SEARCHING EFFECTIVE POLICIES TO PREVENT BIRD FLU PANDEMIC IN BANDUNG CITY USING AGENT BASED SIMULATION

Santi Novani[1], Manahan Siallagan[2], Utomo Sarjono Putro[3], Hiroshi Deguchi[4]

snovan8@yahoo.com, manahan_siallagan@yahoo.com, utomo@sbm.itb.ac.id,deguchi@dis.titech.ac.jp

[1,2,3]School of Business and Management

Institut Teknologi Bandung

Jl. Ganesha No. 10, Bandung 40132, Indonesia

[4]Tokyo Institute of Technology

Abstract

Bandung is surrounded by mountain range gives the city a cool climate throughout the year, so have temperature and humidity low. In Bandung, everything moves in slower pace than metropolitan life in Jakarta. With population of over two millions, as a lifestyle, some of families in Bandung raise fowl such as chicken or bird. New type of bird flu is now spreading. There are assumptions that the pandemic probably spread among the poultry farmers or workers, but so far we can not make such a conclusion. Government had give some recommendations through National Strategic Planning to control bird flu pandemic, but it's a complex problem. Vaccination and anti virus drugs are not the sufficient answer for the problem. To prevent the pandemic, government must take steps not only from medical policies point of view but also from social and culture policies point of view. Accordingly, this paper develops a basic model of simulation and proposes some policies by using agent based modeling to study dynamic interaction between human activities, especially in Bandung City. Based on the infection process model for pandemic depending on social and culture simulation using SOARS [deguchi, et.al, 2007], it will be studied the effectiveness of several strategies or policies for Bandung City.

Keywords: *bird flu pandemic, agent based modeling and simulation, infection models, social program*

1. Introduction

A bird flu pandemic is a large scale epidemic of the influenza virus, such as the 1918 Spanish flu. The World Health Organization (WHO) warns that there is a substantial risk of an influenza pandemic within the next few years. One of the strongest candidates is a highly pathogenic variation of the H5N1 subtype of Influenza A virus which is rapidly mutating and could mutate into a variation that transmits easily human to human causing a pandemic.

The majority of H5N1 flu cases have been reported in southeast, especially in Indonesia. H5N1 infections in humans are generally caused by bird to human transmission of the virus. Until May 2006, the WHO estimate of the number of human to human transmission had been two or three cases, but we must anticipate it before become global spread. To prevent the pandemic we must take steps not only from medical point of view but also from social and culture program point of view.

In Indonesia, the present policies (preparedness) for pandemic is only from medhical view, i.e. bird flu hospital, providing tamiflu capsule, 24 hours posko bird flu. Meanwhile, social program that had been done is risk communication to generate awakenss of people abaout personal protection to prevent bird flu. The objective of this research is to evaluate the effectiveness of social program to protect bird flu pandemic in Bandung City.

In this research, we will propose infection model for bird flu and then simulate it with data in Bandung city. We use Bandung city as a sample, because the spread of bird flu in this city was very high. Beside that, people activities in Bandung who take care the fowl such as bird or chicken. There are so many stall in Bandung. The average of house in Bandung has a small stall to keep their fowl, like chicken or bird, meanwhile there are so many big stall in Bandung which keep their fowl like chicken with number about more than 1000 chicken.

In this research, we use *Agent based simulation approach* to look interaction process dinamycaly between agent. Agents in this model are divided into groups, i.e. baby (0-5 years), schoolchild (6-12 years), student (13-18 years), young (19 -34 years), middle (35-59 years) and old (>60 years).

We will use three modules, i.e. stage disease transition module, contamination and infection model for bird flu based on Deguchi's research and people activities model in Bandung city which using social simulation by SOARS. To prevent this pandemic, not only required medhical support, but also social protection program policies by government, i.e. *social filter* (*virus excretion control*), attenuation contamination control with streilization and humidity, *virtual space density control* and *personal protection control*.

2. Bird Flu in Bandung City

Indonesia is the world's fourth most populous nation, an archipelago of 17,000 - 18,000 islands, 220 million people and 55 million households, 80% of which have backyard poultry flocks. 30 of its 33 provinces have reported infections, but it's likely all of them have infected birds. Doing the math, if 80% of Indonesian households have poultry, and 27% of these poultry flocks are infected, then of the 55 million people in Indonesia, about 12 million are in constant daily contact with H5N1. Based on that, the virus isn't highly infective to humans yet, chickens or no chickens.

The bird flu situation in Indonesia is not good. After 52 deaths in Indonesia from bird flu virus through September, several new cases were treated in several cities this month, including Medan, Bandung, Jakarta, Semarang, and Makassar. Indonesia has seen a steady rise in its number of human infections and deaths since its first known of outbreak of H5N1 in poultry in late 2003. To date the virus has infected 48 Indonesians killing 36 of them, 1600 chickens have been culled in a village in West Java. Following is the cumulative number of confirmed human cases of avian influenza A/(H5N1) reported to WHO as shown in table 1.

Table 1. Cumulative Number of Confirmed Human Cases of Avian Influenza A/(H5N1) reported to WHO

Country	2003		2004		2005		2006		2007		Total	
	cases	deaths	cases	deaths	cases	deaths	cases	deaths	cases	deaths	cases	deaths
Azerbaijan	0	0	0	0	0	0	8	5	0	0	8	5
Cambodia	0	0	0	0	4	4	2	2	1	1	7	7
China	1	1	0	0	8	5	13	8	2	1	24	15
Djibouti	0	0	0	0	0	0	1	0	0	0	1	0
Egypt	0	0	0	0	0	0	18	10	16	4	34	14
Indonesia	**0**	**0**	**0**	**0**	**20**	**13**	**55**	**45**	**21**	**18**	**96**	**76**
Iraq	0	0	0	0	0	0	3	2	0	0	3	2
Lao People's	0	0	0	0	0	0	0	0	2	2	2	2
Nigeria	0	0	0	0	0	0	0	0	1	1	1	1
Thailand	0	0	17	12	5	2	3	3	0	0	25	17
Turkey	0	0	0	0	0	0	12	4	0	0	12	4
Viet Nam	3	3	29	20	61	19	0	0	0	0	93	42
Total	4	4	46	32	98	43	115	79	43	27	306	185

The situation may have to be taken more seriously now. From the above table, Indonesia is the highest number of cases in bird flu. Indonesia has many provinces and from each province, West java is the highest provinces for number cases of bird flu. The Head of the West Java Animal, revealed that his aide had tested over 20 chickens in the house of two men who had died of flu (aged 23 and 20 years), having bought dead chickens from the market for their dogs. The traffic in chickens and poultry cannot be controlled because the demand is so high, which traders will do anything to meet. Traders in

Bogor confessed that they would bring chickens in from anywhere, such as Bandung and Sukabumi that sometimes their stocks would be bought by traders from Tangerang or Jakarta. Following is the victims of bird flu in Indonesia for each province as shown in table 2.

Table 2. The Victims of Bird Flu in Indonesia

No	Province	Bird Flu Positive		
		Number of case	Death	Ratio
1	**West Java**	**28**	**22**	**33,33%**
2	DKI Jakarta	22	19	28,79%
3	Banten	12	10	15,15%
4	North Sumatra	7	6	9,09%
5	East Java	6	4	6,06%
6	Central Java	5	4	6,06%
7	Lampung	3	0	0%
8	South Sulawesi	1	1	1,51%
9	West Sumatra	2	0	0%
Number of Case		86	66	

Government officials are not empowered to interfere with this traffic, but at the same time they must campaign about how dangerous bird flu virus is. Another problem is that infected areas have recently been spreading day by day, with the result that the government has not been able to isolate the outbreaks. More than 600,000 chickens have died and tens of thousands slaughtered.

The next question is: How to stop the spread of bird flu virus if it becomes a pandemic? Would it be possible to destroy every chicken alive? How would any government fund this activity, as there are so many things to be done: campaigning, providing vaccines and medical treatment for victims, research, and subsidizing the farmers and people who raise chickens? To answer this question is not easy. The problem is very complicated; there are some agents who involve in this problem.

3. Agent Based Simulation to Prevent Bird Flu Pandemic

In this paper, we will try to propose three modules based on Deguchi's research. *First*, we introduce stage transition module. Beside that, we compare with influenza model examined by IOM, about incubation period for a pandemic strain that is for seasonal influenza it is usually taken to be 2 - 3 days, but for H5N1 more than 3 - 4 days seems common.

A state transition module gives stage transition structure of agents under the condition of age, vaccination and medical treatment such as Anti Virus drugs. We divide agents into several categories by age and vaccination first. We use five categories of age such as baby, child, young, middle and old. Stages for disease are expressed as 0, 1,2,2m, 3,3m, 3s, 3p, 4c, 4m, 5, D and 0i. Level of virus excretion is expressed in the model not by the number of virus but by excretion scale between 0 and 1. The stage model gives the excretion scale in each stage as shown in figure 1.

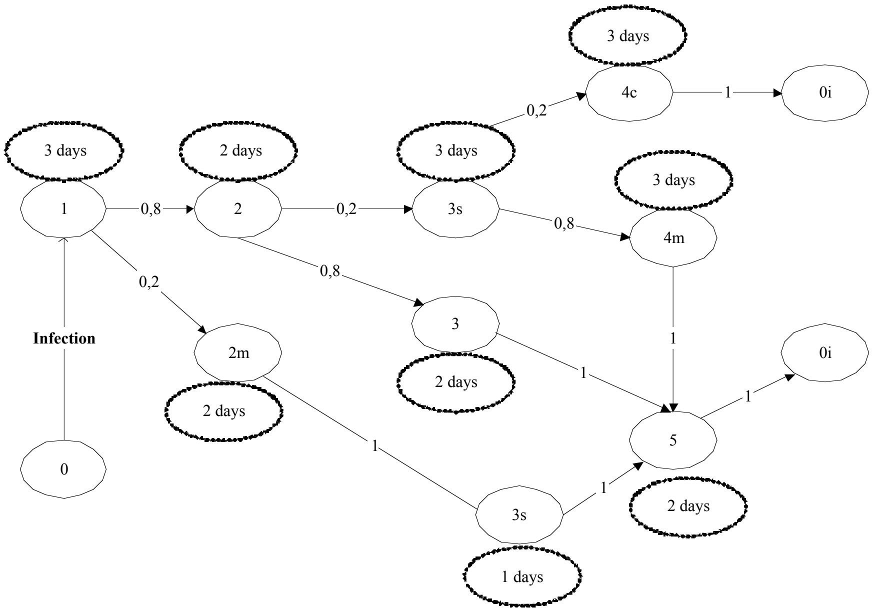

Figure 1. Disease State Transition Model based on Deguchi's Research

Second, we introduce the several types of virus protection policies in our contamination and infection model on the small city model. Total model structure of contamination and infection process is shown in figure 2.

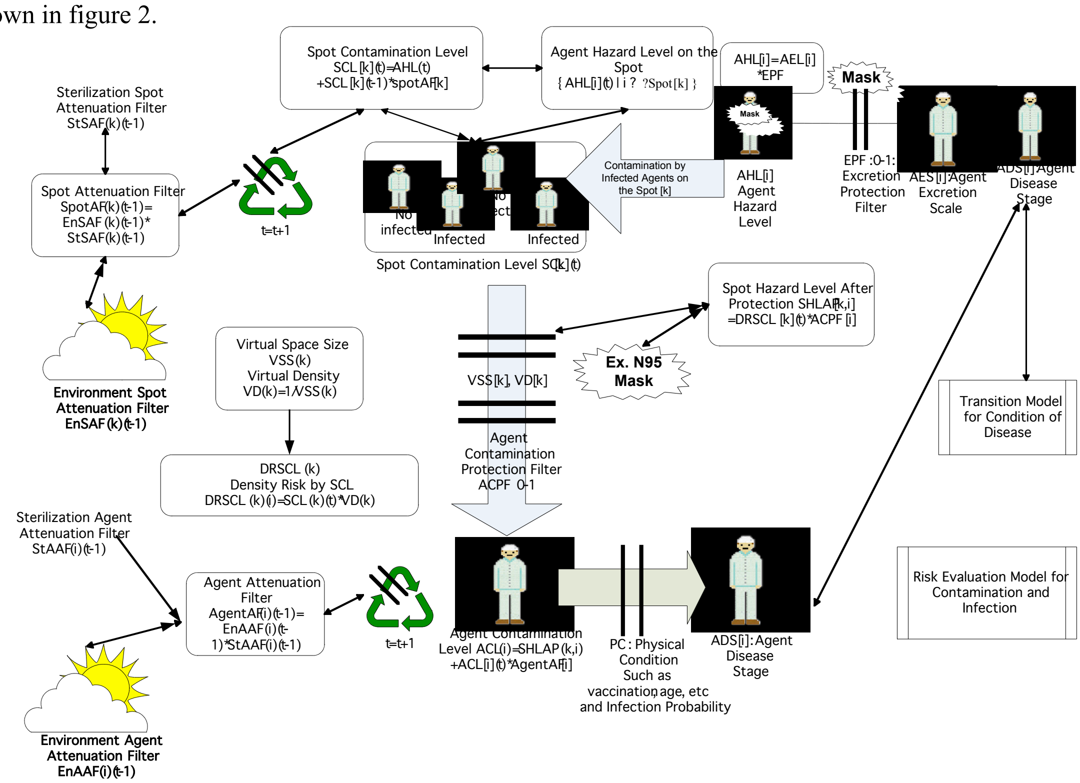

Figure 2. Virus Contamination and Infection Model Based on Deguchi's Research

Based on Deguchi's research, an infected agent has the excretion scale level depending on his disease stage. The agent visits a certain spot. Then the agent might use excretion protection filter such as a mask. Agent hazard level for the spot is defined by the excretion scale and whether the agent is using excretion filter or not. AHL[i] denotes Agent Hazard Level of an agent [i], AES[i] denotes Agent Excretion Scale of agent [i] and EPF [i] denotes the level of Excretion Protection Filter. EPF[i] means the effectiveness of the mask if an agent [i] is using a mask. AHL[k] denotes total agent hazard level of agents who exist in a spot [k].

Spot Contamination Level of a spot [k] is denoted by SCL[k](t), AHL[k](t): the agent hazard level of a spot [k] at the present step, SCL[k] (t-1): the spot contamination level at the previous step, and SpotAF[k](t-1): Spot Attenuation Filter at the previous step. SpotAF[k] denotes the attenuation scale for the previous spot contamination. EnSAF[k] denotes Environmental Spot Attenuation Filter that is affected by the seasonal changes of climate or controlled humidity in the spot. StSAF[k] denotes Sterilization Spot Attenuation Filter that is controlled by sterilization of the spot. The process is shown in figure 2.

Spot contamination causes the contamination of each agent. Then an agent will be infected depending on his physical condition. In our model inter agent infection is divided into such sequential process as the spot contamination by the infected agents, the agent contamination by the contaminated spot and the agent infection by his own contamination. The model becomes equivalent to direct infection model among agents at a spot if we omit attenuation factors.

We introduce two types of protection policies that can be used while a spot contamination affects to an agent contamination. The one is called the virtual space density control or simply the density control. The density means contact density among agents in a spot. The density is affected by both the activity pattern and physical space size among agents. To know the detailed activity pattern of agents we have to construct an activity model detail to the second.

The density can be evaluated by an actual social experiment. The virtual space density of home depends on the cultural life style and the family structure. The virtual space density is an easier factor to control socially.. The other protection policy is called the personal contamination protection by an agent such as wearing N95 mask that is effective for the protection against virus. Then there is density risk. Agent Contamination Protection Filter (ACPF[i]) denotes the effectiveness of the above way of contamination protection by an agent[i]. Then the agent has infection possibility defined as follows. P (infection of agent [i] per Step) =1-exp (-FP*TP*ACL[i]). Where, TP is called the tick parameter that adjusts the selection of time scale in the simulation. FP (Fitting Parameter) denotes a parameter for the total calibration of our model.

We also assume a human activity scenario of how agents move among spots in the society or are isolated in the hospital. In our test model, there are 3667 families of 10000 agents in Bandung city. Figure 3 shows human activity model in Bandung city.

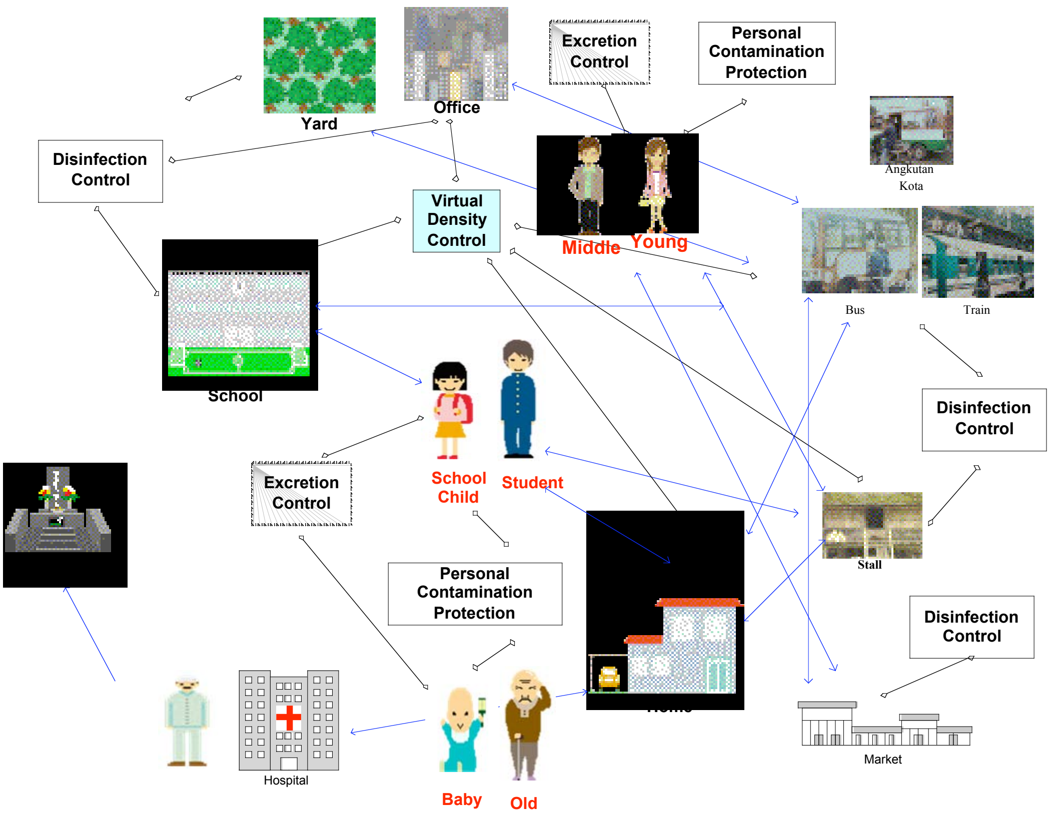

Figure 3. Virtual Human Activities Model in Bandung City

There are several types of spots in the city such as traffic (bus, train, or angkutan kota), office, school, yard, hospital, stall (small and big), market and homes. We assume a simple activity of agents. A young and middle agent goes to the office every morning from the own home via traffic and comes back to the home in the afternoon. But, not all of young and middle agents in Bandung go to the office, they are go to yard (they are not employee, but work as entrepreneur, laborer, etc) and comes back to the home with uncertainty time, almost they are go the stall to keep their animal (bird, chicken, etc).

Also if a young and middle had got marriages, women in Bandung usually as a housewife, so they will go the market to buy some food like meat, chicken or vegetables. A schoolchild and student goes to school every morning and comes back to the home early afternoon. But not all of schoolchild and student in Bandung goes to school, they are go to yard to work as laborer, vagrant, etc. Old agents stay homes in this model, because the average of old agents in Bandung didn't work anymore. They are retired from his work, but they still keep their own animal such as bird, chicken, etc. If they are infected and become stage 2 then they go into the hospital. But, if the stages become 2m then the agents do not go to the hospital for the isolation.

The agents in the hospital go back to the homes and return to their daily lives if they become healthy with immunity that is represented by stage 0i. We evaluated the effect of the social protection filters consist of humidity control policy (environmental spot attenuation filter), the virtual space density control policy, the excretion protection filter policy and the agent contamination protection filter policy. Total strength of the social protection filters is defined as the product of each protection filters.

4. Simulation using SOARS

In order to simulate this model, we combine three modules as shown earlier using SOARS. SOARS is an agent based simulation language and its application development environment. SOARS was developed at Deguchi Laboratory under the COE program of Tokyo Institute of Technology<www.absss.titech.ac.jp/en/>, <www.cs.dis.titech.ac.jp/en/>. The objective is to look what is the policy that must be done by government especially to prevent bird flu pandemic in Bandung city.

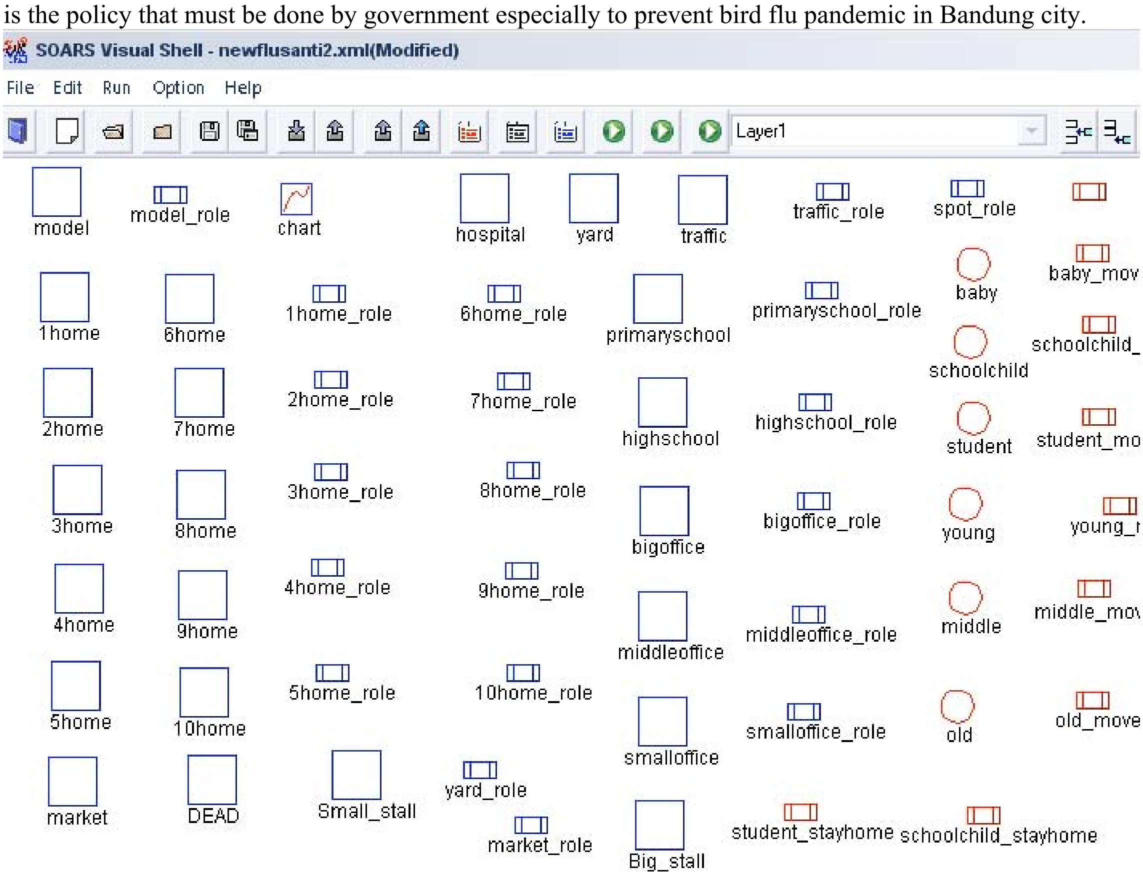

Figure 4. SOARS Visual Shell Modeling for Bird Flu Pandemic

4.1 Parameter Simulation

Scenario in this simulation is only focused on *social protection filter policies*. Following is parameter in this simulation as shown in table 3.

Table 3. Parameter Simulation

Name of variabel	Type 1	Related Place in the Model	Range & meaning of Value
$EnSAF_home	Enviromental Attenuation Filter of *Spot*	*Spot* (Home)	0-1 Strength of filter(0:strongest)
$EnSAF_office	Enviromental Attenuation Filter of *Spot*	Spot (Office)	0-1 Strength of filter(0:strongest)
$EnSAF_school	Enviromental Attenuation Filter of Spot	Spot (School)	0-1 Strength of filter(0:strongest)
$EnSAF_traffic	Enviromental Attenuation Filter of Spot	Spot (Traffic)	0-1 Strength of filter(0:strongest)
$StSAF_home	Sterilizing Attenuation Filter of Spot	Spot (Home)	0-1 Strength of filter(0:strongest)
$StSAF_office	Sterilizing Attenuation Filter of Spot	Spot (Office)	0-1 Strength of filter(0:strongest)
$StSAF_school	Sterilizing Attenuation Filter of Spot	Spot (School)	0-1 Strength of filter(0:strongest)
$StSAF_traffic	Sterilizing Attenuation Filter of Spot	Spot (Traffic)	0-1 Strength of filter(0:strongest)
$StSAF_small stall	Sterilizing Attenuation Filter of Spot	Spot (small stall)	0-1 Strength of filter(0:strongest)
$StSAF_big stall	Sterilizing Attenuation Filter of Spot	Spot (big stall)	0-1 Strength of filter(0:strongest)
$StSAF_yard	Sterilizing Attenuation Filter of Spot	Spot (yard)	0-1 Strength of filter(0:strongest)
$StSAF_market	Sterilizing Attenuation Filter of Spot	Spot (market)	0-1 Strength of filter(0:strongest)
$VSS_home	Virtual Space Size of Spot	Spot (Home)	50-1000 (depend on cases)
$VSS_office	Virtual Space Size of Spot	Spot (Office)	50-1000 (depend on cases)
$VSS_school	Virtual Space Size of Spot	Spot (School)	50-1000 (depend on cases)
$VSS_traffic	Virtual Space Size of Spot	Spot (Traffic)	50-1000 (depend on cases)
$VSS_small stall	Virtual Space Size of Spot	Spot (small stall)	50-1000 (depend on cases)
$VSS_big stall	Virtual Space Size of Spot	Spot (big stall)	50-1000 (depend on cases)
$VSS_yard	Virtual Space Size of Spot	Spot (yard)	50-1000 (depend on cases)
$VSS_market	Virtual Space Size of Spot	Spot (market)	50-1000 (depend on cases)
$a	Fitting Parameters	Model Structure	0.5 fixed
$agent_ACPF	Contamination Protection Filter of Agent	Agent (all)	0-1 Strength of filter(0:strongest)
$agent_EPF	Excretion Protection Filter of Agent	Agent (all)	0-1 Strength of filter(0:strongest)
$agent_EnAAF	Enviromental Attenuation Filter of Agent	Agent (all)	0-1 Strength of filter(0:strongest)
$agent_StAAF	Sterilizing Attenuation Filter of Agent	Agent (all)	0-1 Strength of filter(0:strongest)

Parameter for physical condition was taken based on age classification, i.e., PC_baby= 0.8; PC_schoolchild=0.8; PC_student=0.8; PC_young=0.8, PC_middle= 0 or 0.3; PC_old=0 or 0.3. The school attendant rate for schoolchild is 0.5722 and for student is 0.4112 that was taken based on data in Bandung. Job rate for young is 0.3134, middle is 0.2237 and old is 0.107.

5.2 Data Simulation

Data for our research was derived from *"Bandung Dalam Angka 2005"*, i.e., number of people based on age classification, number of family structure, number of public transportation, number office (big and small office), school attendant rate, job rate, number of stall, (small about <2000, big about >10000), number of hospital, number of market, etc. From real data, we scale into data simulation with number 10000.

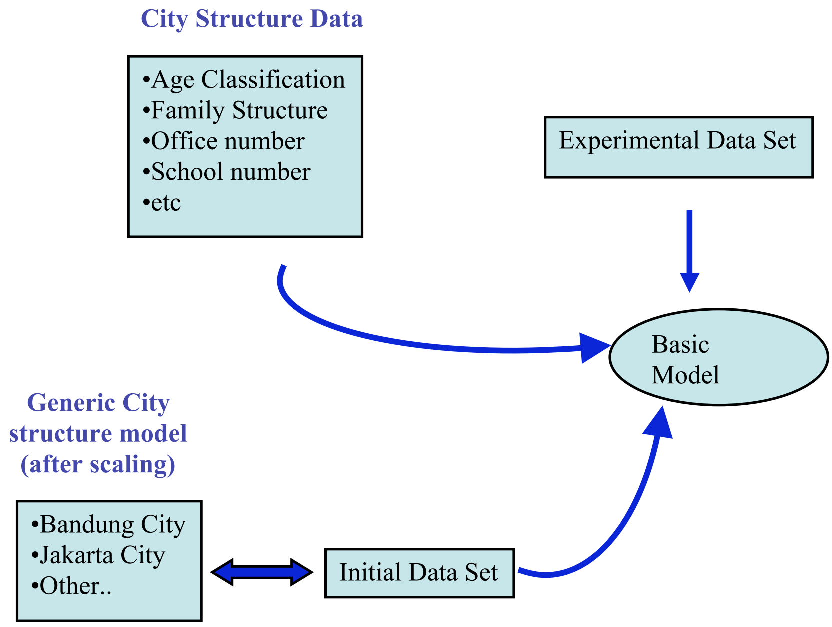

Figure 5. Process of Scaling Data into Simulation

5.3 Experiment

Our Focus in Simulation of bird flu model is only to social protection filter policy. We had run many our model simulation, but in this paper we only run four times with different parameter which consists of parameters agent and parameters spot.

a. Experiment 1

In the first experiment, we make the worst scenario. We use parameters of agent such as environmental attenuation filter of agent which has value 0, 9 (it means that the strength of attenuation filter is not strongest), sterilization attenuation filter of agent is not strong which has value 1 (it means that agent was not use a mask to protect the excretion), agent contamination protection filter which has value 1 (it means that protection to contaminate of virus was not strongest) and excretion protection filter is not strongest which has value 1 (it means that agent didn't use mask to protect the excretion).

The parameters of spot in our simulation is environmental attenuation filter for spot big stalls is 0.9 (it means that the filter is not strongest, there is no filter to protect spot big stall, such as vaccination, etc), environmental attenuation filter for spot small stalls is 0.9 (it means that the filter is not strongest, there is no filter to protect spot small stall, such as vaccination, etc). Value of environmental attenuation filter for spot home, school, traffic, hospital, market, office and yard has a same value 0.9. It means that the filter was not strongest at each spot, so the virus can be spread largely.

Other parameter of spot is sterilization attenuation filter for spot big stall and small stall is 1 (it means that small stall and big stall was not sterile, because there is no filter to protect, especially if there are chicken was dead in the stall). The value of sterilization for spot home, school, traffic, hospital, market, office and yard has a same value 1. It means that the filter was not strongest at each spot, so the virus can be spread largely, because the spot was not clean from virus.

The others parameter of spot is virtual space size. These parameters can affect the spread of bird flu virus for each spot. Virtual space size for each spot is 400, which a size was not too big. The virus can be spread faster in the small spot. The result of simulation for experiment 1 is described in figure 6.

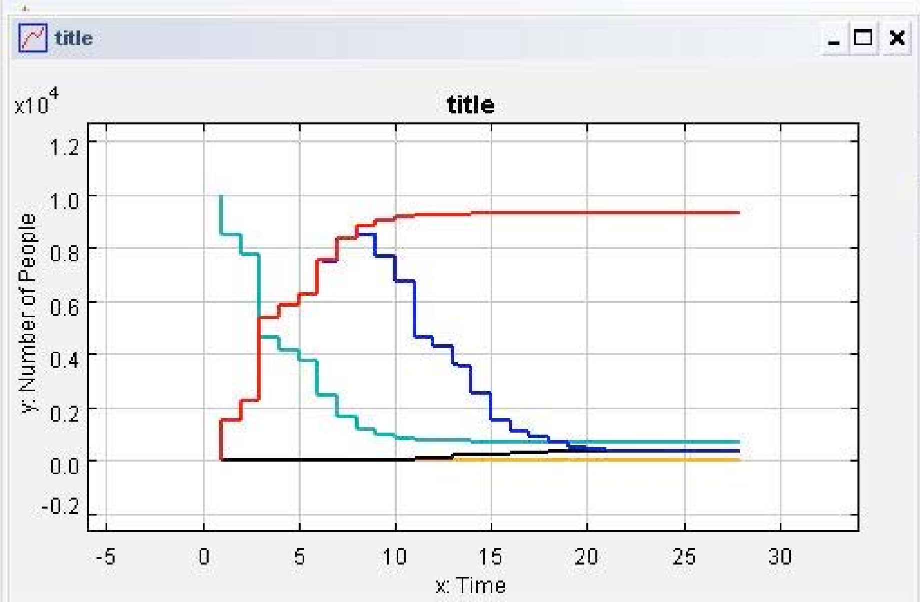

Figure 6. Graphic of Number Infection and Death in Experiment 1

From the above figure, can be described that number of people which infected (red line) is 9306 people and number of death (black line) is 335. The ratio of death for this experiment is 0.03599. This number was very high, because the social filter for agent and spot for experiment 1 was not strongest, so the virus can be spread fast.

b. Experiment 2

In the second experiment, we use parameters of agent such as environmental attenuation filter of agent which has value 0, 5 (it means that the strength of attenuation filter is half strong (not very strong)), sterilization attenuation filter of agent is not strong which has value 1 (it means that agent was not use a mask to protect the excretion), and agent contamination protection filter which has value 1 (it means that protection to contaminate of virus was not strongest) and excretion protection filter is not strongest which has value 1 (agent didn't use mask to protect the excretion).

The parameters of spot in our simulation is environmental attenuation filter for spot big stalls is 0.5 (it means that the filter is a half strongest, there is a filter to protect spot big stall, such as vaccination, etc, but it had not be done seriously), environmental attenuation filter for spot small stalls is 0.5 (it means that the filter is a half strongest, there is a filter to protect spot small stall, such as vaccination, etc, but it had not be done seriously). Value of environmental attenuation filter for spot home, school, traffic, hospital, market, office and yard has a same value 0.5. It means that the filter was only a half strongest at each spot, so the virus still can be spread.

Other parameter of spot is sterilization attenuation filter for spot big stall and small stall is 1 (it means that small stall and big stall was not sterile, because there is no filter to protect, especially if there are chicken was dead in the stall). The value of sterilization for spot home, school, traffic, hospital, market, office and yard has a same value 1. It means that the filter was not strongest at each spot, so the virus can be spread largely, because the spot was not clean from virus.

The others parameter of spot is virtual space size. These parameters can affect the spread of bird flu virus for each spot. Virtual space size for each spot is 150, which a size was small. The virus can be spread faster in the small spot. The result of simulation for experiment 2 is described in figure 7.

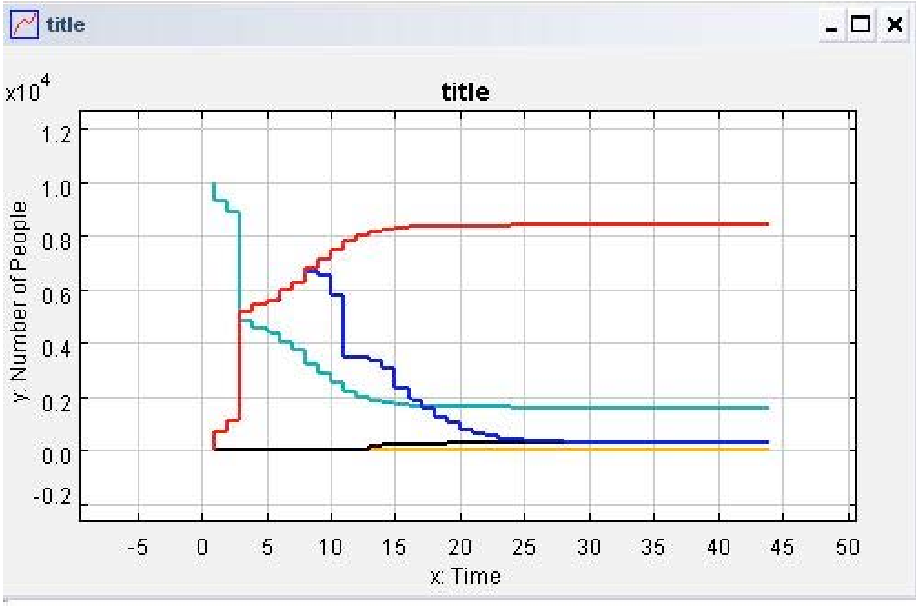

Figure 7. Graphic of Number Infection and Death in Experiment 2

From the above figure, can be described that number of people which infected (red line) is 8403 people and number of death (black line) is 292. The ratio of death for this experiment is 0.03475. This number is high, but not higher rather than experiment 1. The social filter for agent and spot for experiment 2 was only half (not too strong), so the virus can be still spread in air.

c. Experiment 3

In the third experiment, we use parameters of agent such as environmental attenuation filter of agent which has value 0,1 (it means that the strength of attenuation filter is almost strong), sterilization attenuation filter of agent is not strong which has value 1 (it means that agent was not use a mask to protect the excretion), and agent contamination protection filter which has value 1 (it means that protection to contaminate of virus was not strongest) and excretion protection filter is not strongest which has value 1 (agent didn't use mask to protect the excretion).

The parameters of spot in our simulation is environmental attenuation filter for spot big stalls is 0.1 (it means that the filter is almost strongest, there is a filter to protect spot big stall, such as vaccination, etc), environmental attenuation filter for spot small stalls is 0.1 (it means that the filter is almost strongest, there is a filter to protect spot small stall, such as vaccination, etc). Value of environmental attenuation filter for spot home, school, traffic, hospital, market, office and yard has a same value 0.1. It means that the filter was almost strongest at each spot, so the virus could not be spread easy.

Other parameter of spot is sterilization attenuation filter for spot big stall and small stall is 1 (it means that small stall and big stall was not sterile, because there is no filter to protect, especially if there are chicken was dead in the stall). The value of sterilization for spot home, school, traffic, hospital, market, office and yard has a same value 1. It means that the filter was not strongest at each spot, so the virus can be spread largely, because the spot was not clean from virus.

The others parameter of spot is virtual space size. These parameters can affect the spread of bird flu virus for each spot. Virtual space size for each spot is 200, which a size was not too big. The virus still can be spread in the spot which has size was not too big. The result of simulation for experiment 3 is described in figure 8.

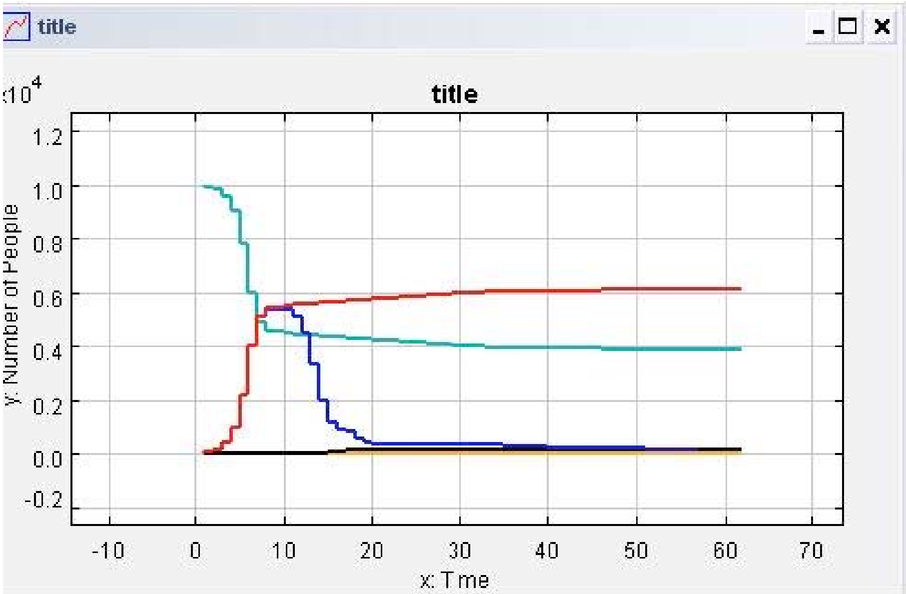

Figure 8. Graphic of Number Infection and Death in Experiment 3

From the above figure, can be described that number of people which infected (red line) is 6090 people and number of death (black line) is 173. The ratio of death for this experiment is 0.02841. This number is lower rather than the previous experiment. The social filter for agent and spot for experiment 3 was almost strongest, so the virus could not spread with easy in this case.

d. Experiment 4

In the fourth experiment, we use parameters of agent such as environmental attenuation filter of agent which has value 0,2 (it means that the strength of attenuation filter is almost strong), sterilization attenuation filter of agent is not strong which has value 1 (it means that agent was not use a mask to protect the excretion), and agent contamination protection filter which has value 1 (it means that protection to contaminate of virus was not strongest) and excretion protection filter is not strongest which has value 1 (agent didn't use mask to protect the excretion).

The parameters of spot in our simulation is environmental attenuation filter for spot big stalls is 0.0 (it means that the filter is the strongest, there is a filter to protect spot big stall, such as vaccination, etc), environmental attenuation filter for spot small stalls is 0.0 (it means that the filter is the strongest, there is a filter to protect spot small stall, such as vaccination, etc). Value of environmental attenuation filter for spot home, school, traffic, hospital, market, office and yard has a same value 0.0. It means that the filter was the strongest at each spot, so the virus could not be spread easy.

Other parameter of spot is sterilization attenuation filter for spot big stall and small stall is 1 (it means that small stall and big stall was not sterile, because there is no filter to protect, especially if there are chicken was dead in the stall). The value of sterilization for spot home, school, traffic, hospital, market, office and yard has a same value 1. It means that the filter was not strongest at each spot, so the virus can be spread largely, because the spot was not clean from virus.

The others parameter of spot is virtual space size. These parameters can affect the spread of bird flu virus for each spot. Virtual space size for big stall spot is 400 and small stall is 50, which has a size was not too big. For each spot like home, traffic, office, yard, market and hospital is 400. So the virus still can be spread in the spot which has size was not too big. The result of simulation for experiment 4 is described in figure 9.

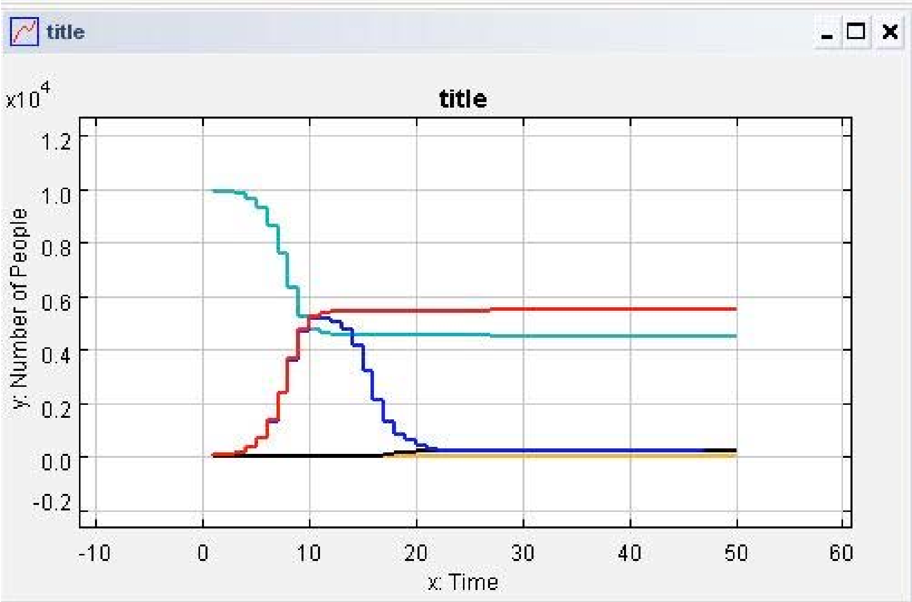

Figure 9. Graphic of Number Infection and Death in Experiment 4

From the above figure, can be described that number of people which infected (red line) is 5499 people and number of death (black line) is 191. The ratio of death for this experiment is 0.03473. This number is the lower number rather than the previous experiment. The social filter for agent and spot for experiment 4 was the strongest, so the virus could not spread with easy in this case.

6. Conclusion

Based on the result simulation by using SOARS, it can be seen that the number pople who infected and death is 3 %. With the present policy that was been done by government is equal to 33%. This number is higher rather than we use social protection filter to prevent bird flu pandemic in Bandung city. It happened because the government is only socialization about the danger of bird flu to society.

Hence in this research, we propose a policy of social protection filter such as usage of masker (virus of excretion control), control of attenuation of contamination protection filter with dampness and sterilization, especially in Bandung city which has a lot of stall, control density of room (control density space virtual) in school, market, yard, home and transportation such as bus, angkutan kota and control personal protection like civilizing clean life, is very important to prevent bird flu pandemic.

Government has to pay attention for policy of social program related to human activity. The human activity in Bandung almost related to keep their fowl like chicken or bird. So government and society must focus on environment and sterilization attenuation filter of spot like stall (big or small stall). A fowl must be given a vaccination and sterilization of stall, so the chicken or bird could not be infected by virus that will be infected to human also.

7. References

Alvin, (2005) the bird Flu epidemic, *skyscrapercity*.

Axelrod, Robert. (1997). *The Complexity of Cooperation. Agent-Based Models of Competition And Collaboration*, Princeton University Press, Princeton, New Jersey.

Bandung Dalam Angka 2005, Badan pusat statistik propinsi Jawa Barat.

Bharwan, Nirman, (2000), *Model state influenza pandemic preparedness and response plan*, Ministry of health and family welfare, New Delhi, India.

Deguchi, Hiroshi. , Kanatani, Yasuhiro. , Kaneda, Toshiyuki. , Koyama, Yusuke. , Ichikawa, Manabu. , Tanuma, Hideki. (2006). *Anti Pandemic Simulation by SOAR*S, SICE-ICASE International Joint Conference, Oct. 18-21, Bexco, Busan, Korea.

Deguchi, Hiroshi. (2006). Program and Project Design for Pandemic Protection Via Social Simulation, Tokyo Institute and Technology, Japan.

http://www.who.int/csr/disease/avian_influenza/avian_faqs/en/,The WHO (World Health Organization) website.
Influenza Pandemic (2006), Wikimedia Foundation, Inc.
Metro TV Online (2006), Avian Influenza / Flu Burung di Indonesia.
Metro TV Online (2006), Di Kota Bandung, Sembilan Daerah Endemis Flu Burung.
Putro, Utomo Sarjono, (2000), Adaptive Learning of Hypergame Situations Using a Genetic Algorithm, IEEE Transactions on Systems, Man, and Cybernetics, Vol. 30, No. 5.
Putro, Utomo Sarjono, et al., (2005) Agent Based Modeling and Simulation of Knowledge Management, Proceeding IFSR.