method of making a policy scenario. And there are some researches which discussed System Dynamics and scenarios making related to the theme of the infection disease policy (Pruyt, 2010; 2007). However, the main interest is the model comparison for the simulation, and the framework which derives policy scenarios was not discussed as the main subject.

There is a research which discussed System Dynamics and Scenarios Planning related to the theme of making strategy (Andrea, 2004). However, the main interest is the differences of the approaches between the standard manager analysis and the methodology proposed, and the application of using the methodology was limited to making company strategies.

There are research which treated epidemic processes using simulations of mathematical models (e.g., Kermack & McKendrick, 1927; Anderson and May, 1991; Nishimura, Kakehashi & Inaba, 2009), and a research which treated decision-making of polio vaccine policy in 1950s using SD model of system dynamics (Thompson KM, et al, 2006). However, we could little find a research which described the policy scenario in the group which keeping high immunization rate like present Japanese situation.

As a research of the behavior of epidemic process, there is a research which mentioned the usefulness of simulation regarding the efficacy of the preventions (Yang, 2009). However, that did not show the conclusion as a policy scenario which was derived from simulation results.

Regarding the importance to make a prediction about the future of the environment changes using mathematical methods is descried, but we rarely find the way of finding the controllable parameter from the mathematical method and relation between the parameter and the scenario which is lead as a solution (Kees, 2004).

This research also pursues the new way to create a public policy by combining the system dynamics and the scenario planning. One the one hand, the conventional approach of the system dynamics to create a public policy stresses the significance to make the complex relations of casualties simple and visible (e.g., Stave, 2002; Homer and Hirsch, 2006). However, this approach often refers to less method to make a policy maker visionary for the future policy courses. On the other hand, the conventional approach of scenario planning refers to the importance of assumptions for the future policy courses, but not to causal backgrounds why such assumptions can be rational (Fleisher and Bensoussan, 2002). Thus by bridging the causal backgrounds drawn by the system dynamics and visionary outcome enriched by the scenario planning, this research provides a consistent and cause-based platform of policy creation.

3 Design of SSP Methodology

3.1 Outline of the methodology

This research called the methodology System Dynamics Driven Scenario Planning “SSP” (Figure 1.). The hypothesis of this research is that the methodology which this research proposed is effective for policy scenario making. And we empirically validated the effectiveness of SSP in a case of policy scenarios for current Japanese polio issue.

To confirm the effectiveness of SSP, we derived policy scenarios using this methodology. The design of the methodology is shown below.

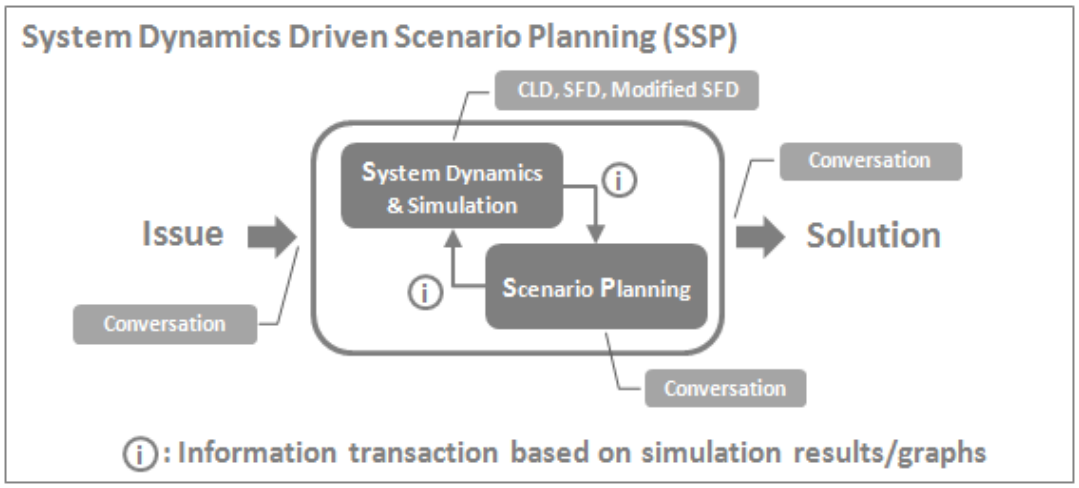


Figure 1. Design of SSP methodology

The SSP is a methodology for creating policy options based upon the system dynamic and scenario planning in the cycling process. Once an issue is input in it, then scenarios are output as a solution. When the issue inputs and the solution outputs, conversations will be held in accordance with the method of Scenario Planning.

Those conversations are an approach in the process of scenario making by considering the environmental structure which surrounds the issue or causal relationship with the stakeholders.

And in this methodology, the simulations using SD model are performed repeatedly. Then, this research gets a better scenario as a result. In this process, the simulation results play the role to tie System Dynamics and Scenario Planning. So, the simulation result is used as a vehicle of information to connect both methods.

The methodology finally generated the policy scenarios against the issue and we proposed them.

3.2 Basic Causal Loop Diagram (CLD) And Stock-Flow Diagram (SFD) for Infection Disease

We are able to easily perform the simulation using any tools or programming with those basic models which are the Causal Loop Diagrams (hereinafter referred to as the “CLD") (Figure 3.) and the Stock-Flow Diagram (hereinafter referred to as the “SFD") (Figure 4.) for infection disease.

Those diagrams are known as CLD and SFD to show an infection disease expansion process (Sterman, 2000; Pruyt, 2010). To be consistent with the mathematical model, the parameter of "Contact rate" was excluded from those diagrams.

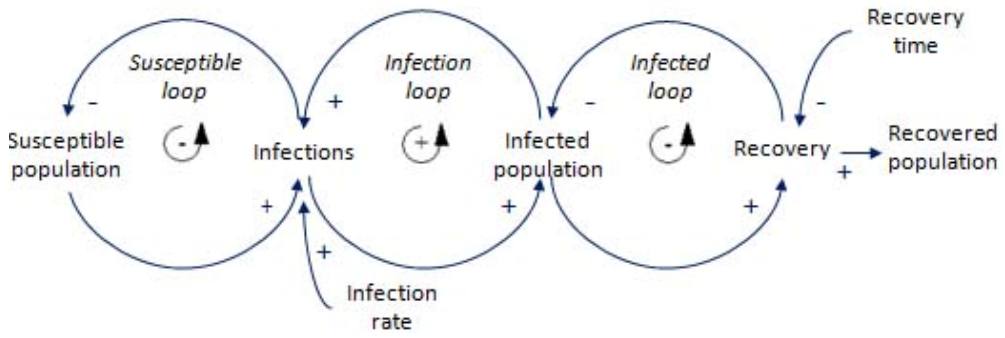


Figure 3. Causal Loop Diagram (CLD): Basic Infection Model

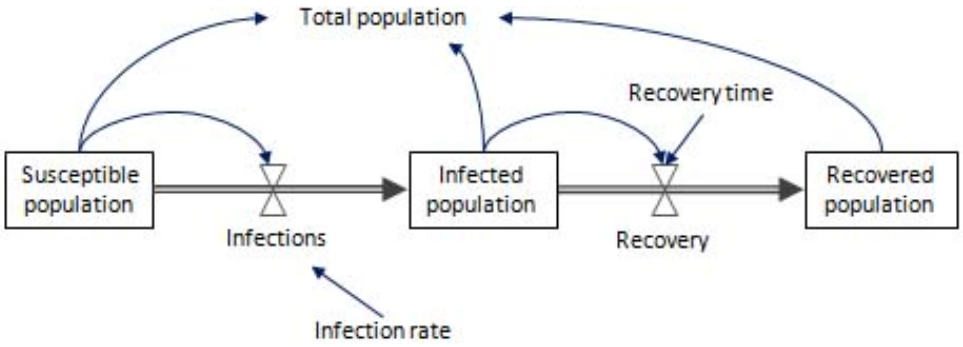


Figure 4. Stock-Flow Diagram (SFD): Basic Infection Model

SD model strongly relates to CLD and SFD. Once the CLD and SFD are generated, the analyst could realize the model and get simulation results using them. The CLD and SFD become basic tools whenever making a change to the model. Then after generating the model for the simulation, it is easy to modify them depends on the diagram changes. Then, this approach is easy and very effective to keep the accuracy of the simulation results for not only policymaker but also everyone.

3.3 Why does a problem-owner need to have conversations to generate scenarios?

Conversation is an approach in the process of scenario planning by considering the environmental structure which surrounds the issue or causal relationship with the stakeholders. Scenario Planning is known as an effective way to cope with uncertainty by considering multiple, equally plausible futures as well as traditional and conventional way of thinking (Kees, 2004).

And this research defines the meaning of scenario is below:

> Thinking the issues associated with the future, two or more possibilities are made as stories while thinking about the movement of the environment in the surrounding and other relating subjects. Then the outputs from this thinking are called scenarios.

> The scenario is a kind of hypothesis. If it is validated, it becomes an established theory. Therefore, scenario is a speculative idea until being validated.

Merits and demerit of conversation approach

There are both merits and demerits to have conversation in order to generate scenarios. But the authors considered there are more merits than demerits to improve the accuracy of the generated scenarios as a solution through the conversation. The merits and demerits are below:

Merits:

There are merits to have conversations to generate scenarios.

- Understand and share ideas among its members and implement organizational learning
- Examine an essential solution to the issue by multi aspects
- Reduce missing some critical things
- Get rid of the self-righteous of the person in charge of the analysis
- Construct network between stakeholders
- Secure social trust by examination in a group

Demerits:

The two biases are thought as the demerits when we have conversations to generate scenarios.

Selection bias is:

- Bias that happens when the group is not correctly representing proper opinion. For instance, only noncooperation persons or aggressive cooperator.

Information bias is:

- Bias that happens because information obtained is not correct when it is observed. For instance, very limited information or depending on their memories.

And the conversation is a kind of human-interface whose objective is to confirm the important decision among the member.

3.4 Process of SSP methodology

This section describes the process of methodology (Figure 6.).

Firstly, this process defined the issue having a conversation with the stakeholders as an approach of Scenario Planning. Then we made the model of the issue with CLD and SFD of System Dynamics. After that, this research conducted a simulation to know the behavior of polio epidemic process. Once the simulation was implemented, the authors were able to make hypothesis and find target parameter through having conversation. And it re-generated the model depends on the simulation results and reflected the target parameter which is discussed among the member. Finally, this research confirmed the policy scenarios based on the simulation results by having conversation.

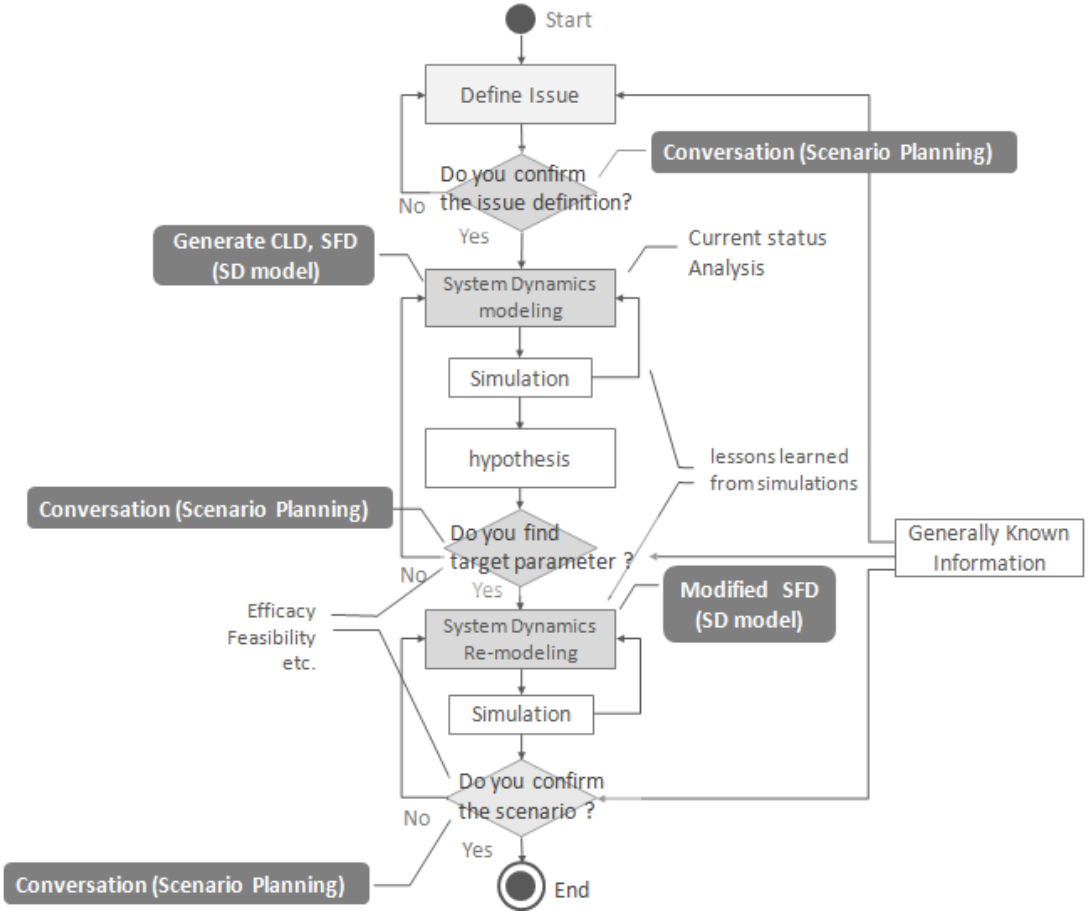


Figure 6. Process of SSP methodology

4 Example Application

In order to recognize the current status of Japanese polio issue, the authors performed the simulations to know an epidemic process. This research proposes the use of SD model for the simulation to derive a policy scenario. Though it is known that a simulation is useful for a discussion regarding infectious diseases countermeasures, the discussion process which is based on a simulation result is tied to a policy scenario is rarely described in previous researches. This research realized that this is a point which was not covered by using SD model for making scenarios. And the authors deemed that we are able to resolve this issue by using SD model with Scenario Planning method.

In this section, firstly, this research described the importance of the Herd Immunity with vaccine in the area of epidemiological research. Next, we mentioned the usefulness of the simulation of System Dynamics in epidemic process research. In addition, it showed the results of simulation related to the polio epidemic process by using SD model. Finally, it performed the Scenario Planning based on the results of the simulations.

4.1 Importance of the Herd Immunity with vaccine

There are two important concepts in epidemiological research.

① H: It is believed that immunizing some members of a community against a disease would protect the entire community and that this called herd immunity could be used to control infection outbreaks. The immunized rate in a group is called Herd Immunity (hereinafter referred to as the “H").

② R0: The number shows the strength of reproductions that the infectious disease spreads from the human to the human. This is called Basic Reproduction Number (hereinafter referred to as the“R0"). This is an average number of second infected persons who were infected from an infected person.

The followings are the relational expression of these concepts (1.1).

$$H = (1 – 1 / R0) \times 100 \quad (1.1)$$

For instance, R0 5-7 and H 80-86% is known as Poliovirus. R0 5-7 means that a person who is infected poliovirus will infect 5-7 persons on the average. H 80-86% is a concept that the epidemic of the infectious disease doesn't happen if a group has immunization rate of 80-86% or more. In other words, the value of H becomes the boundary whether the epidemic happens or doesn't happen. It is called the Herd Immunity Threshold.

Also, R0 and H of the infectious diseases other than poliovirus are known below (Table 1.).

Table 1. Basic Reproduction Number and Herd Immunity thresholds

Infection	R0: Basic Reproduction Number	H: Herd Immunity thresholds
Mumps	4-7	75-86
Polio	5-7	80-86
Measles	12-18	83-94
Malaria	5-100	80-99

H=(1-1/R0)*100 Fine PEM: Epidemiologic Reiews 15; 265, 1993 (modified)

4.2 Purpose of simulation for the epidemic process research using System Dynamics

First of all, the use of SD model for the research of epidemic process is intended NOT to find the time point and the route where an expansion of epidemic happen. But, the purpose of using simulation is rather to confirm how the behavior of the epidemic process is changing by setting different values of parameters (Meadows and Robinson, 1985). In addition, by changing values of the parameters, or by changing the model according to analyzed environment and object, we could learn the behavior of the epidemic process from the simulation result.

4.3 Simulations: Polio epidemic process using SD model

This research confirmed the behavior of the epidemic process of polioviruses using simulations. The purpose of those simulations is to make policy scenarios for the polio issue in Japan.

Firstly, this research performed the simulations to know the possibility of occurrence of the polio epidemic for two years among a group of one million people that reflected the Japanese status which is decreasing Oral Polio Vaccine vaccination in 2011. Next, it performed the simulations to know the possibility of epidemic in a group of 50 infants which is including the infants who did not have the polio vaccination in 2011. Then, it discussed a parameter which could be a factor of solution. It was a contact rate. The authors thought the contact rate could be a parameter which has possibility to control the behavior of the epidemic process. Finally, this research conducted the simulation to know the effectiveness with the virtual group of 50 infants using contact rate as a parameter.

Simulation 1: Confirmation of the process of polio epidemic in a group of one million person including adults

From the results of simulation 1, the authors realized that the epidemic would not happen in a group of one million people including adults even if its Herd Immunity is decreasing by 17.5% per year for over 2 years from 2011.

The number of births in 2010 is estimated that 1.57 million people and birthrates per 1000 population are 8.4 in Japan (MHLW, 2011). In 2011, The decreasing of the Oral Polio Vaccine vaccination having been seen in the infants who were recommended to dose in the age of from six months to one year and half years old. The decreasing rate in 2011 was 17.5% compared with the simultaneous in period 2010.

Based on these Japanese situations, the authors conducted the simulation using a virtual group of one million people which is the same population ratio of the adults and infants of Japan. Before the simulation, they generated the SFD which reflected the Japanese situation decreasing the polio vaccination of infants for over two years by 17.5% annually (Figure 7.). This model is almost the same as the basic SFD of infection disease (Figure 4.), but the model is constructed by two parts. One is the part of adults and another is infants. And we put the “contact rate” in the both parts to clearly specify it as a parameter. In addition, they put “Immunized decreasing rate” in the part of infant. The “immunized decreasing rate” means the rate of infants who kept from polio vaccination in 2011.

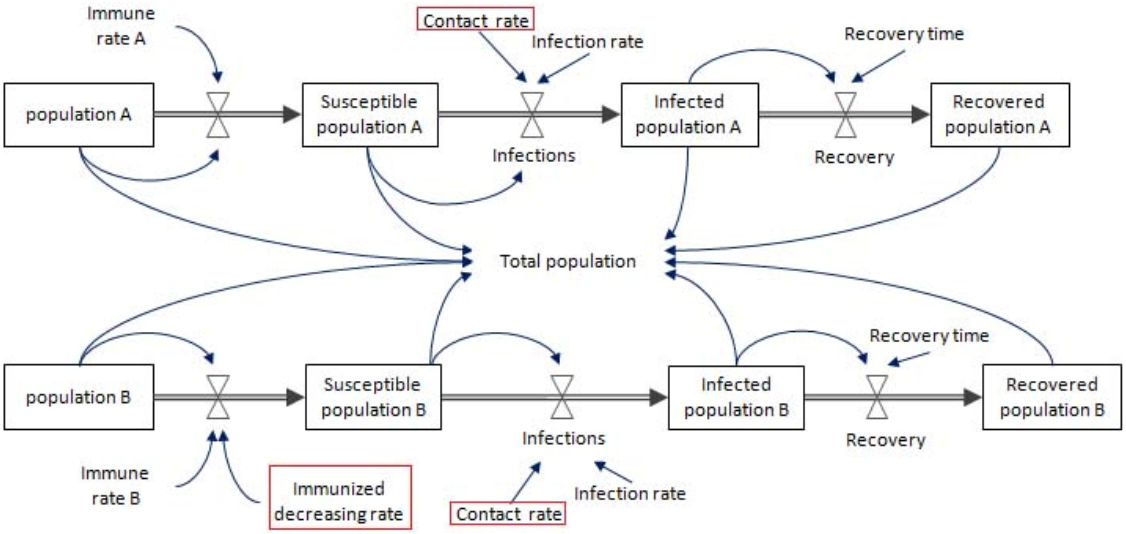
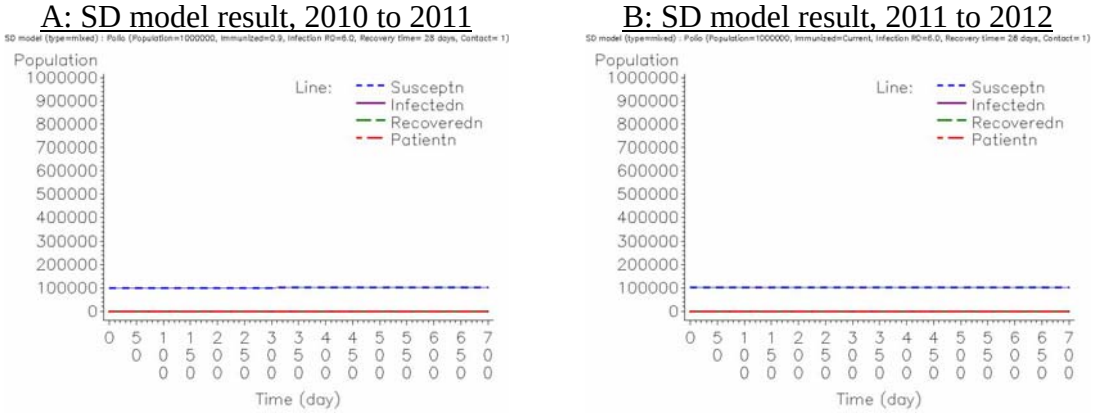


Figure 7. Modified Stock-Flow Diagram (SFD): Infection Model Including Immunized Decreasing Rate

The simulation result using the model is below (Figure 8.).



Condition: Disease=Polio, R0=6.0, Recovery time=28 (day), Population=1M, Default immunization rate=90% & Current

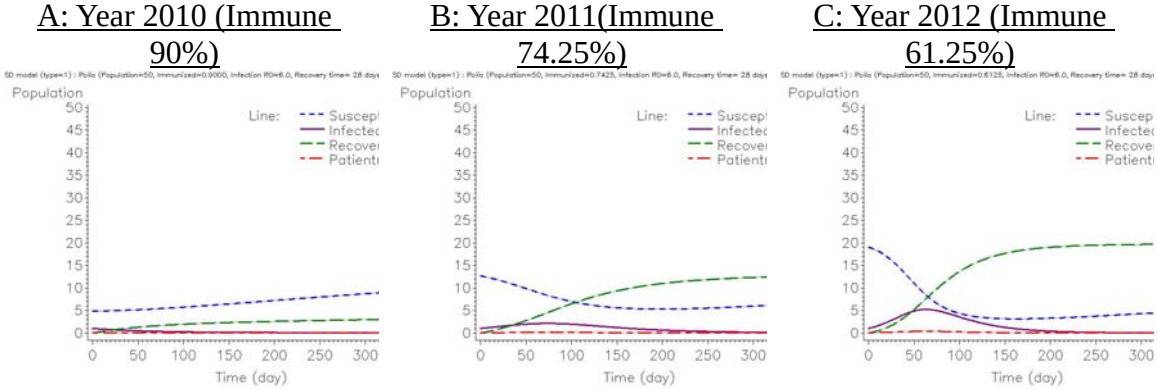
Figure 8. Polio epidemic process in a group of one million person including adult

The authors learnt that there were no changes from the simulation results. This means, even if the influence of keeping from infant vaccination in 2011 is considered or not, that the epidemic does not occur in the group of one million people including adults and infants. The reason why the epidemic does not occur is that the population of the infant is very small. Therefore, the epidemic of polio will not be caused in the group of one million persons even if the group includes the infants who kept from vaccination decreasing at the rate of 17.5% for over two years in the future.

Simulation 2: Possibility of polio epidemic in a place where infant gathers a lot

The authors learnt that there was a possibility of the polio epidemic in a group which gathers infants after 2011. Possibly, the places where the infants are gathered lot are a child care place or hospital, etc. The infants who including the infants kept from the polio vaccination are gathered those places.

In this simulation, they would like to know the possibility of occurrence of polio epidemic in a group of 50 infants including the infants who kept from the vaccination. As the condition in this simulation, we set the immunized rate in 2010 is 90%, in 2011 is 74.25% and in 2012 is 61.25% which reflected Japanese situation (Figure 9.).



Condition: Disease=Polio, R0=6, Recovery time=28 (day), Population=50, Default immunization rate=60, 70 and 80%

Figure 9. Influence of immunization rate in an infant group a lot in 2012, 2011 and 2010

In the simulation, it was learnt that the polio epidemic would occur after 2011. This meant, if a polio virus holder entered the group, an epidemic of polio was caused in the group. In this case about 10 infected persons by the accumulation in 2011 are generated. In addition, the result is understood that there is a possibility that about 20 infected persons in the group are caused by the accumulation in 2012 when the decreasing rate of kept from vaccination was 17.5% in the annual rate continues after 2011.

Simulation 3: Behavior of polio epidemic process by change of the parameter "contact rate" that could be controlled in an infant group

The authors learnt that it caused the delay of infection expansion by controlling the contact rate through the simulation.

Before the simulation, based on the results of Simulation 2, this research discussed the parameter to control the infection expansion. Then it focused on contact rate as a parameter which could be controlled by any regulations or restrictions.

When it focused on the contact rate, we had known that some parameters which effect changes to the behavior of epidemic process were seen in the SFD, Figure 6. For instance, they are the parameters like group immunization rate (Immune rate), infection rate (Infection rate), recovery period (Recovery time) and etc. However, these parameters are characterized by each infectious disease. Therefore, it is difficult to use

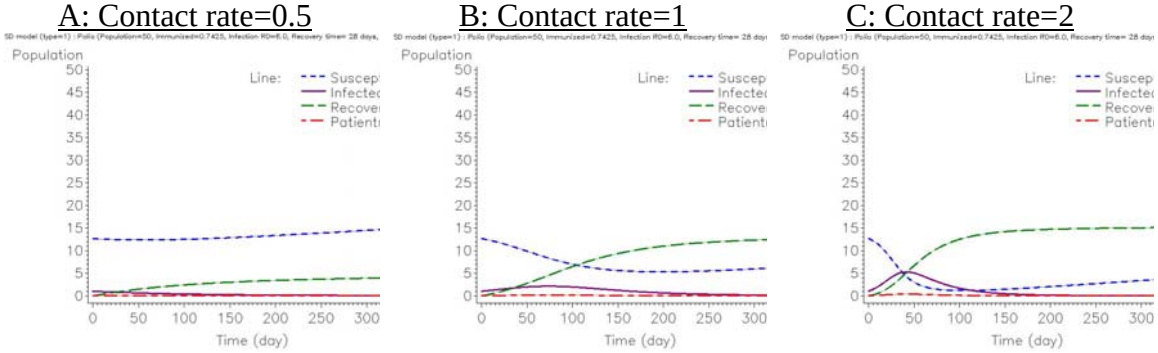
them as controllable parameters. On the other hand, the contact rate (Contact rate) may be possible to control it as a parameter. Then we listed those parameters below (Table 2.) to show those parameters are whether controllable or not.

Table 2. Listing of parameters which can be possibly controlled or not (in case of Polio)

Possibility of control	Descriptions	Value
No	Basic Reproduction Number (R0)	5～7
No	Recovery time (infectious period)	3～5 weeks
No	Herd Immunity (H)	90% (-17.5% per yr for infant)
Yes	Contact rate	Greater than or equal to 0
Yes	Frequency of hand washing	Greater than or equal to 0

It was understood that the parameter which has effectiveness against the poliovirus expansion is contact rate and a frequency of hand washing from the listing, Table 3. However, the research considered a quantitative effect of the frequency of hand washing might be not clear. Then this research excluded it from the candidate of parameter which would derive scenarios.

Then it performed simulations that the contact rate is set as a parameter. The values of contact rates were set to 0.5, 1, and 2 in this simulation (Figure 10.). In this case, the authors set the average normal contact rate in the group is Contact (rate) =1. And R0=6 which is known by the epidemiologic research for polioviruses. The group which is used for the simulation is a virtual 50 infants group including the infants who kept from polio vaccination which reflected present Japanese situation in 2011.



Condition: Disease=Polio, R0=6, Recovery time=28 (day), Population=50, Default immunization rate=74.25%

Figure 10. Influence of contact rate in an infant group including infants who kept from polio vaccination

When it set to Contact=1, as the peak of the infection, about 10 cumulative infected persons were caused around the day 80. And when the contact rate is set to 0.5, the epidemic did not happen. In contrast, when contact rate is set to 2, about 15 cumulative infected persons were caused around the day 40 as the peak.

4.4 Simulation results summary

This research exercised performed three simulations above. And the results lead the scenarios for Japanese polio issue. In this process, it focused on the effectiveness of contact rate which was a parameter for changing the behavior of the epidemic process in the simulation. In particular, it implemented Simulation 3 followed by Simulation 2. This sequence is very important to find and confirm the parameter that leads the scenario.

The following were the results which were clarified by above simulations.

- Polioviruses would not occur epidemic over the next two years in the group of one million person including the adults and infants.
- There was a possibility of the polio epidemic in the group of 50 infants including the infants who kept from polio vaccination.
- A parameter "contact rate" caused the delay of expansion of polioviruses in the group.

This research completed two scenarios from policy aspects with conversations based on the results of simulation. The conversations are an approach in the process of Scenario Planning. One of the scenarios is for a polio prevention scenario in usual status and another is for an epidemic scenario in a large group including adults and infants.

Two scenarios from policy aspects
- Prevention in usual status
- Delay expansion in epidemic status by decreasing contact rate

4.5 Flow of leading scenarios through this methodology

The flow of the Scenario Planning using System Dynamics for epidemic issue is shown below.

1. Define and confirm the issue through conversation
2. Recognize current status using simulation results
3. Make a hypothesis to solve the problem
4. Figure out the parameters which change the behavior of epidemic process using CLD, SFD, simulation results and generally known information. And confirm it.
5. Learn the effectiveness of the parameter which influence the epidemic process using re-modeling SFD and simulation
6. Verify the feasibility of the parameter using generally known information and generate scenario.
7. Confirm the scenarios through conversation

Some of those procedures would be repeatedly performed for making scenarios with CLD, SFD and the simulation.

4.6 Policy scenarios for Japanese polio issue

These authors conducted the following scenarios by using this methodology.

Scenario 1: Vaccination policy using Oral Polio Vaccine in usual status

The research developed a scenario that the vaccination policy using Oral Polio Vaccine in usual status from a policy aspect by taking into accounts the result of Simulation 1. This scenario means that we thought it was an important policy to continue the vaccination with Oral Polio Vaccine to current Japanese polio issue.

Because, the polio epidemic is observed in some foreign countries, and the spread to Japan is also undeniable. Therefore, it is necessary to keep the high immunized rate for the prevention of polioviruses in Japan.

And the following are generally known information as prevention ways of keeping from infectious disease,

Generally known information: Prevention of infection disease	
Population-level	Herd Immunity by vaccination
	Water and sewerage

It was learnt that the current Herd Immunity did not cause polio epidemic over next two years from the simulation results. And, it is known that the necessity of keeping Herd Immunity level by vaccination to prevent infection disease in a population level. As described above, the authors judged that keeping Herd Immunity in a group is the most important thing from a policy aspect. Besides, the confirmation of the risk of Inactivated Polio Vaccine in Japan was still ongoing. So, the necessity for the usage of Inactivated Polio Vaccine with unknown risks and spending additional public expense is not high priority. Therefore, in this research, it proposed as a prevention scenario in a usual status was the necessary of continuing the vaccination using Oral Polio Vaccine. However, it also would suggest that the Inactivated Polio Vaccine should be promptly taken the place of Oral Polio Vaccine after evaluating its efficacy and safety in Japan.

Scenario 2: Delay expansion of infection disease in the epidemic status by decreasing contact rate

From the results of Simulation 2 and 3, this research developed a scenario from a policy aspect that is by controlling the contact rate in epidemic status, it would delay the expansion of infection disease.

Details process of the scenario making is as follows. It had been understood that Herd Immunity in Japan had been decreasing because of keeping from the vaccination of Oral Polio Vaccine. And it had been learnt that the possibility of epidemic in an infant group in 2011 was undeniable from the result of the Simulation 2. At the same time, by the Simulation 2, it could be understood structurally how the infection was expanded. Additionally, the authors researched population level countermeasures which were generally known in an epidemic status.

The following are generally known as population level countermeasures against

epidemic.

Generally known information: Countermeasures against epidemic	
Population-level	Temporary closing of classes, School closure Canceling of meeting

This research selected the contact rate as a parameter that influenced the epidemic process based on the result of the Simulation 2 and generally known countermeasures for a population level in epidemic status. And, it performed the Simulation 3 to confirm the effectiveness of contact rate in the simulation. As the result, it confirmed that decreasing contact rate caused delay of expansion of infection. It identified this was a factor which leads scenario from a policy aspect.

5 Discussion

This research proposed two scenarios from a policy aspect against the Japanese polio issue

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1) In usual status
   - Continuation of the vaccination with Oral Polio Vaccine.
   - From the safety concern, recommendation of early introduction of the Inactivated Polio Vaccine.

2) In epidemic status
   - By decreasing contact rate, it is expected that controlling expansion of infection in epidemic status.

These scenarios supported the generally known countermeasures from epidemiologic researches. However, the behavior of the polio epidemic process could be recognized quantitatively by the simulation results using SD model and Scenario Planning method in this research.

By being clear the reasons why these scenarios were selected against the Japanese polio issue, additional policy discussion can be expected to be activated. For instance, they might be discussed below. Those are additional topics which lead by the conversation with stakeholders. This is the secondary efficacy of using this methodology.

- Improvement of the environment of watching infection disease and information transmission in domestic and foreign.
- Operation procedure in case of epidemic happens and the way of keeping everyone informed it.
- Confirmation of time to secure the vaccine in emergency
- Backup of forcibly isolate from the infection, traffic interception, work restriction and etc. which are expected when the infection disease expanded.

In addition, the authors expect other applications of SSP to other topics in addition to

the case of Japanese polio issue. For instance, it may be an unemployment policy issue. The model that workers move from current industry to other industry is similar to the model of infection disease. Then the simulation results would show the transition process visibly. And the results could lead a scenario against the unemployed issue by finding the factor that controls the behavior of transition. After that, the scenario might cause decreasing the insurance cost which is a finance pressure for the government.

Therefore, it is expected that the possibility of making scenarios based on data not only the Japanese polio issue but also the unemployed issue and others by using simulation results of SD and discussion.

6 Conclusion

This research was to propose a methodology for making scenarios called SSP. And it tried to validate whether SSP lead the policy scenarios in the case of Japanese polio issue. And it validated that SPP could lead some policy scenarios.

The SSP is a methodology composed of understanding of the structural clarification of the problem with visible results from performing simulations based on System Dynamics and scenario making through conversations which are an approach in the process of Scenario Planning. This methodology generated the scenarios as the solution derived from the simulation results for Japanese polio issue.

The flow of this research is that, firstly, it defined the issue with conversions. And it performed simulations to know the epidemic process in a case of current Japan polio issue. By performing the simulations, it found a parameter which would change the behavior of the epidemic process in the simulation. Then it executed another SFD model and simulation using the parameter that is contact rate. From the simulation results, it visually and quantitatively recognized the parameter impacted the behavior of the epidemic process. Therefore, the authors were able to lead the scenarios against the Japanese polio issue from a policy aspect using the parameter.

The authors expected this methodology which we proposed in this research will contribute to activate the discussion of making policy scenarios based on data.

7 Further research

As a further research, there might be other aspects and parameters that should be discussed in this research. In This research, we generated two scenarios against the vaccination of Oral Polio Vaccine in Japan from a policy aspect. But, for instance, In addition to the policy aspect, there may be some aspects from health care practitioners such as medical doctors and the nurse who related to the infectious disease treatment, or an aspect from parents of infants. Moreover, although this research specified the contact rate for the parameter, other parameters should be discussed using different models which cause change of the behavior in the epidemic process. The authors would like to reflect them into the models in the further research.

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