Group Model Building Intervention in Developing Country: Lesson Learned from Developing Strategies for Clean Air

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Abstract
This article uses the framework proposed by Rouwette et al. (2002) that has been tested by Stave (2005) to report group model building intervention of a project to develop vehicle emission reduction strategy in Jakarta, Indonesia. The project is among the first attempt that was conducted in the developing country to solve the public issue. Many rapidly developing countries exhibit a faster vehicle emission grows over time compare to those of developed world at comparable income per capita (Marcotulio et al., 2005:125). Consequently, the need to solve the problem under the economic restriction is pressing. The case supports the findings of Rouwette et al. (2002) regarding a strong connection between group model building and group learning about the problem. The group has not reached a consensus, as the participants who attended the final meeting were not broad enough. Nevertheless, the findings demonstrate a potential of the group model building intervention to build a consensus among stakeholders. The approach in setting up the workgroup needs a modification to enhance the stakeholders' participation throughout the meetings.

Keywords: vehicle emission, air quality, system dynamics, stakeholders participation

Introduction

In developing world, bad governance is being increasingly regarded as one of the root causes of all evil, including environmental problem. Policies directing or guiding the everyday decisions by many individuals are usually not developed by the people affected by these policies (van den Belt, 2004:6). For these reasons, conflicts are likely to arise during the implementation phase. A move toward a participatory attitude in addressing environmental problems has occurred at the global level since the 1992 Rio Declaration. Since then, to ensure good governance is undertaken, many International Development Agencies demand the developing country to employ the participatory and process approach in the early stage of policy formulation.

In Jakarta, Indonesia, the Asian Development Bank (ADB) supported the formulation of an Integrated Vehicle Emission Reduction (IVER) Action Plan for Jakarta using a participatory and process approach as part of its Regional Technical Assistance (RETA).

Thus, a multi stakeholders group consisting of national and local government, the private sector, academia and non-government organizations set up under the guidance of National and Local Environmental Impact Management Board. The group success in accommodating every one “stake” into the action plan, but failed to solve the Jakarta’ air quality problem. The prediction until the year 2015 by indicates that the measures may only lead to a relatively modest improvement in air quality and unfortunately, the ambient air quality standard is predicted to be still exceeded (Syahril et al., 2002).

What is wrong with public participation?

An air quality researcher of Yayasan Pelangi Indonesia (YPI) [1] identified that the IVER action plan is merely a wishing list without a priority setting. Furthermore, YPI discovered that there was no feedback from the technical consultants to the stakeholders group on the relative impact of their proposed interventions during the formulation process. An institutional consultant and two technical consultants were hired by the ADB to assist the group. The institutional consultant organized a series of workshops to draft the action plan from October 2001 to February 2002. In parallel to that, the technical consultants constructed a simple model to assess current contribution of vehicle emission to Jakarta’s pollution levels and the impact of the action plan.

As the results, several stakeholders profoundly promoted their agenda, i.e. biodiesel company proposed a fuel switch to biodiesel, where as an international development bank that interested in financing gas infrastructure proposed a fuel switch to gas. On the other hand, alternative interventions that may have significant impact in reducing vehicle emission but remain within public domain i.e. improving public transport, received very little attention. Even though many non-government organizations raised the importance of that intervention, they just did not have enough evidence to convince the group.

Assuming the feedback was available back then, still YPI doubts that the stakeholders can readily accept it. Because they did not understand or do not agree with the underlying assumption of the model. Moreover, in the country that is notorious for corruption, no one is trustworthy; include the consultants who constructed the model. Thus, it is important to involve the stakeholders from the early stage of model development.

Potential for system dynamics to improve public involvement in developing country

Previous work by Stave (2002:1) reveals the potential of system dynamics to improve public participation in environmental decision. It provides a framework for structured deliberation when stakeholders are involved in making decisions and a more transparent and participatory educational framework to persuade stakeholders to help implement decisions. Based on the above findings, YPI developed a research project proposal to examine the applicability of system dynamics in engaging the stakeholders in Jakarta to improve and strengthen cooperation in the formulation of clean air strategies. Participation in model-building process is expected to build stakeholders’ understanding

[1] Yayasan Pelangi Indonesia (YPI) is an independent environmental research institutes based in Jakarta, Indonesia. See http://www.pelangi.or.id

and enhance team learning. In turn, it is expected to change the way stakeholders evaluate the policies as they learn about the way policies affect what they value.

The project finally started in April 2004 when START[2] awarded a research seed grant for the proposal submitted by YPI. Unfortunately, the project team did not have a very good understanding what makes the group model project work on not. Moreover, all the group model building projects described by Rouwette et. al., 2002; Stave, 2002; and van den Belt, 2004 were taken place in the developed world. Hence, the project team documented all the process. In part, the project team is motivated to share the findings to others in the same position and hoping to have some suggestion from more experience one.

Context

Jakarta, in the estuary of the Ciliwung River, started as Sunda Kelapa, a humble but important trading port of the Pajajaran Sultanate. Over the centuries, the small trading port has expanded to become a sprawling megacity. As also known as DKI (Daerah Khusus Ibukota, the Capital Special Region), Jakarta is not only a city that obtains the status of a "province" — a common treatment of the capital of any country — but also centers of business, investment, international gateway, tourism destination, social and political movements, and other functions (Mokoginta, 1999).

As the richest province in Indonesia, Jakarta continues to attract more immigrants from all over area of the country. The development of Jakarta follows a classic model of a so-called "radial-concentric" city.[3] This model forces a radial movement of commuting. Figure 1 shows the development of the city since it was a colonial trading town in the early 1600s until late 1900s. Based on the Governor Decree No. 1227 Year 1989, it comprises a total land area of 661.52 km^2 (Bureau of Statictic DKI Jakarta, 2003). Unfortunately, Jakarta's air quality is deteriorating along with these rapid urbanization and development mainly due to vehicle emission (Shah and Nagpal, 1997; JICA and Bapedal, 1997; Syahril et al, 2002).

[2] START is a global change SysTem for Analysis, Research, and Training of the International Human Dimensions of Global Environmental Change Programme (IHDP), the International Geosphere-Biosphere Programme (IGBP) and the World Climate Research Programme (WCRP). See http://www.start.org

[3] Rahmah, A., Transjakarta Busway: Akankah Menjadi Tulang Punggung Sistem Transportasi di Jakarta? (Transjakarta Busway: Will It Be the Backbone of the Transportation System in Jakarta?). Yayasan Pelangi Indonesia, Jakarta, forthcoming.

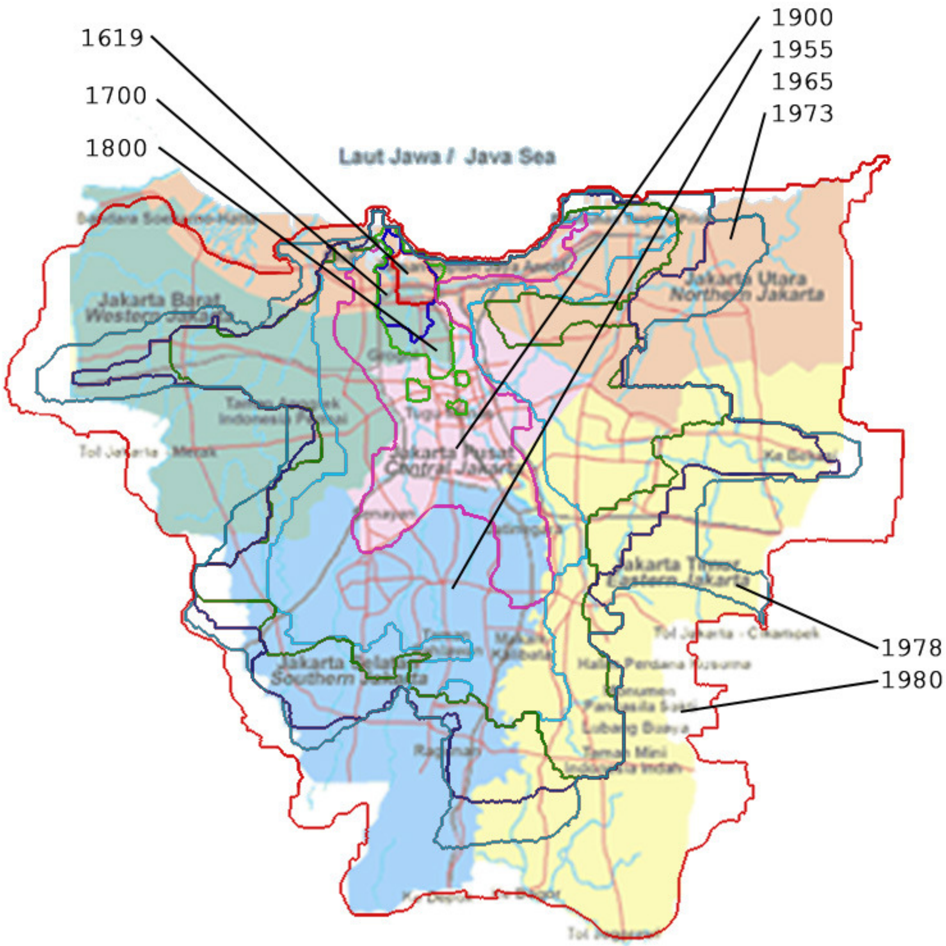


Figure 1: The ever sprawling Jakarta (Sari and Susantono, 1999)

In recognition of the growing severity of air pollution in Jakarta, many international development agencies have offered their assistance to develop the strategy to combat the air pollution since more than a decade. Begin with the World Bank that initiated the Urban Air Quality Management Strategy (URBAIR) in 1992 as part of its Metropolitan Environmental Improvement Program (MEIP). From 1994 to 1997, Japan International Cooperation Agency (JICA) and National Environmental Impact Management Board (BAPEDAL) commenced the Integrated Air Quality Management Study for the Greater Jakarta. Still, the Jakarta's air quality index as shown in Figure 2 indicates no improvement. Later in 2002, the Asian Development Bank (ADB) supported the formulation of an Integrated Vehicle Emission Reduction (IVER) Action Plan for Jakarta using a participatory and process approach as part of its Regional Technical Assistance (RETA).

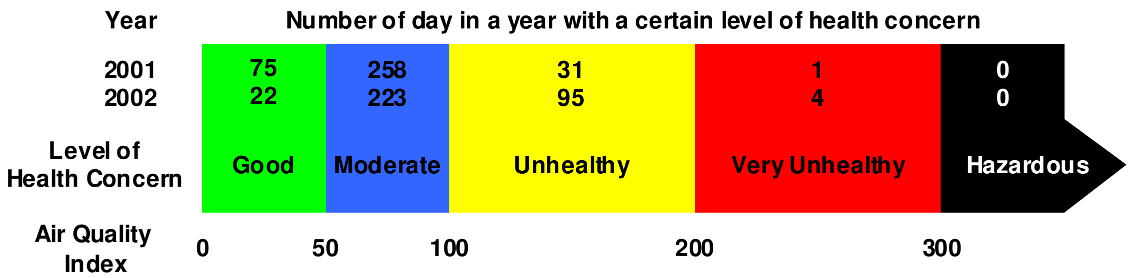


Figure 2: Jakarta's air quality index in year 2001 and 2002

Mechanism

Pre-project activities

Assigning the project team members' roles

The project team members were limited to four people with the following characteristic:

(1) Muhammad Tasrif, a system dynamics expert with 20 years experience on modeling, but no experience on public facilitation process;

(2) A. Taufik Mukhith, that has involved in several system dynamics model development and extensive experience in public facilitation process;

(3) Shanty Syahril, an air quality researcher of YPI that has taken a short course on system dynamics, but no hands-on experience on modeling project who was also the Principle Investigator (PI) of this project; and

(4) Lucentezza Napitupulu, a program assistant of YPI with no background on system dynamics at the beginning, but later attended a short course on system dynamics.

None of them has any experience in group model building intervention. Therefore, to fill in the roles prescribed by Richardson and Andersen (in Vennix, 1996:133-134), the PI assigned each person the role(s) as indicated in last column of Table 1.

Table 1: Roles of personnel in a group model-building meeting

Role	Description	Personnel
Facilitator	The person who actually guides the group process and who elicits the participants' points of view on the problem in order to construct the system dynamics model. The person need to understand the philosophy underlying system dynamics and group model-building and have sufficient understanding of group processes.	Mukhith
Recorder	The right hand of the facilitator. The facilitator and the recorder must work together as a team. The recorder may also participate more actively in the process as the group becomes larger. The person need to understand the philosophy underlying system dynamics and group model-building and have sufficient understanding of group processes.	Tasrif
Content	The person needs to be particularly experienced in system	Tasrif &

coach	dynamic modeling. In addition, it may help if the person is also knowledgeable about the subject matter. The person may help to prevent the group from developing a one-sided view of the problem.	Syahril
Process coach	The person who primarily focuses on group process and group dynamics. In general the person does not interact with the group; it is more of a silent observer role. The person may reflect his or her observations back to the facilitator during breaks and helps the facilitator to identify strategies to keep the group effective.	Syahril
Gatekeeper	The person who responsible for the project. The gatekeeper is a sort of liaison person between the model builders and relevant persons from the client organization.	Syahril & Napitupulu

Identifying the stakeholders and setting workgroup

A *stakeholders* term is defined as those who have an interest in a particular decision, either individuals or representatives of a group. This includes people who influence a decision, or can influence it, as well as those affected by it.[4] ADB RETA (2002:35) identified 49 institutions as the stakeholders of vehicle emission control in Jakarta and listed eight key stakeholders as follow:

(1) Ministry of Communication
(2) Ministry of Energy and Mineral Resources
(3) Ministry of Environment
(4) Ministry of Industry and Trade
(5) Jakarta's Communication Office
(6) Jakarta's Development Planning Board
(7) Jakarta's Environmental Management Board
(8) State Police

However, Venix (1996:111-113) reminds that a larger group (more than 10 to 12) may have negative side-effect i.e. less satisfaction with amount of time for discussion and difficulty of building interpersonal relationship. Nevertheless, he also warns that excluding certain stakeholders from the person may create the risk of lack of commitment with the final decision.

In addition, Stave (2002:160-161) has identified three major challenges of involving the stakeholders in the public model-building project as follows:

(1) Since the stakeholders' participation in the project is volunteer, it may be difficult to force them to come to meetings. Group composition may keep changing, which limits their potential involvement in model building;
(2) Voluntary participants also may have less time available for participation than people who participate as part of their job; and
(3) Public participants in environmental management discussions also tend to be self-selecting. That is, if they participate, they do so because they are invested somehow in the issue.

[4] Refer to the Earth Summit 2002, available at http://www.earthsummit2002.org/ic/process/stakeholders.htm (July 17, 2003)

The PI ultimately decided approximately 25 stakeholders should represent a broad enough background to ensure a balanced discussion during model-building and at the same time still can be managed by facilitator. Hence, to identify and gain stakeholders' commitment for the project, the PI applied several strategies as follows:

(1) directly contacting the key stakeholders and explaining about the project as well as asking their recommendation who else should be invited;
(2) conducting a focus group discussion with a forum titled Mitra Emisi Bersih (MEB or Partnership for Clean Emissions) to identify the stakeholders. The MEB members consist of the national and local government agencies, private sector, and civil society that concerned on the vehicle emission problem in Jakarta;
(3) inviting all identified institutions or the person who was expected to participate with an easy-read leaflet explaining about the project either by facsimile or e-mail and later find out who turn up in the meeting;
(4) sending the invitation as well as a short introduction about the project to the MEB mailing list
(5) inviting the journalists from all well-known printed mass media to the first meeting. The PI expected the journalist to not only involve in the project, but also inform the public about the project.

As much as 70 stakeholders from were identified and invited to the first meeting. The invited stakeholders grouped into 8 categories i.e. (i) national government; (ii) provincial government of Jakarta; (iii) private sector and business association; (iv) non-government organization; (v) university; (vi) political party; (vii) mass media; and (viii) individual who interested on the issue. The invitation was addressed either to the institutions or directly to the person who was expected to participate in the project; and sent either by facsimile or e-mail.

In total, 77 people from 54 institutions had come at least once to the meetings. The group consisted of representative of national government (29 percent); local government (17 percent); private sectors and business association (6 percent); non-government organization (21 percent); university (6 percent); mass media (14 percent); and individual (6 percent). Two representatives from YPI were part of the group. The gender breakdown of the group was 70% male and 30% female. The meeting was held during office hour, therefore some stakeholders that their job did not directly related to the issue i.e. association of railways passengers, have been unable to participate because of day-time work commitments.

In the first meeting, 40 people showed up and ten of them were journalist. Two participants heard about the project from the MEB mailing list and two participants knew it from their friends. The second meeting was attended by 28 participants. The significant decrease in the participant number mainly because only one out of ten journalists who attended the first meeting came to the second meeting. The PI then learned that a series of three hours meetings burden was too heavy for the journalists. They declined to continue participation.

The number of participants was never less than 20 people until the fourth meeting. Out of the expectation, only nine participants came to the fifth meeting. Unlike the previous meetings, the PI sent the invitation by fax or e-mail as usual, but did not contact each of the participants by phone prior to the fifth meeting to confirm their attendance. Later, the PI discovered that an institution that actively participated in the meeting conducted a writing meeting on air quality issue for their partners on the same day. The PI identified at least seven regular participants attended the writing meeting.

Thus, to have a broad enough stakeholders to design the policy in the sixth (last) meeting, the PI sent the invitation and called by phone all the stakeholders that had ever participated in the meeting. About 25 stakeholders had confirmed their attendance but due to last minutes cancellation only 16 stakeholders that came to the sixth meetings. Figure 9 shows the number of meetings participants.

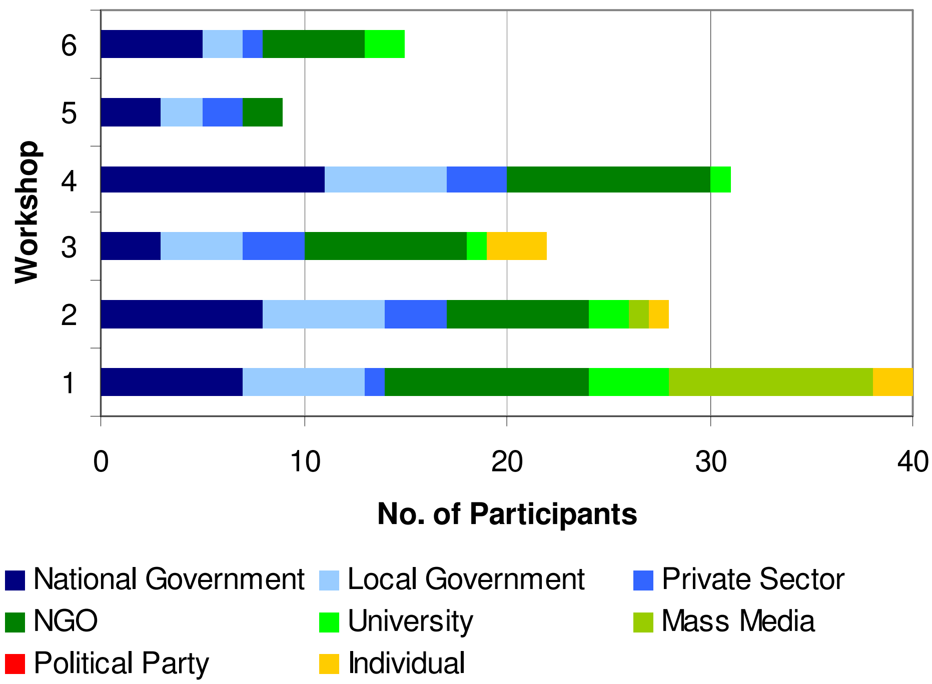


Figure 3: Meetings participant

There were always newcomers to each meeting, either a substitute from the same institution or recommended by the other participants. Thirteen participant of the second meeting; five participants of the third meeting; fourteen participants of the fourth meeting; and even four participants of the sixth meeting were newcomers. On the other hand, among all the participant, one person never missed the meetings; four people came five times; six people came four times; five people came three times; twelve people came twice; and the remaining 42 people only came once to the meetings.

Model building meetings

Number and duration of meetings

The workgroup met six times in the 15 months between July 2004 and September 2005. The first meeting lasted for six hour. The remaining was initially designed for three hours. However, after the evaluation of the second and third meeting as well as suggestion from the workgroup, the remaining meetings were scheduled for six hour. Table 2 presents the six meetings in chronological order.

Table 2: Agenda of the meetings

Meetings	Duration
Meeting 1: July 15, 2004 (09:00 to 15:00 hrs)	
Introduction to the project	0 hr 30 m
Introduction to system dynamics methodology	1 hr 30 m
Identify the problem	2 hr
Develop dynamics hypothesis	2 hr 00 m
Meeting 2: August 12, 2004 (09:00 to 12:30 hrs)	
Continue to develop dynamics hypothesis and identify reference behavior	3 hr
Meeting 3: September 14, 2004 (09:00 to 12:30 hrs)	
Continue to develop dynamics hypothesis and identify leverage points	3 hr
Meeting 4: February 15, 2005 (09:00 to 16:00 hrs)	
Build a computer simulation model	6 hr
Meeting 5: May 11, 2005 (09:00 to 16:00 hrs)	
Test and validate the model	6 hr
Meeting 6: September 22, 2005 (09:00 to 16:00 hrs)	
Design and evaluate policy	6 hr
Total	30 hr

Total time investment by participants

Approximately 30 hours per participant

Client participation

The stakeholders participated almost in all modeling stages, but the project team conducted most of the quantification through a backroom work due to participants' time constraint. Nevertheless, the participants had their hands on experience on building a computer simulation model on the fourth meeting.

Introduction to system dynamics

The first meeting was started with an introduction to system dynamics methodology because almost none of the participants had any knowledge on system dynamics.

Modeling Process

The first meeting. The all day meeting started with introduction to the project and system dynamics. The PI introduced the problem of declining Jakarta's air quality and revealed the study that indicated the vehicle emissions as the major emission source in Jakarta. As the vehicle emission strongly related to the transportation sectors, the facilitator started the model–building process by asking the participants to generate variables related to transportation problem in Jakarta (nominal group technique).

The participants silently wrote down ideas individually. Then, ideas were listed in a flip chart and grouped for similar ideas. A total of 143 ideas were generated by the participants and grouped into 12 categories i.e. (i) traffic congestion; (ii) infrastructure; (iii) pollution; (iv) road worthiness; (v) public transport; (vi) road user behavior (vii) private vehicle (viii) policy (ix) health impact; (x) law; (xi) fuel; and (xii) others.

The facilitator invited the participants in round-robin fashion to pick and discuss one group of ideas. The first participant picked the traffic congestion list and identified the traffic congestion as a problem. Then, the first participant identified the causes of the traffic congestion by looking at the list of generated variable in traffic congestion groups.

Afterward, the facilitator started building the causal diagram by selecting problem variable (in this case "traffic congestion") and putting it on the white board. Next, the facilitator placed two variables i.e. the "vehicle number" and the "road capacity" that identified by the first participant as the causes of the traffic congestion in the white board. Then, the facilitator linked both the variables into the "traffic congestion".

Having completed the step, the facilitator asked whether any of the participant disagreed with the relationships. This question turned into a heat debate. One participant argued that the traffic congestion was caused by a poor public transport services and not necessarily caused by the shortage of road capacity. The facilitator overcame the debate by suggesting that the system dynamic model-building would most probably reveal that those defined variables are strongly related.

The process was continued by the second participant picked the public transport list. The second participant suggested that Jakarta currently has to deal with very low public transport attractiveness problem. The list covered all the variables that determine the public transport attractiveness. The other participants actively added the explanation to the public transport problem. The discussion on the public transport problem took quite a long time until the facilitator had to stop the discussion and suggested to move to the next list of idea. It appears to the PI that all the participants seem strongly agree that the public transport is a root of Jakarta's transportation problem. Public transport attractiveness is one of the variable that causes for increase or decrease in vehicle numbers.

Next, the third participant picked the regulation list and identified that weak law enforcement has caused all the problems. However, this variable has not included in the causal diagram that was developed during the first meeting because the participants could not yet explicitly identified its relation with the other defined variables. The fourth participant specifically elaborated on the infrastructure for non-motorized transport mode that was among the variable in infrastructure list. This variable also has not included in the causal diagram that was developed during the first meeting.

Not until the fifth and last participant picked the air pollution list, the group discussed about the air pollution. The group indicated that the air pollution deteriorated human health. The group also identified several causes of increase of air pollution.

As the consequence of the introduction and the discussion on public transport, the time was run out before the participants elaborated the remaining categories. The participants suggested the PI to analyze the remaining categories and modify the causal diagram based on that. The first meeting ended with the causal diagram shown in Figure 4. No feedback loop has been identified by the participants.

The PI prepared the workbook of the first meetings that consist of the summary of the first meeting; the causal diagram that has been restructured, but not changed; and ten questions. The workbook was sent by mail to the all invited stakeholders (not only to those who were coming to the first meeting) 10 days before the second meeting and they were asked to return the workbook 3 days before the second meeting. Unfortunately, only two participants reacted to the questions.

The PI added the information from the two workbooks as well as the analysis results of the remaining categories that have not been discussed during the first meeting to the causal diagram that resulted from the first meeting. It is important to mention that not all additional information could directly include in the causal diagram that resulted from the first meeting. Thus, on addition to the adapted causal diagram of the first meeting, the PI constructed six new causal diagrams i.e. (i) road construction; (ii) road capacity; (iii) road user behavior; (iv) trip generation; (v) fuel; and (vi) vehicle maintenance. All those causal diagrams were taken as a starting point for the second meeting.

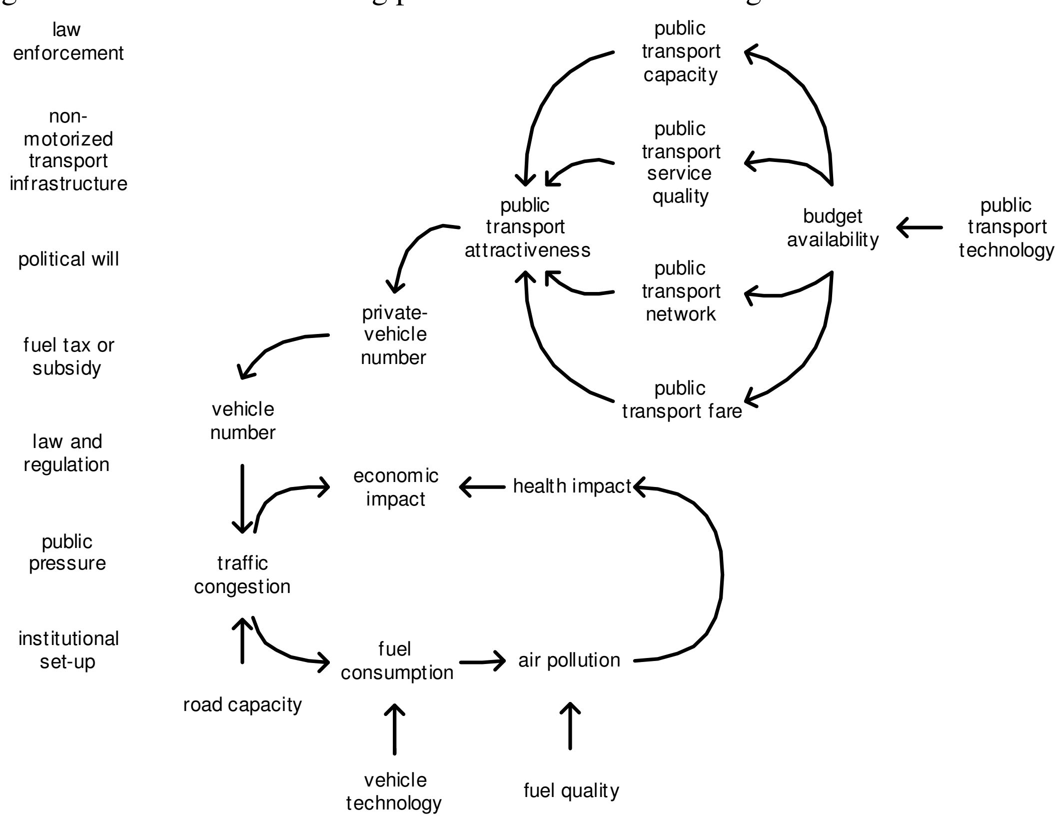


Figure 4: Causal loop diagram after the first meeting

The second meeting. The objectives of this three-hour meeting were to define the problem which included reference mode and time horizon; and to integrate all those causal diagrams, in particular to focus on to find a feed-back loop. In the first 30 minutes of the second meeting, the PI presented all the causal loop causal diagrams developed based on the information of the first meeting to the participants. The facilitator started the discussion by asking the participants to select the starting point i.e. traffic congestion, emission, fuel, etc. It took more than an hour for the group to make a decision.

Several participants hold into their favored point of interests. The discussion became even longer because several new participants have no idea about the group model-building (even though the PI has sent to them the introduction to system dynamics methodology hand-out and the workbook). Pressure for a quick solution came from one of the new participant. He suggested a shortcut to solve the problem, but not necessarily understand the system better or have their basic beliefs challenged. To clarify the situation, the PI had to explain about the group model-building to the whole group once again. Finally, the discussion started to get going. The participants divided all the causal diagrams from previous meeting into four categories (sub-model) i.e. (i) vehicle emission; (ii) traffic congestion; (iii) public transport; and (iv) fuel.

Thus, the group determined the reference mode for vehicle emission as vehicle emission load in ton/year for parameter carbon monoxide (CO), hydrocarbon (HC), sulfur dioxide (SO2), nitrogen oxides (NOx) and total suspended particulate (TSP). Again, the participants' argument diverted in defining traffic congestion i.e. (i) average speed vs time; (ii) travel time vs time; and (iii) volume per capacity vs time.

Unfortunately, the second meeting ended without having time to improve the causal diagram. Nevertheless, two participants gave their written input on causal diagram to the PI at the end of the second meeting. Despite the minimum improvement to the causal diagram, the second meeting best represented the current relationship condition among the vehicle emission reduction stakeholders in Jakarta. The process clearly reflected how diverse the mental model of participant and how important to understand each other to formulate a better policy.
Similar to the first meeting, the PI prepared the workbook and sent by mail to the all invited stakeholders 4 days before the second meeting. However, they were not asked to return the workbook. The workbook described the summary of the second meeting; the adapted causal diagrams; and several questions that need to be addressed in the third meeting.

The third meeting. The basic idea of the third meeting was to improve the diagram and to demonstrate a result of sub-model simulation development. The idea of showing a sub-model simulation was to encourage the participants to continue with this group model-building process.
The group had a very fruitful discussion in this three-hour meeting. Several valuable inputs came from the participants to improve the causal diagrams. It seems that the participants have already had a better understanding among them. Even the new participants had been very constructive. One of them was the representatives of

Provincial Monetary Office of Jakarta. He was a knowledgeable person about the process of how government allocated funding for its projects. Another person gave an input of the impact of road construction to the decreasing of the green area. As a result, not much time left for a sub-model simulation demonstration. However, the participants have been triggered with the result and look forward for a complete result.

The fourth meeting. Started from the fourth meeting, the meeting duration was expanded to all day because the process reached to the transition stage from a qualitative model to a quantitative model. In the fourth meeting, the participants gained hands-on modeling skills. The participants started by translating a very simple population causal loop, as shown in Figure 5, into a simulation model. Then, they built a simulation model to calculate traffic volume generated by the population and evaluate the congestion level based on causal loop in Figure 6.

In agreement to the finding by van den Belt (2004), it proved challenging to focus from elaboration on the details of qualitative model to finishing a quantitative simulation model. It was worth the trouble of insisting on the transition. New possibilities for learning emerged when the variables were related in a quantitative manner to each other. Then, the research team continued the remaining quantification through a backroom work.

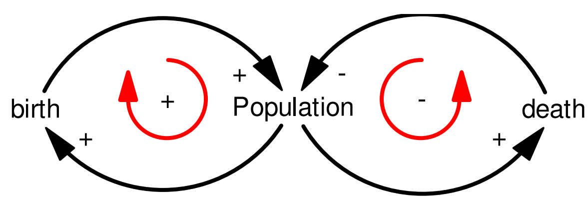


Figure 5: Causal loop of population

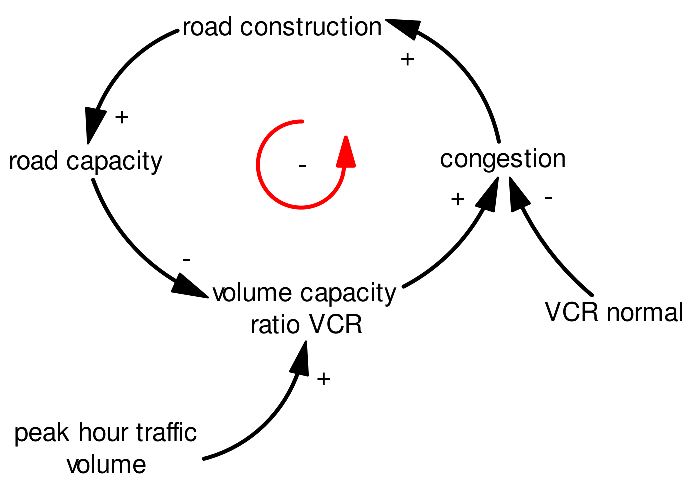


Figure 6: Causal loop of population

The fifth meeting. The PI had tried to keep the causal loop diagram to be expedient, ‘‘good enough,’’ and not too detailed so it can keep the attention of a broad array of participants. Still, the research team experienced a chaotic period to relate all parameters in quantitative manner to each other. Consequently, the fifth meeting was three months behind the schedule since the research team required longer time to collect all the quantitative data. Yet, not all part of the simulation model was ready for testing. Nevertheless, the user interface was ready to a certain extent and the participants had a chance to test the simulation model to be certain that it reproduced the behavior seen in the real world.

The sixth meeting. The sixth meeting began with a brief verbal description of the model given by the PI. Then, the participants were divided into four groups and each group had one person who had participated more than three meetings. Each group worked with two computers that had been preinstalled with the iseePlayer version 8. The freeware allowed the participants to manipulate the model parameter, but not to save the file or modify the model structure. The PI then walked the participants through the model basics, beginning with the user interface, and showed them how to manipulate the model.

The PI asked the participants to reduce total vehicle emission for CO and NO_x to the 1998 emission load. Table 3 shows major assumptions for the base run of the model. Each group tried "maxing out" different policy levers to gauge the effect on the total emission output graph. The policies were limited to the first six interventions. All group discussed the results after they decided on the best scenario.

The immediate lesson was that Group 1 and Group 3 were so busy changing the parameter, thus they ended up with unrealistic policy. Group 1 was so favored to meet the public transport demand by setting a prompt delivery time for new bus. Group 3 was also favored the public transport demand and they even sacrificed the economic growth by setting zero growth target. Still, both groups did not get lower emission than what Group 2 achieved.

Table 3: Major assumptions for base run

Intervention	Base run	Group 1	Group 2	Group 3
1. Economic growth rate target (frac. per year)	0.04	0.01/0.07	0.04/0.05	0/0.04
2. Increase non-motorized transport (fraction)	0	0.9/0.42	0.86/0.1	1/1
3. New large bus delivery time (year)	5	0.1/1.5	2/1	0.24/2
4. New medium bus delivery time (year)	5	0.1/3.06	3.5/3	0.24/3
5. New small bus delivery time (year)	4	0.1/3.06	5/5	0.24/4
6. Road construction time (year)	3	3.5/4.0	4/2	4/4
7. Car life time (year)	20	20/10	20/10	20/10
8. Large bus life time	15	15/7.1	15/5	15/10
9. Medium bus life time	15	15/7.1	15/7	15/10
10. Small bus life time	15	15/7.1	15/5	15/5
11. Year to implement emission test	2025	2025/2025	2025/2005	2025/2025
12. Year to implement EURO 1	2025	2025/2025	2025/2005	2025/2025

None of the groups could achieve the vehicle emission reduction goal. The PI gave all groups a second chance to play with the model and try all the available interventions. Figure 12 shows the base run along with the results. All scenarios clearly indicate that the participants learned that the bus fleet size significantly affected the emission. For the same number of trips that served by the bus, larger bus contributed a smaller emission in total. The participants learned that no silver bullet to reduce vehicle emission. They had to combine the transport demand management with implementation of cleaner vehicle technology and good maintenance.

Model

The model has five reference modes: the number of car, the number of motorcycle and the number of bus (large, medium, small). It is spatially and temporally aggregated, treating the transportation system of Jakarta as a whole, and calculating changes to the system on annual basis. It includes only personal travel by Jakarta residents and the travel to work of the Bodetabek residents that work in Jakarta. The model runs from 1985 to 2025. Policy decisions made at the beginning of a model run take effect in 2005. The model was developed using Stella.

Figure 7 shows a high-level overview of the model. Jakarta population and workers from Bodetabek determine travel demand, which is satisfied by private vehicle, bus, and non-motorized transport (NMT) i.e. walking and cycling. As the NMT shares increases, the total motorized travel demand decreases. An increase in the bus attractiveness decreases the private vehicle volumes and in turn increases bus ridership. The volume of vehicles relative to road capacity defines congestion. Increasing congestion reduces trip per day per bus which decreases bus adequacy. It builds an important feedback by decreasing bus attractiveness and increasing private vehicle volumes and in turn even causes more congestion. Many other feedbacks are built within the system.

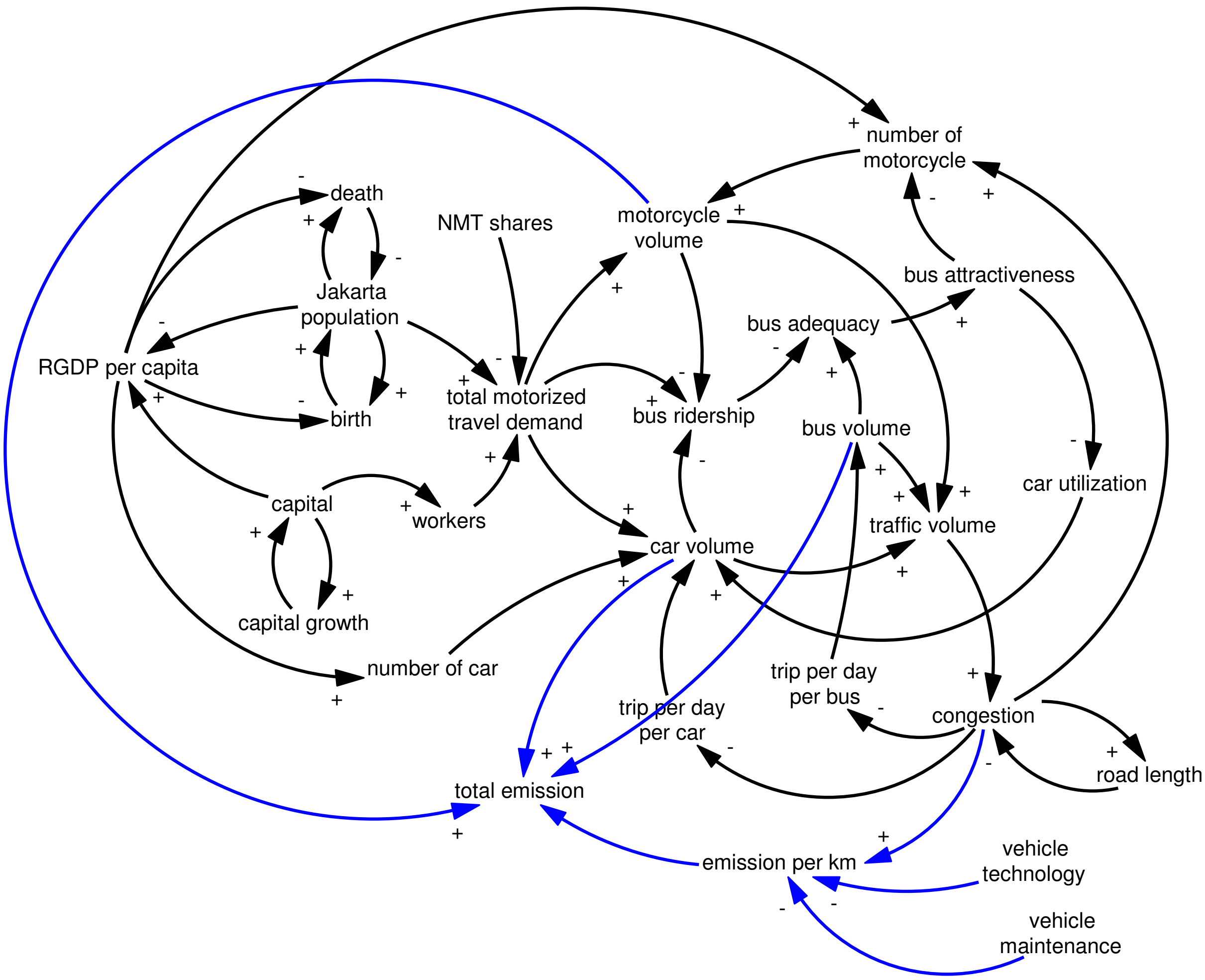


Figure 7: Overview of causal structures

Table 4 identifies endogenous and exogenous variables and Table 5 lists the six sectors and 16 stocks. Table 6 identifies major assumption in the model. The "dashboard" is shown in Figure 8.

Table 4: Key model variables

Endogenous	Exogenous	Omitted
Regional gross domestic product	Housing availability	Spatial variation
Population	Inmigration and outmigration	Temporal variation
Birth rate	Capital worker ratio	Tourist traffic
Life expectancy	Work trip per day per worker	Commercial traffic
Trip per day per capita	Non-motorized transport modal shares	Trip other than work generated by Bodetabek residents
Number of car	New bus delivery time	Public transport attractiveness due to
Number of motorcycle		

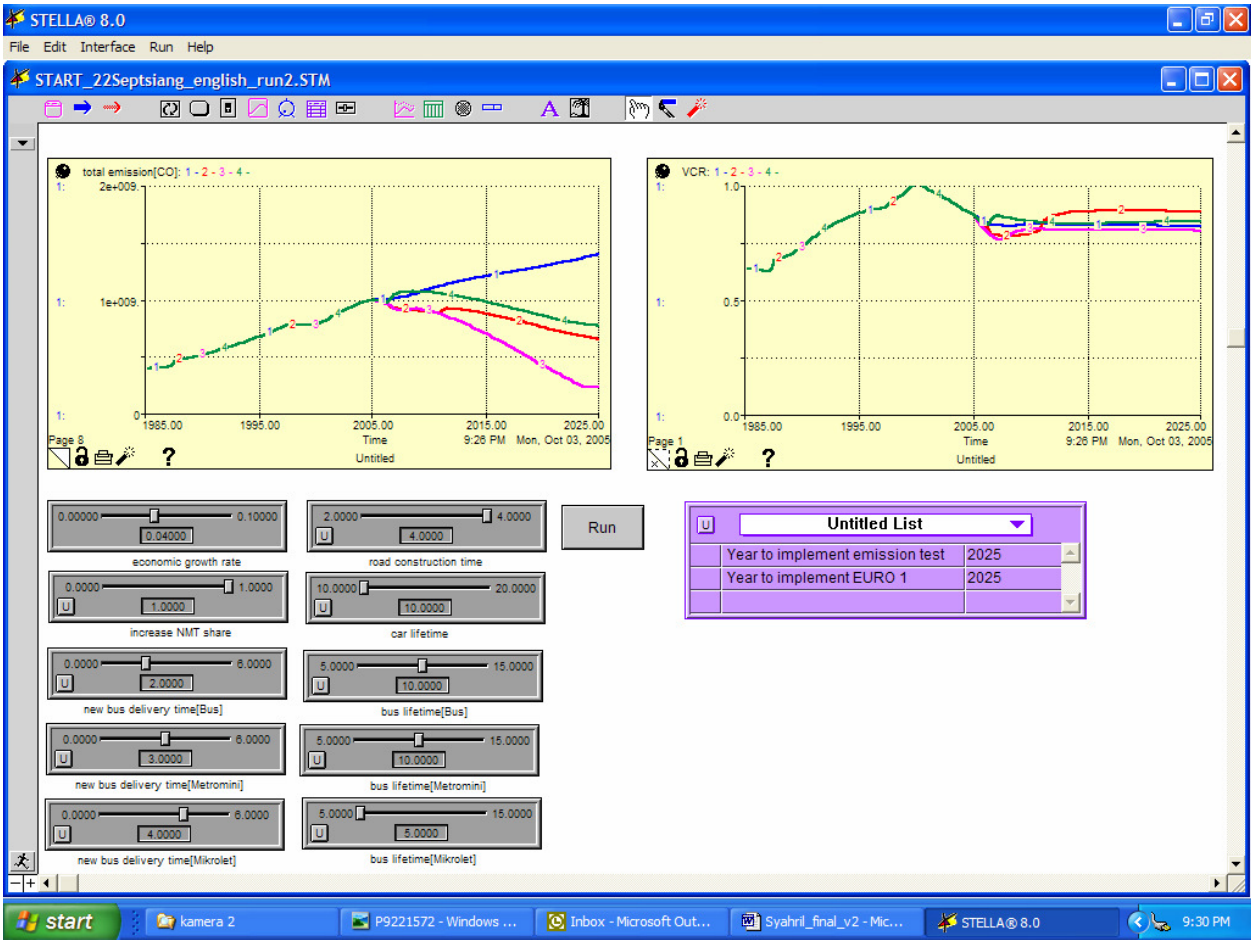
Bus attractiveness Bus ridership Congestion CO emission per km NOx emission per km Total CO produced Total NOx produced	Car and motorcycle life time Car occupancy Road construction time Vehicle technology Vehicle maintenance	service, fare and security Railways modal shares

Table 5: Summary of model structure

Sector	Stocks or major variables
Trip Generator	Capital (1 stock), Jakarta population (1 stock)
Motorized shares	Volume of motorized trips (no stock, calculated)
Private Vehicles	Number of car (1 stock), Number of motorcycle (1 stock)
Bus attractiveness	Number of bus (3 stocks)
Congestion	Road length (1 stock)
Emission	CO per km (8 stocks)

Table 6: Major assumption in the model

Birth rate will decrease and life expectancy will increase as the income ratio increase
Inmigration rate will decrease and outmigration rate will increase as the housing availability decrease
Trips per day per capita will increase as the income ratio increase
Capital workers ratio is constant. Number of workers will increase as the capital growth
Non-motorized modal shares will decrease as the distance per trip increase
Every household are willing to own a car and car per household and motorcycle per household will increase as the income ratio increase.
Motorcycle per household will increase as the income ratio increase.
Bus adequacy will increase bus attractiveness
Car utilization and potential shares of motorcycle will increases as bus attractiveness decreases
Trip per day per car and bus will decrease as the congestion increases
Potential shares of motorcycle will increase as the congestion increases



Note: (1-Blue) Base run (2-Red) Group 1 (3-Pink) Group 2 (4-Green) Group 3

Figure 8: User interface with the best scenario after the second chance

Elicitation of mental models

Realizing the issue has the history of conflicting situation, the model building was started from the scratch. Simply to create a sense of ownership from the participants.

Workbooks

The meetings were interspersed with workbooks to keep the model-building efforts focused. Figure 2 shows the alternating sequence of meetings and workbooks. The workbook sent to the participants before the next meeting. If the time permits, the participants were requested to return the workbook to the gatekeeper. The workbook helped the project group members to prepare the next meeting and speed up the process. The detail agenda for the next meeting then largely depends on the results of the previous meeting and the workbook. The workbooks mainly consisted of:

(1) The model built during the meeting. The model need to be restructured by the research team after each meeting, but not changed, because the model was usually not very organized.

(2) Analysis and summary of the discussion during the meeting

(3) List of questions that had to be answered in the next meeting if there were any

Logistics

All the meetings took place in the meeting room of Hotel Ambhara, Jakarta, Indonesia. The seating position was customized for each meeting. The extra seating was arranged to anticipate more participants. The list of equipment prepared for each meeting was:

(1) LCD screen and portable computers
(2) White board and markers
(3) Flipchart
(4) Cards with dimensions 10 x 20 cm and markers for brainstorming meeting
(5) A tape recorder and cassettes (the discussions were taped and these recordings were transcribed afterward)
(6) The meetings were videotaped since this study was exploratory in the sense that this was totally new experiences to all of project team as well as the stakeholders. The documentation allowed the project team to do some evaluation afterward.

Follow-up survey

After the six series of meetings, the participants were interviewed with the aid of questionnaire. The respondents were asked to rate a statement ranging from 1 (=strongly disagree) to 5 (strongly agree) and two open ended questions. The statements and the full answers are listed in Annex A.

Outcome

In general, the respondents rated very positive about the group model building using system dynamics. Since the participants who discontinued participation in the process or unable to come in the sixth meeting were therefore not interviewed, it cannot be confirmed with certainty that the process allows for effective participation in all cases.

The participants were neutral about the realism and precision of the model. According to van den Belt (2004) the level of complexity of a scoping model produced through a group model building process such in this project can be expected to extend into several variables but remain relatively low in resolution.

Despite what the participants had learned during the process, this project did not reach a consensus among stakeholders on how to reduce vehicle emission in Jakarta during the last meeting. To reach a consensus, it required (i) a broad enough stakeholders and (ii) an understanding on the model structure and behavior it reproduces. Unfortunately, the participants who stayed until the sixth meeting end were not broad enough to ensure a balanced discussion on the model. In addition, the PI identified from the follow-up questionnaire that the participants need additional meeting to better understand the model. They need more time to play with the model.

In this project, the total length of stakeholders in group meeting was about 30 hours. The stakeholders' involvement could be categorized as low compare to all van den Belt's case studies which were around 32 to 56 hours of participant's involvement (van den Belt, 2004). In addition, the project expanded over a period of 15 months. Several participants that represented government officials had moved to new post during that period.

Nevertheless, the participants were highly rated the potential of the approach developed in this project to build a consensus on the goals among stakeholders. Thus, as the next step the PI will try to accommodate additional meetings as requested by the participants to build a consensus and seek fund to conduct them.

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Annex A: Ranked participant statements from questionnaire

Statements are ordered according to average score from most agreement to most disagreement

5 = strongly agree　　4 = agree somewhat　　3 = neutral

2 = disagree somewhat　　1 = strongly disagree

Statement	R1	R2	R3	R4	R5	R6	R7	R8	Average
I have learned something by participating in the group model building meetings	5	5	4	5	4	4	4	5	4.5
I am willing to participate again in the group model building	5	4	5	4	4	3	4	5	4.3
Group model building helped in structuring the discussions	4	4	5	5	4	4	4	4	4.3
System dynamics methodology could apply to solve other problems	5	5	4	5	4	3	4	4	4.3
The problem addressed by the model needs to be discussed on a regular basis across stakeholders groups	4	4	4	5	4	4	4	4	4.1
I realize more linkages with other sectors and stakeholders than before the process	4	5	4	4	4	4	4	4	4.1
The discussions were constructive during the meetings	4	4	5	4	4	4	4	4	4.1
The model has a potential to build a consensus on the goals among stakeholders	4	5	4	4	4	4	4	4	4.1
Group model building helped in structuring the thinking	4	5	4	4	4	4	4	3	4.0
The facilitation was effective	4	4	4	4	5	3	3	5	4.0
I have better understanding on how the linkage between the problem structure and the resulting behavior for air pollution from transportation sector	4	4	5	4	4	2	4	4	3.9
The approach can improve public participation	5	4	5	3	3	4	4	3	3.9
I need additional meetings to better understand the model structure	3	3	4	5	4	4	4	4	3.9
The human interactions (communication) were pleasant	4	4	4	4	4	4	3	4	3.9
Workable alternatives were generated during the group model building process		4	4	4	4	3	4	4	3.9
I can express my opinion freely during the meeting	3	4	4	3	4	4	3	5	3.8
The model represents well the problem the group set out to investigate	4	4	4	4	4	4	3	3	3.8
I support the conclusions drawn from the model	4	4	4	4	4	3	3	4	3.8
The link between ecology and economics is addressed appropriately by the model	4	4	4	4	4	3	3	3	3.6

The meetings were well organized	4	4	4	3	4	3	3	3	3.5
I feel that I contributed to the design of the model	3	3	4	4	3	4	3	3	3.4
Realism: The structure mimics the real world, and the output is realistic	3	4	4	4	3	2	4	3	3.4
I am planning to use the model in communications with others	3	3	4	4	3	2	4	4	3.4
The model satisfactorily answered my questions	3	4	4	2	3	3	3	4	3.3
Precision: The model predicts the outcomes accurately	3	4	3	4	3	3	3	3	3.3
The range of stakeholders representation broad enough to ensure a balanced discussion	4	3	4	3	3	2	2	2	2.9
The model in lacking in precision to the point it should not be shown to others	2	2	3	2	3	2	3	3	2.5
The process burden of six meetings was too heavy	2	3	2	2	2	3	3	1	2.3
The modeling group did not operate as a real group	1	2	2	2	2	2	2		1.9
The meetings were not worth my time	1	2	2	1	1	2	2	1	1.5
Total attendance(s) out of six meetings	6	5	4	3	1	1	1	1	2.8