

## **Review and validation of early Japanese local government SD models**

Saburo Kameyama, Faculty of Commerce, Chuo University

E-mail: kameyama@tamacc.chuo-u.ac.jp

Hidenori Kobayashi, Faculty of Policy Studies, Chuo University

E-mail: kobaken0@fps.chuo-u.ac.jp

Toru Suetake, Arthur Andersen Tokyo

E-mail: tohru.suetake@jp.arthurandersen.com

### **Abstract**

During 1970s, many Japanese local governments built their SD models for formulating their long and medium term development plans. However, as we mentioned in our presentation last year ISDC at Wellington, these models have not been used any more for their policy making.

However, sufficient time has passed to verify these Japanese local models. We have reviewed some of these models such as Saitama Prefecture Model, Hyogo Dynamics Model and Tokyo Metropolitan Model and found some meaningful hindsight as follows:

**Conceptual validity:** SD as the design methodology based on the core concept of feedback is exclusively valid. Without the feedback concept it is impossible to design complex social systems.

**Institutional validity:** Connected with institutional resources such as annual budget, SD model can carry its validity into the practical planning and implementation processes of local government policy.

**Operational validity:** Simulation results of above models were not always valid. But errors can be accrued defendable to initial conditions, while intrinsic operational properties of the model remains.

Key Word: local government model, macro economics

### 1. Japanese local government models developed during 1970s

The System Dynamics was introduced to Japan in later 1960s by Professor Watanabe, Professor Sakakura and other pioneers. After their introduction, a kind of boom has happen and started many introductory seminars and application trials in many areas.

As one of this big streams, in during 1970s, there were a kind of SD modeling boom in Japan for local governments aimed to give some direction of their visioning and long term planning. These SD simulation results expected to give some trustful perspectives on their future and also the local government staffs believes that they can control perfectly if they know the right results or right target.

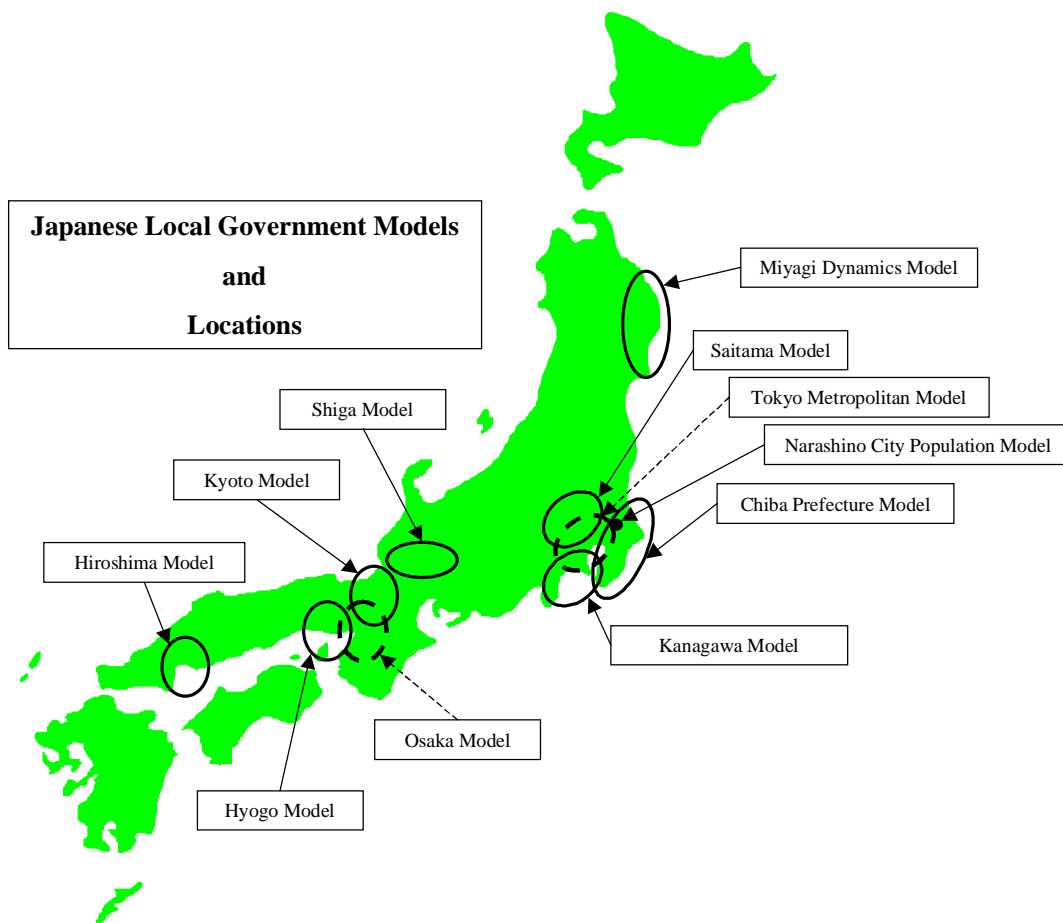


Fig-1: Map of local government model area

The major local government SD models developed in those days is as follows:

Table 1: Models and Major Simulation Results

Name of the models	Major simulation results	Information Resources
Miyagi Dynamics Model	<ul style="list-style-type: none"> <li>• Target years is 2025 (50 years after)</li> <li>• Population would be grow to 3,578 thousand (1.8 times of present population)</li> <li>• Aged person over 65 years would be 15% of the total population (3.6 times)</li> <li>• Household would be increased to 1,181 thousands (2.2 times)</li> <li>• GNP would be 10 trillion Yen (8.2 times) and agriculture sector would be reduced from 11% to 3%, industry sector would be grow from 26% to 30% and service sector would be grow from 63% to 67% in target year</li> <li>• GNP per capita would be growing from 630 thousand Yen to 2.9 million Yen.</li> <li>• They expect very optimistic view on environmental issues and NOx of air pollution would be reduced to 30% (8 thousand tons per year) and BOD of water pollution would be reduced to 40% (9 thousand tons per year)</li> <li>• Electric consumption would be increased to 27.3 billion KWH/year (6.1 times)</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Overview of Miyagi Dynamics Model</i>, manuscript report by Mr. Syoichi Toyohara, Planning Department of Miyagi Prefecture, June 1977</li> <li>• <i>Challenge with System Model to Socio-economic Environmental Dynamics: Development of Miyagi Prefecture Long-term Total Planning Model</i>, by T. Matuzaki et al,</li> </ul>
Chiba Prefecture Model	<ul style="list-style-type: none"> <li>• Target year is 1999 (21 years after)</li> <li>• Population would be increase from present 4.6 million to 6.6 Million.</li> <li>• Aged person over 65 years old would be increased from present 6% to 14% of total population.</li> <li>• GNP would be increased from present 4.6 trillion Yen to 18.3 trillion Yen.</li> <li>• Service sector would be rapidly increase from present 51% to 60%.</li> <li>• GNP per capita would also present 1.1 million Yen to 2.7 million Yen</li> <li>• They rather have pessimistic environmental issues and NOx of air pollution would be increased to 1.89 times and BOD of water pollution would be increased to 1.15 times worse. Also worried about solid waste material</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Chiba Prefecture Vision of 21<sup>st</sup> Century</i>, February 1980</li> <li>• <i>Development Study of Chiba Prefecture System Dynamics Model</i>, by Japan Long Term Credit Bank, March 1978</li> </ul>
Narashino-shi Population Model	<ul style="list-style-type: none"> <li>• Only forecast population of Narashino City.</li> <li>• Target year is 2000.</li> <li>• The population would be increase from 135 thousand in 1985 to 145 thousand in 2000.</li> </ul>	<ul style="list-style-type: none"> <li>• <i>A Population Forecast of Narashino-shi by the Method of System Dynamics</i>, by Toshiyuki Horiuchi, et al. Report of Chiba Institutes of Technology, No.27, 1982</li> </ul>
Saitama Model	<ul style="list-style-type: none"> <li>• Aim to check and validate effectiveness and reliability of SD modeling.</li> <li>• Target year is 1972.</li> <li>• Calculate during 1965 to 1972 on public sector capital stock, population, industry output, air pollution, traffic and find that the difference is within 10% compare with real statistic figures.</li> <li>• However, we could not find out that this model use for planning process of Saitama Prefecture .</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Study on Urban Area Government Planning Support System</i>, Japan Operation Research Society, March 1975</li> </ul>
Toyo Metropolitan Model	<ul style="list-style-type: none"> <li>• Target year is 2005.</li> <li>• Population of Tokyo metropolitan area would be increase rapidly.</li> <li>• Shortage of water resources in Tokyo metropolitan area obstacle economy growth.</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Study on Population dynamics in Tokyo Metropolitan Area</i>, manuscript draft of Dr. Masahige Tuji, for Japan Industrial Engineering Society, Fall 1976</li> <li>• <i>Study on Water Resources in Tokyo Metropolitan Area</i>, manuscript draft of Dr. Masahige Tuji, for Japan Industrial Engineering Society, Spring 1977</li> </ul>

Name of the models	Major simulation results	Information Resources
Kanagawa Model	<ul style="list-style-type: none"> <li>Expand double of old aged population (over 65) in the 21<sup>st</sup> century</li> <li>Increase nitro-oxide (NOx) and other pollution rapidly to be double of present state</li> <li>Decrease the green area percentage of urban area drop down to half of present state</li> <li>Become secure to keep water resources and only 70% of the demand could fulfil</li> <li>Industrial structure change rapidly shift to leaded by the service sector</li> </ul>	<ul style="list-style-type: none"> <li>Nagakiyo Takahashi and Nagashige Shinozaki "Control and Disclosure of Local Government Information", Jichitai No Keiei To Koritsu, I: Keiei to Gyozaisei Unei (Management and Efficiency of Local Government, I: Management and Operation, ed. Makoto Takahashi), Gakuyoshobo, Tokyo 1982, p131-147</li> </ul>
Shiga System Dynamics	<ul style="list-style-type: none"> <li>Target year is 2000.</li> <li>Population grew to 1.6 million but not so rapidly increase the old age percentage</li> <li>Decrease 10,000 ha agriculture land</li> <li>Industry and service sector increase rapidly</li> <li>GDP would be 5.8 times and GDP per capita would be 3.2 times of present status</li> <li>Water pollution could be reduce 30% at 1990 but again increase and almost same level in target year</li> <li>They have pessimistic opinion on air pollution and solid waste problem</li> <li>Also they have pessimistic opinion on local government financial issues.</li> </ul>	<ul style="list-style-type: none"> <li>Regional Prediction using System Dynamics, by Yoshio Morita and Sadaichi Okada, Nihon Denki Giho No.120/1977</li> </ul>
KLUD: Kyoto area Land Use Model	<ul style="list-style-type: none"> <li>Target year is 1995.</li> <li>Land use could be rapidly change and face to over population and rapidly decrease of green area.</li> <li>They recommend to government organizational reform for abolish sectionalism to accomplish much effective city planing and urban re-development.</li> </ul>	<ul style="list-style-type: none"> <li>KLUD I: Development of KLUD: Kyoto area Land Use Model, 1974, City Planning Development, Kyoto City</li> <li>KLUD II: Kyoto City structure shift from 971 to 1995, 1975, Ib</li> <li>Appendix of KLUD No.1: KLUD dynamic model equation, 1976, Ib</li> </ul>
Osaka Model	<ul style="list-style-type: none"> <li>Target year is 2000</li> <li>They have very pessimistic future</li> <li>Environment protection could be progress with effective energy consumption policy and improve efficiency and productivity.</li> <li>However, social development oriented policy and low pollution policy may face up with difficulty to keep balance with high economic growth</li> </ul>	<ul style="list-style-type: none"> <li>Dynamics Model for Urban Environment, Resources and Economic Growth I, by Isao Maniwa, Ohtemon Economic Study Report, July 1974</li> <li>Dynamics Model for Urban Environment, Resources and Economic Growth II, by Isao Maniwa, Ohtemon Economic Study Report, 1976</li> </ul>
Hyogo Dynamics Model	<ul style="list-style-type: none"> <li>Target year is 2020.</li> <li>Population would be increase from present 4.8 million to 6.3 million in 2010 but decrease after that. But urban area population increase from present 3.7 million to 4.2 million in 1995 but decrease after that.</li> <li>Aged population over 65 years old could be increase from present 6% to 20% in 2010 in urban area. 20% in 1995 and 26% in 2020 in the prefecture level.</li> <li>Moving population to other prefectures and urban areas would be increase rapidly than coming from.</li> <li>Aged mortuary rate is higher than infant mortuary rate.</li> <li>They recommend to prevent good socio-economic welfare for aged people.</li> <li>They also recommend protecting to change into slum in urban area for urban re-development with deeply concerned environment protection.</li> <li>Water resources would be shortage and recommend of recycling sewerage water.</li> </ul>	<ul style="list-style-type: none"> <li>Long-term Prospecting about Population, Pollution, Resources and Industry of Hyogo Prefecture, manuscript report of Planning Department, Hyogo Prefecture, October 1973</li> </ul>

Name of the models	Major simulation results	Information Resources
Hiroshima City Model	<ul style="list-style-type: none"> <li>• Target year is 1990.</li> <li>• Life style oriented public infrastructure investment policy cause the overpopulation and this may cause 11% increase of air pollution, heavy water pollution and traffic jam.</li> <li>• Industry development oriented public policy cause over population and heavy air and water pollution.</li> <li>• People may rather choose public transportation with suitable policy on transportation sector.</li> </ul>	<ul style="list-style-type: none"> <li>• <i>A Dynamics Model to Analyze the Repercussions of Urban Policies</i>, by Hiroyuki Kitajima and Ryoichi Sasaki, manuscript report at July 1980.</li> </ul>

Remark: US-Yen conversion rate in those days was fixed at 360Yen/US\$

## 2. Model and information resources

We already mentioned that after booming of the System Dynamics in Japan during 1970s, however, these models are not used for long term planning of Japanese local government anymore suddenly after 1980s. There are several reasons and we already mentioned at the ICSD last year.

In this study, we find that already some of detail information are disappear. The Shimada SD Library at Senshu University is the only SD information resources library in Japan. We use the information in this library. However, this library has limited information because they have only documents provided from Professor Shimada and do not try to collect other information from other providers. We try to collect more detail information about the activities of those SD golden days in Japan and send questionnaires to prefectures and cities of these models before start of this study. But we could not get any replay until now. This is all information we have now about Japanese local government SD models developed during in 1970s.

Even though there are limitations of information we have in these models and also these models are not use for planning of local government nowadays, however, we fell some of these concepts and ideas are still useful and we can learn things from these models and model builder's experiences. Also, it may be the last chance to collect information about these models because many model builders in these days are retired and we strongly afraid that the memory of those pioneer are also gone forever. That is the reason we start this study.

Following list is the information we collect for this study and what kind of information we can get. It shows how limited information we have. About most models, we only know the concept and the simulation results.

Table 2: Models and Information Resources

Models and Information Resources	Structure and concept Information	Detail simulation results	Equations or program source code
<b>Miyagi Dynamics</b>			
<i>Overview of Miyagi Dynamics Model</i> , manuscript report by Mr. Syoichi Toyohara, Planning Department of Miyagi Prefecture, June 1977	Overview description and feedback loop concept diagram but enough to know the model structure.	Detail table of simulation results and population growth graph.	No information
<i>Challenge with System Model to Socio-economic Environmental Dynamics: Development of Miyagi Prefecture Long-term Total Planning Model</i> , by T. Matuzaki et al.	Overview description and concept diagram, stock and flow diagram	Much detail graphs and simulation results tables	No information
<b>Chiba Prefecture SD model</b>			
<i>Chiba Prefecture Vision of 21<sup>st</sup> Century</i> , February 1980	Just overview description and overview conceptual diagram.	Comparison table of start year and target year.	No information
<i>Development Study of Chiba Prefecture System Dynamics Model</i> , by Japan Long Term Credit Bank, March 1978	Detail explanation about the model structure with detail model structure diagram.	No information	No information but some of them can know from the description of element relations.
<b>Narashino-shi Population Model</b>			
<i>A Population Forecast of Narashino-shi by the Method of System Dynamics</i> , by Toshiyuki Horiuchi, et al. Report of Chiba Institutes of Technology, No.27, 1982	Detail structure diagram and enough description	Simulation result tables.	DYNAMO program source code
<b>Saitama Model</b>			
<i>Study on Urban Area Government Planning Support System</i> , Japan Operation Research Society, March 1975	Detail explanation and detail feedback diagram.	Detail simulation results tables and graphs.	Equations and program source code
<b>Tokyo Metropolitan Model</b>			
<i>Study on Population dynamics in Tokyo Metropolitan Area</i> , manuscript draft of Dr. Masahige Tuji, for Japan Industrial Engineering Society, Fall 1976	Diagrams and overview explanation	One graph	No information
<i>Study on Water Resources in Tokyo Metropolitan Area</i> , manuscript draft of Dr. Masahige Tuji, for Japan Industrial Engineering Society, Spring 1977	Relation concept chart.	One graph	No information
<b>Kanagawa Model</b>			
Nagakiyo Takahashi and Nagashige Shinozaki "Control and Disclosure of Local Government Information", Jichitai No Keiei To Koritsu, I: Keiei to Gyouzaisei Unei (Management and Efficiency of Local Government, I: Management and Operation, ed. Makoto Takahahi), Gakuyoshobo, Tokyo 1982, p131-147	Not much information	Brief results only.	No information
<b>Shiga System Dynamics</b>			
<i>Regional Prediction using System Dynamics</i> , by Yoshio Morita and Sadaichi Okada, Nihon Denki Giho No.120/1977	Overview explanation and conceptual feedback diagram	Result graph	No information
<b>KLUD: Kyoto area Land Use Model</b>			
<ul style="list-style-type: none"> <li>• <i>KLUD I: Development of KLUD: Kyoto area Land Use Model</i>, 1974, City Planning Development, Kyoto City</li> <li>• <i>KLUD II: Kyoto City structure shift from 971 to 1995</i>, 1975, Ib</li> <li>• <i>Appendix of KLUD No.1: KLUD dynamic model equation</i>, 1976, Ib</li> </ul>	Detail explanation with conceptual diagram and feedback loop diagram.	Detail simulation results tables.	Not enough information but many of them can know from the description of element relations. No program source code.
<b>Osaka Model</b>			
<ul style="list-style-type: none"> <li>• <i>Dynamics Model for Urban Environment, Resources and Economic Growth I</i>, by Isao Maniwa, Ohtemon Economic Study Report, July 1974</li> <li>• <i>Dynamics Model for Urban Environment, Resources and Economic Growth II</i>, by Isao Maniwa, Ohtemon Economic Study Report, 1976</li> </ul>	Detail explanation with conceptual diagram and feedback loop diagram.	Detail simulation result graphs.	Equations and program source codes.

Models and Information Resources	Structure and concept Information	Detail simulation results	Equations or program source code
<b>Hyogo Dynamics</b>			
<i>Long-term Prospecting about Population, Pollution, Resources and Industry of Hyogo Prefecture</i> , manuscript report of Planning Department, Hyogo Prefecture, October 1973	Conceptual relation chart and overview explanation.	No graph and tables	No information
<b>Hiroshima City Model</b>			
<i>A Dynamics Model to Analyze the Repercussions of Urban Policies</i> , by Hiroyuki Kitajima and Ryoichi Sasaki, manuscript report, July 1980.	Overview and conceptual diagram	Overview graph and tables	No information

### 3. Validation of these models

We decide to validate these models with 3 levels: conceptual level, institutional level and operational. Of course we already know other validation methods but in this case, this three kinds of validation are suitable for old model for we can use statistic data, historical background and results of their policy decision making as validation criteria.

#### 3-1) Conceptual validity

SD as the design methodology based on the core concept of feedback is exclusively valid. Without the feedback concept it is impossible to design complex social systems. However such as KLUUD, some of these model use econometric methods and we feel somehow not fully follow the System Dynamic's philosophy that tacitly request to composed with relation of only with flows and stocks. Therefore, we think considering concept of the model carefully. As concept validity, we select following criteria as validation elements:

- Consistency: Consist feedback loop concept
- Focus: Is the model focus on purpose or objectives to the simulation? Or on the other word, multi purpose or single purpose
- Structure: Whether model structure is adequate for purposes of the simulation objectives.

Consistency is validated with the existence of detail feedback philosophy. But some of the models are not perfectly build by 100% pure flows and stock feedback models. We could understand that the machine (computer) does not had enough memory and computing ability in those days. Especially on finance sector, it is sometimes so difficult to make 100% perfect elements relationship with linkage of macro level and micro level economic factors. There are many unknown economic factors between national level, prefecture level and municipality level by industry sectors and household expenditures. Also science and technology development factor is difficult to make component. On the other hand, in such model so called hybrid which composed with econometric part and SD part make shorten its life of usage. For the sake of in-composed with econometric part, KLUUD and Saitama Model forecast at most 10 years.

Focus, or single purpose or multi purposes affects complexity of the model. Single purpose makes rather simple model structure and easy to trace or validate. Multi purposes makes much complex model and sometimes difficult to trace or validate. Also we think multi purposed model is hard to keep maintaining and keep using planning processes.

Structure is also very important element to check the completeness of concept. It also related with difficulty to keep maintain the model and using for planning processes. We suspected that complex model such as KLUD, though which has single purpose, makes difficult to keep maintaining.

We try to trace as much resource we can but confessed that the information resources are much rely on academic paper which sometimes drop off many related information such as back ground information of the model builder and their true objectives or demand. For example, the Saitama Model developed to check the effectiveness of SD model for planning processes as first objectives. The model builder got the conclusion that SD simulation results are within 10% error of the statistic data. Then we know the model was presented to Saitama Prefecture but even we try to trace the subsequence of the Saitama Model but could not get much information. Model, program source codes and recommendations are still in mist.

Table 3-1: Conceptual Validation

Name of the models	Consistency	Focus	Structure
Miyagi Dynamics Model	Not enough information for validating consistency in detail.	Multi purposes but seem to be that main concern is future of life standard rather than future of industry or finance.	Composed with 6 components, population, land use, infrastructure, industry, environment and life style.
Chiba Prefecture Model	We think this model have perfect feedback loops and keep consistency in detail.	Multi purposes and main objective of this model is to provide information for planning staff. We think this model has rather difficulty to clearly focus on specific issues.	Composed with 8 components, population and household, public infrastructure, transportation and traffic, environment, finance, industry, labor market and land use.
Narashino-shi Population Model	Perfect consistency of feedback loop.	Single purpose that only for calculate population of the Narashino City.	Mainly simple 9 elements loops, population density, population, household, land use, land usage, land price, factory area, commerce area and population moving rate.
Saitama Model	We think this model have perfect feedback loops but doubt to have consistency in detail. Suspected that use some linear relation for simplify such as using attractiveness multiplier.	Main purpose is not assist to planning but validate the effectiveness of SD techniques on government planning.	Briefly composed with 4 sectors, industry, population, finance, pollution and public services.
Toyo Metropolitan Model	Not enough information	Not enough information	Not enough information
Kanagawa Model	Not enough information	Not enough information	Not enough information
Shiga System Dynamics	Seem to be good feed back loop in overview level but do not have enough information for check the detail.	Multi purpose but rather focus on environment protection issues.	Mainly composed with 5 components, industry, population, land use, finance and public services and the environment centered on Biwa Lake.



Name of the models	Consistency	Focus	Structure
KLUD: Kyoto area Land Use Model	This model have perfect feedback loops but doubt to have consistency in detail. Suspected that use some linear relation for simplify in finance sector.	Single purposed focus on land use only.	Composed with 6 sectors, population, household, commerce area, industry area, traffic and environment.
Osaka Model	This model have perfect feedback loops both conceptual level and detail level.	Multi purposed but focus on providing information for policy decision support.	Composed with 8 sectors, local government policy, social capital, investment plan, energy and resources, industries, population, economic growth and environment.
Hyogo Dynamics Model	Do not have enough information	Multi purpose.	Briefly composed with 4 sectors, population, industries, resources and environment pollution.
Hiroshima Model	Do not have enough information	Multi Purpose but rather focus on transportation sector policy and environment	Briefly composed with 2 level, macro level and micro level. Marco level handle industry and population. Micro level composed with three sectors, traffic and communications, Environment and life style. But we feel this macro micro layer structure may not accomplished in this model because there are no description about time delay linkage between two layers.

We can conceptual validated only 5 models out of 11, Chiba Prefecture Model, Narashino-shi Population Model, Saitama Model, KLUD and Osaka Model. Some of them are not completely followed SD's flows and stock loop relation concept. This is because they want to introduce the simplification for avoiding the arguments on especially economic sector. However excluding that point, these models are conceptually acceptable.

Also many of these models are multi purpose and aimed to provide the information for policy decision-makers of planning division. But this multi-purpose does not mean to give some standard form to the model. Every model has their own background needs and they change the structure of the models for this background needs. For example, Shiga Model is multi purposes model but rather focus on environment issues stand for this prefecture's unique position. This prefecture has the largest lake in Japan and the lake area shared nearly 50% of the area. Also this lake is main water resource for Kyoto and Osaka and this prefecture has very heavy duty to protect from water pollution.

All models' structures are typical sector related model. Sector relations could be validated whether loop is closed within the system. In this term, all models have closed loop with in the system as sector relation and concept level. However, as we mentioned early, some of these models use econometric techniques and this make linear relationship between parameters. We have many experiences to know that the economic and financial relation sometimes has non-linear relation.

Also, the relation between the sector is so called non-hierarchy structure. Hiroshima City Model is only model, which clearly try to identify macro level and micro level with hierarchy structure.

However, we feel they may not accomplished this macro-micro layer structure. As our experiences, model builder must consider time delay of information between two layers, macro level and micro level. It is sometimes very difficult to keep consistency and feel to insert some functionality to give judgement after get some interim result on the simulation. For this purpose, we once make interim result tables between the simulation for linkage of macro and micro level. Therefore, we think this Hiroshima City Model may have non-hierarchy structure (flat structure) and may not consider time delay mechanism. However, we think that, for basic purpose of the model, this model may not necessary to have hierarchy structure.

We could not validate other models because shortage of detail information within the model's sectors.

### 3-2) Institutional validity

Connected with institutional resources such as annual budget, SD model can carry its validity into the practical planning and implementation processes of local government policy.

As institutional validity, we select following criteria as validation elements:

- Initiatives: Who is model builder in term of concept development or concept determination
- Background demands: What kind of information they truly need?
- Recommendation: What kind of recommendations they provide and how it was affected to their policy.

Initiatives, is very important even all models are actually developed by computer scientist or system engineer. Some of these models are developed only for study purpose. For example, main purpose of Saitama Model is for check whether SD is effective and could simulate real world. In this term, initiatives are conducted by OR scientist but not local government staff. On the other hand, Miyagi Dynamics Model and Hyogo Dynamics are good example that the government staff takes initiatives for their long term planning.

Background demands are also so important for try to make in such models. Generally in those days in Japan, local governments have mainly three big issues. One is population movement and economic structure transform. Economic structure shift from agriculture based to industry based. That makes people move from rural area to urban area and the government staff feel the needs of re-develop of urban area. Second issue is environment protection. They afraid the air pollution and water pollution. It is also connect with over population of urban area, they feel the need to build more water supply and sewerage system, control the number of car and try to shift more public transportation including bus and subway. Third issue is financial problem. The government staff was afraid that they could not get enough tax income for conducting many infrastructure developments

and social welfare needs for growth of aged population. This treats are much strong especially surrounded prefectures of Tokyo and Osaka such as Chiba Prefecture, Saitama Prefecture, Kanagawa Prefecture which are neighbor prefectures of Tokyo, Hyogo Prefecture, Shiga Prefecture and even Kyoto City which are neighbor prefectures of Osaka. They've afraid to keep balance of huge public infrastructure development investment. However, Miyagi Prefecture does not have much in such fear compare with other surrounded prefectures.

Strong recommendations also related with whether government staff take initiatives or not. If the government staff takes initiatives of model building and simulation, the recommendations also built into their planning processes including to keep sufficient budget for implementation. We validated the results of recommendations with their new laws, regulations, policy statements and new projects. This may be the best institutional validation if based on the previous two information, who take initiatives and their background demands.

Table 3-2: Institutional validity

Name of the models	Initiatives	Background Needs	Recommendation
Miyagi Dynamics Model	Government staff: Planning Department of Miyagi Prefecture Government. They make project team and build the model.	Under-population problem that people move to Tokyo. Also search to give satisfaction to the people keep living in the prefecture.	Need policy considering rapidly age population growth, and balanced socio-economic development of urban and rural areas. Environment protection policy is very important to keep maintain the level of life standard and must accelerating public infrastructure investment including water supply an sewerage system, public park, traffic safety, safety consumer products, etc. Focus on social services to keep sustain and up the life standards for give more satisfaction to the people living in the prefecture.
Chiba Prefecture Model	Government staff: Planning Department of Chiba Prefecture Government	Over population problem in bed town area and under population problem in rural area. Rapidly growth of industry sector and pollution problem.	Not clear from the information resources.
Narashino-shi Population Model	Academic side: Chiba Institutes of Technology	Over population problem and necessity of urban development.	Not clear from the information resources.
Saitama Model	Academic side: Japan Operations Research Academy	Over population problem in bed town area and under population problem in rural area. Rapidly growth of industry sector and pollution problem.	Not clear from the information resources.
Toyo Metropolitan Model	Academic side:	Over population problem, shortage of house, pollution, shortage of water resource, and so many typically on big cities.	Not clearly mentioned but suggest the relation between the number of university, GNP growth water resources and population.
Kanagawa Model	Not enough information	Not enough information	Not enough information
Shiga System Dynamics	Government staff: Project team of Shiga Prefecture	Pollution of water resources	Need to take protection of water pollution. Must consider financial problem.

Name of the models	Initiatives	Background Needs	Recommendation
KLUD: Kyoto area Land Use Model	Government staff: Study team in Kyoto City Government	Needs of urban re-development to keep balance of historical environment.	Need to develop public transport system including subway. Need to control strict control of land use under urban development plan.
Osaka Model	Academic side: study team	Over population and heavy pollution. First oil shock makes economic recession.	Environment protection could be progress with effective energy consumption policy and improve efficiency and productivity. However, social development oriented policy and low pollution policy may face up with difficulty to keep balance with high economic growth
Hyogo Dynamics Model	Government Staff: Planing Department of Hyogo Prefecture	Over population problem in bed town area and under population problem in rural area. Rapidly growth of industry sector and pollution problem.	They recommend to prevent good socio-economic welfare for aged people. They also recommend protecting to change into slum in urban area for urban re-development with deeply concerned environment protection. Water resources would be shortage and recommend of recycling sewerage water.
Hiroshima CITY Model	Not clear	Rather unique position in industry area of the Seto Inland Sea. Industrial pollution problem.	They do not recommend anything. Just describe the forecast based on the simulation results.

On 5 models, the local government staff takes initiatives. In such model and simulation results gives very clear recommendations. However, models take initiatives by academic side are not give so much clear recommendations. Also these models seem to be much focus on providing the information rather than recommendations.

Based on the models' background, these models could categorized briefly into three types, urban model such as Osaka model and Tokyo model, suburb model such as Chiba Prefecture Model, Hyogo Dynamics and rural model such as Miyagi Dynamics. The local governments of these urban models have every trouble the big cities have such as over population, urban re-development, pollution and shortage of resources. The local governments of these suburb models have complicated features. They have urban problems that big cities have such as over population, shortage of public infrastructure but also have under population in their rural area. The local governments of these rural models have under population problem and feels some necessity to give other satisfaction or value to keep maintain the population or stop the under population.

Recommendations also clearly show the importance of government staff initiatives. They take much clear recommendations and could take incorporate into their planning processes. We can know from their new regulation such as environment protection laws, policy statement and new projects such as rural area infrastructure development. For example, Shiga Prefecture takes strict water-pollution-

control law for protecting the pollution of the Shiga Lake. This law request to stop usage of synthetic detergent. We believe that their recommendations makes the government's action to take in such pioneering anti-water-pollution activities in Japan. Also, we believe that the recommendations of Miyagi Dynamics Model keep behavior of the governments' people's life style oriented policy in this prefecture. In Hyogo Prefecture's case, they also succeed to keep urban re-development with many parks and museum, and keep balance of industry development in the prefecture. Kyoto City still keeps balancing policy of socio-economic development and historical landscape. They also succeed to build the subway. All of these cases could have sufficient budget to keep their policy implementation.

Therefore, government staff's initiatives on model building and strong recommendation are key factor of institutional validity.

### 3-3) Operational validity

Simulation results of above models were not always valid. But errors can be accrued defendable to initial conditions, while intrinsic operational properties of the model remains.

As operational validity, we select following three criteria:

- Modification: Easiness to modify the structure of models
- Sensitiveness of initial conditions
- Accessibility to model or simulation environment

Modification or easiness to modify the structure of the model is very important element to keep using the model on their planning processes. Log term planning basically not routine work but pile of ad-hoc type works for planner. They need to re-calculate for specific issues suddenly as ad-hoc work. Many times, they feel to modify the model structure of model components. Especially the model partly using simplification needs to modify or update much frequently. Easiness of modification is better for operational purpose. If the model does not allow the modification, in some days, it may not used anymore.

Sensitiveness of initial conditions mainly come from the model's complexity. More complicate, the bigger chance to falls into sensitiveness of initial condition. Sometimes, operator could not get suitable data but sensitiveness of initial condition may cause the difficulty to make try and error initial condition settlement. It makes also barrier of modification and accessibility.

Accessibility is also sometimes makes barrier to keep using the model for planning processes. Many cases, planner do not have much time for arrange the simulation. If they could not get the simulation

results immediately, they rather use statistical data and make simple estimation. Linear statistical estimating data can easily get using simple calculator or spread sheet. Accessibility depended on two elements, whether the initiatives of the model building carried by the planning section of the government staff or academic side. If the government staff take initiatives, they try to keep using for their planing and therefore try to keep accessibility to the model. Second is computer language and availability of the source code. If they keep having source code and compiler, it also increasing the accessibility.

Table 3-3: Operational validity

Name of the models	Modification	Sensitiveness	Accessibility
Miyagi Dynamics Model	Not enough information but model was composed with matrix described by APL computer language and other part describes by GSMP III. We feel in such model may not easily make modification in necessary of planning. However, they disclose stock and flow diagram and it may possible to modify on this diagram level.	Not enough information	Not enough information but initiatives conducted by planing section of the government. We feel that the staff may need official procedure to use and feel not so easy to access.
Chiba Prefecture Model	Easy to modify for disclose of detail model. But we feel the government staff may not do for complexity of the model.	No information but the model is so complicated and we feel this model may have sensitiveness to initial condition.	No information
Narashino-shi Population Model	Easy to modify because source codes and model structures are open and model is simple and clear to understand. Even though the model can also possible to expand and include other sector but we feel the government staff do not do that for the academy take initiatives on development of the model.	Original structure of the model is simple and may not have so much sensitiveness to initial condition.	Easy as same reason mentioned at modification section. However, initiatives lead by academic and we feel that the government staff does not use this model so much on their planning.
Saitama Model	Easy to modify for disclose of detail model. But we feel the government staff may not do for academy take initiatives on development of the model.	Not enough information	Not enough information on accessibility but source codes are disclosed.
Toyo Metropolitan Model	Not enough information	Not enough information	Not enough information
Kanagawa Model	Not enough information	Not enough information	Not enough information
Shiga System Dynamics	Not enough information	Not enough information	Not enough information but the model describes with DYNAMO.
KLUD: Kyoto area Land Use Model	Possible but we feel difficult to modify. Also hard task to modify financial sector for adapt industrial structure transformation.	It may face up the sensitiveness of initial condition.	Not enough information but it may be possible for many models information are disclosed.
Osaka Model	Possible.	Original structure of the model is simple and may not have sensitiveness to initial condition.	Possible and the model described by with FORTRAN language.
Hyogo Dynamics Model	Not enough information	Not enough information	Not enough information
Hiroshima City Model	Not enough information	Not enough information	Not enough information

We could not get enough information for validate modification criteria but 6 models, Miyagi

Dynamics Model, Chiba Prefecture Model, Narashino-shi Population Model, Saitama Model, Osaka Model and KLUD are seen to be easy to modify. They disclose the detail relation loop models and some of them are even disclosed the stock and flow diagram too. If accessibility is quite good condition, the government planning staff may keep using and maintaining as the part of planning processes. However some of them have complicated structure for modification such as Miyagi Dynamics Model. It may also come from the limitation of computer abilities in those days and availability of DYNAMO, many models are described with other computer languages including FORTRAN, APL and GSMP III. FORTRAN is popular in those days and could find many system engineers who know well about FORTRAN language but we feel it may be not so easy to find the system engineer who knows other computer languages such as GSMP III.

Also we have very limited information about the sensitiveness of initial condition and we have no way but to validate from the complexity of the model's structure. If we could have a chance to get complete equations and source codes of the models, we hope to validate by our own computer someday. Anyway, the simple and small model such as Narashino-shi Population Model and Osaka Model obviously seem to have not been composed with any trouble part which may fall into chaos.

Availability may be key issues to keep using the model for planning processes. This matter comes from three elements, easiness of modification with simple enough and still have necessary functionalities, initiatives of the government staff for the model building, and ideally initial data re-setting and source code compiling can do on their personal computer. Unfortunately there are no models that meet in this condition. Osaka Model may be said only one if insisted to select because FORTRAN may be rather easy to translate into BASIC. The reason that suddenly these models do not use any more in the 1980s may come from such reasons (difficulties of modification and compiling). Models that include the diagrams with flows and stock may also be rather easy to translate into other SD simulation software such as STELLA. Miyagi Dynamics Model, Saitama Model, Kyoto area Land Use Model, Osaka Model and Narashino-shi Population Model disclose in such type of diagram. Chiba Prefecture models also disclosed relation diagrams and may also be possible to translate into other SD Models.

#### 3-4) Other validation

We also try to validate available statistical data with their forecasts. However, the difference does not mean that straightly existed some errors conceptually, institutionally and operationally.

### 3-4-1) Miyagi Dynamics Model (target in 1995)

Table 3-4: Miyagi Dynamics Model and Statistical Data

	Simulation Standard	Simulation Case I	Statistics
Population (thousand)	2,783	2,786	2,338*1)
Population age 0-14	21.9%	21.9%	16.5%
Population age 15-64	67.2%	67.2%	68.5%
Population age 65-	10.9%	10.9%	15.1%
Household (thousand)	876	876	787*2)
Population Density*3)	381.7	382.2	321
Labor population *4)	1,285	1,287	1,164
Agriculture	10.9%	10.8%	8.2%
Industry	29.6%	29.8%	27.5%
Services	59.5%	59.4%	63.9%
GNP (100 million Yen)	42,446	42,434	64,000*5)
Agriculture	2,025	2,021	2,699
Industry	13,420	13,446	36,923
Services	27,000	26,968	26,815*5)

\*1) population in 1996

\*2) household in 1997

\*3) person per square kilometers

\*4) thousand

\*5) GNP in 1994

\*) GNP of simulation use price index in 1970

\*) Standard case consider the limitation of green area and try to keep more than 75% but CASE I do not consider any conditionality of green rate.

\*) Consumer index price in 1975 is 55.3 as 100.0 in 1997 seem to almost double.

Miyagi Dynamics Model seems to have under estimate on growth of aged population. This growth of aged population (over 65 years old) goes so rapidly especially in rural area in Japan. Also they under estimated the GNP growth. (In this case actually mean gross prefecture product. Same concept of GNP which much less than GDP.) It may affected the economic recession since middle of 1990s but SD model builder thought the economic growth would be goes as linear relation.

### 3-4-2) Chiba Prefecture Model (target in 2000)

Table 3-5: Chiba Prefecture Model and Statistical Data

	Simulation	Statistics	
Population	6,640	5,824*1)	Thousand
Population age 0-14	19%	15.4%	
Population age 15-64	67%	72.8%	
Population age 65-	14%	11.7%	
Household	2,270	2,092*2)	thousand
Labor population	1,988	2,992	thousand
Agriculture	8%	4.6%	
Industry	26%	27.5%	
Services	66%	67%	
GNP	129,000	181,662*3)	100 million Yen
Agriculture	3,627	4,850*4)	
Industry	44,143	116,655*4)	
Services	81,230	60,355*3)	

\*1) in 1996



\*2) in 1997

\*3) in 1994

\*4) in 1995

\*) GNP based on price in 1975

Chiba Prefecture Model shows very good forecast except economic growth. They also over estimated the economic growth.

Unfortunately, we could not have enough forecast information compared with statistical data on other models. Saitama Model is for validation purpose with SD simulation and statistic data and we decide not validate this time.

#### **4. Conclusion**

We are happy to introduce the Japanese local government models developed during 1970s and could have chance to validate. As lessons from these models and the effort of the pioneers, following maxims may conclude though someone may said already.

- Focus on single purpose and/or make simple model
- Make simple structure model but avoid to making hybrid structure
- Take initiatives of the government staff for model building
- Need to support their demands and recommendations
- To disclose all information for maintaining the model or/and running simulation on other computer

We though that we may find some general or standard model form through comparison and validation of the old Japanese local government models. Every model has similar structure of several sectors linkage block diagram. Selected sectors and elements are also very similar. However, small change comes affected their background demands even though all of them start similar concept.

Validation results show much strong recommendation comes from the model and simulation results the government staff takes initiatives of model building. Also validation results show that in such SD model and simulation results support their background needs and recommendations.

#### **5. Bibliography**

- A Computer Assisted Long Range Comprehensive Planning System for a Regional Project Impact Assessment in Land Use Planning, draft by T. Shiina et al. for IFAC Sixth Triennial Congress, Boston/Cambridge, Aug. 1975.

•