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Developing strategic initiatives through Triple Helix interactions: Systems modelling for policy development

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Abstract

Public policy problems are socially complex due to a range of stakeholders who involve in the coordinated action. They are also often not stable due to situation changes or stakeholders' behavior changes. Holistic thinking is actually required to solve a public policy problem, which is generally non-linear and highly complicated, through collaborative efforts across organizational boundaries. The approach of systems modelling offers an option for formulating and rehearsing strategic initiatives to resolve the problems in a systematic, structured and accountable. This paper presents an innovative effort to implement a triple helix model for supporting the development of national policies using systems modelling approaches initiated by the President's Delivery Unit for Development Monitoring and Oversight (UKP-PPP) of Republic Indonesia and the School of Business and Management, Institut Teknologi Bandung (ITB). Series of workshops have been initiated to facilitate communication and cooperation among researchers in academic institutions, practitioners in industry and business, and decision makers in government. Analyzing this finding and interactions that occurred among stakeholders during the workshops, a model of Triple Helix interactions is formulated. In addition to known interaction between university and industry, interaction between university and government on policy development through the channel of state-owned research and development agencies was identified. Not only promoting systems modelling as a methodology in policy development, the workshops also provided evidence on the importance of having a holistic or systemic approach in formulating policies to address a complex national problem that requires interactions among stakeholders.

Keywords: systems modelling, policy development, triple helix

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1. Introduction

Public policy problems are generally categorized as wicked problems (Australian Public Service Commission, 2007). They are difficult to be clearly defined since different stakeholders may have perceptions on the problems and are socially complex due to a range of stakeholders who involve in the coordinated action. They are also often not stable due to situation changes (e.g. evolving legislation) or stakeholders' behavior changes (e.g. changing political alliance). Many problems faced by the nation of Indonesia today are in this category, such as problems in fulfilling the needs for

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bureaucratic reform, better education and health care, reliable energy supply, food security, poverty eradication, environment conservation and many other policy problems.

Traditionally, policy making is an orderly and linear process, working from finding the root cause of problems to developing solutions. Holistic thinking is actually required to solve a public policy problem, which is generally non-linear and highly complicated, through collaborative efforts across organizational boundaries. In a complex problem, many stakeholders and aspects are involved. They are interrelated and interacting with each other forming a system that is dynamic. Therefore, decision makers in would need support in the form of policy making tools that are able to anticipate the dynamic nature of a public policy problem. The approach of systems modelling offers an option for formulating and rehearsing strategic initiatives to resolve the problems in a systematic, structured and accountable. In academic world, systems modelling approach appears as a solution that can accommodate complex problems. However, this approach is generally known among the researchers, but is rarely among practitioners, and is more rarely be used by the policy makers.

This paper presents an innovative effort to implement a triple helix model for supporting the development of national policies using systems modelling approaches initiated by the President's Delivery Unit for Development Monitoring and Oversight (UKP-PPP) of Republic Indonesia and the School of Business and Management, Institut Teknologi Bandung (ITB). As widely known, the triple helix system (Etzkowitz and Leydesdorff, 1995) has emerged from the needs of universities to work closely with the industry, with the support from the government as the policy maker. As the model evolved, government's role is not only as a support act anymore but also as an active actor in the triple helix model. Although the triple helix paradigm has been well-recognized in Indonesia, its implementation and contribution still relatively low especially in contributing to the national policy development.

The collaboration aims to facilitate communication and cooperation among researchers in academic institutions, practitioners in industry and business, and decision makers in government (e.g. ministries, agencies), especially in the sectors included in the 11 national priorities such as poverty eradication, food security, energy, environment conservation and disaster management. The systems modelling for policy development effort is expected to enhance the collaboration of three stakeholders in the triple helix model through various activities including regular workshops, thematic workshops and national seminars. These activities are intended to identify the results of research that have the potential to be implemented by decision makers in government as well as to encourage the stakeholders to work together to contribute to national policy development.

2. Literature review

As defined by Etzkowitz (2002) the triple helix is "a spiral model of innovation that captures multiple reciprocal relationships at different points in the process of knowledge capitalization." He defines that the first dimension of the triple helix model is internal transformation in each of the helices, such as the development of lateral ties among companies through strategic alliances or an economic development mission by universities. While the second dimension is the influence of one helix upon another, the third dimension is the creation of a new overlay of trilateral networks and organizations from the interaction among the three helices.

The dynamic of complex system of innovation is non-linear, which is a consequence of interaction among subsystems and the recursivity in each of them (Leydesdorff and Meyer, 2003). The non-linear interaction between 'demand pull' and 'technology push' is an example (Kline and Rosenberg, 1986; Mowery and Rosenberg, 1989).

The Triple Helix model of university-industry-government relations tries to capture the dynamics of both communication and organization by introducing the notion of an overlay of exchange relations that feeds back on the institutional arrangements (Leydesdorff and Meyer, 2003). It denotes the university-industry-government relationship as one of relatively equal, yet interdependent, institutional spheres which overlap and take the role of the other Etzkowitz (2002).

The phenomenon of the triple helix system has been recognised widely in developed countries (Etzkowitz and Mello 1994; Leydersdoff 1997) as it has emerged from the needs of universities to work closely together with the industry and to maintain the sustainable development of the industry-university integration, and the supporting role of the government as a policy maker. Etzkowitz and de Mello (2004) stated that university-industry-government interaction is the key to improve the condition for innovation in a knowledge-based society where the university as a source of new knowledge and technology (e.g. center of excellence); industries are the locus of production and provider of customer demand; and the government as the source of contractual relations that guarantee stable interactions and exchange. However this complementary concept among university-industry-government is introduced in developed countries, therefore to make it

as sensible concept for developing countries such as Indonesia it is necessary to adjust the interactions between these three actors, such as with a government-led initiative particularly in the context of policy development. The triple helix model of innovation has been tried to be implemented in different ways in various parts of the world, whether occurring from the bottom up or top down through the interactions of individuals and organizations from different institutional spheres. However in developing countries, its successful implementations are still not much evidenced.

Irawati (2006) conducted a conceptual and theoretical analysis on the implementation of the triple helix model in a developing country, particularly in Indonesian. She discussed the essential stages required to establish a synergy between three different actors, mainly the role of university in providing help for SMEs in Indonesia together with the government or other institutional developing agencies through a cluster-approach interactions, as exemplified by ITB and Gadjah Mada University. She also highlighted that universities in Indonesia, through the triple roles of a university called as the "Tri Dharma Perguruan Tinggi", which are education, research and community service, tried to improve the quality of the university's role in advancing the education in Indonesia alongside the industry sector and the government. This means that ideally a university work together with industry as a business partner to produce applicable science and technology for the betterment of society, with the role of government to provide relevant policies and incentives.

The level (multi-national, national and regional) is also to be taken into account (Etzkowitz, 2002). In this System Modelling for Policy Development effort, the focus is at the national level, where there are overlapping institutional spheres involving knowledge, consensus and innovation spaces, created at the intersection of the spheres. The first step in a three-stage process is the creation of "knowledge spaces" or concentrations of related R&D activities in universities, industry or government agencies. The second stage is the creation of a "consensus space" a venue that brings together persons from different organizational backgrounds and perspectives for the purpose of generating new strategies and ideas. The activities described in this paper fall in this category of space. The third stage is the creation of an "innovation space" a new organizational mechanism that attempts to realize the goals articulated in the consensus space. This would be the objective that the activities initiated by SBM ITB and UKP-PPP described in this paper. From the creation of a consensus space bringing the different actors in a society together, a new innovation space is to be created to provide advice and to support with technical assistance in the development of policies based on systems modelling approach.

3. Workshops of Systems Modelling for Policy Development and their outcomes

A series of workshop involving academia, industry and government (e.g. ministries, agencies, local governments) were planned and conducted. Three workshops have been run in the space of four months started on 22 October 2011, 26 November 2011 and 28 January 2011. These three workshops involved 24 presenters and 6 invited speakers, 111 submitted papers and attended by 226 participants, which consist of 38% academics, 14% practitioners from private companies, 17% practitioners from state-owned research and development agencies, and 31% representatives of government (e.g. ministries, presidential office) as presented in Figure 1.

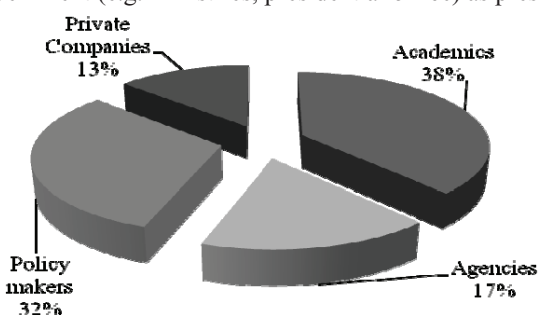

Figure 1: Participants' background

The participants were researchers and practitioners from academic institutions, industry, ministries, agencies and local governments from many geographical locations in Indonesia as well as experts from well-known overseas institutions, who presented insights on the approaches for policy development in Indonesia (Azis, 2011), a paradigm shift in national policy development to people-centred approaches (Ananta, 2011) and the application of economic models for environmental policy development (Resosudarmo, 2012). Several presentations to enrich participants knowledge and

skills in the system approach were also provided, including system dynamics approach (Tasrif, 2011), soft system methodology (Sudarsono, 2012) and social network anaysis (Muhammad, 2012a) and geospatial modelling of national economic corridors (Syahrudin and Indrajit, 2011).

3.1. Energy

In the energy sector, the topics conveyed by the presenters mainly centred on biodiesel and electricity. Winarno (2012) stated that the government needs to have a detailed policy and target of the national renewable energy plans. Biodiesel as one of candidates for Indonesia's energy diversification strategy is targeted to have 20% share in all diesel fuel in 2025. Using a system dynamic model, Hidayatno et al. (2011) found that there is visible trade off on socio-economic growth and environmental impact in the interrelationship between sustainability challenges in developing palm-oil based biodiesel industry in Indonesia. Handoko et al. (2012) developed a dynamic model to investigate the structure and behaviour of biodiesel industry to study the impact of energy policy interventions, such as biodiesel subsidy, diesel subsidy, blending mandate and diesel environmental tax. From industry point of view, Udayana (2011) presented a risk management DSS (decision support system) for palm-oil based biodiesel to minimize the risks in biodiesel agro-industry using the industrial cluster approach. In electricity area, Al Irsyad (2011) presented a model for estimating the nation's electricity demand in 1971-2007 with the main finding that the current planning of three 10.000-MW power plants would not be enough to fulfill 2050 electricity demand. Keeping electricity consumption at an efficient level is required to keep the electricity price low and reduce the amount of government subsidy. Sari et al. (2011) developed an agent-based simulation model to get insights in formulating strategies to reduce excessive use of electricity. Several combinations of electricity fares to various household groups obtained in the simulation can be recommended to the decision makers.

3.2. Food security

Food security is a major concern for the government of Indonesia as emphasized by the President with 10 millions ton surplus of rice in 2014. This needs to be seriously responded by the Ministry of Agriculture and related ministries with a comprehensive plan to achieve the target. Taking an example from a neighbouring country, Tasrif et al. (2011) presented a study on Malaysia's capability to achieve self-sufficiency in rice production. A system dynamics model is developed to analyse the causal and feedback relationship of variables, such as fertilizer and cash subsidies, land conversion and fertility level. It is shown that Malaysia may be able to sustain the targeted self-sufficiency level with adequate investments in R&D to address the production constraints. This paper is responded with a paper on Indonesia's strategies to achieve self-sufficiency and targeted surplus of 10 millions ton in 2014. The Riset and Development Agency, Ministry of Agriculture (2012) presented a system dynamics model of the national strategy and developed four scenarios to achieve these targets. It is concluded that several strategies need to be implemented, including the use of seed varieties that are resistant to impacts of climate change, improvement of irrigation networks, application of efficient and environmentally friendly pest control technology, and expansion of crop filed with land use conversion. From the consumption side, increased diversification of food (e.g. reducing rice consumption, more vegetables and fruits) would help in achieving self-sufficiency as well as increasing people's health.

In the distribution side, Tjakraatmadja et al. (2011) analyzed the supply-chain models of rice supply, which are the Core and Plasma models. CORE model is to be implemented by the government, through state-owned enterprises for rice (state-owned corporations, Bulog and Local Government), including support for Infrastructure. This model can be used to meet the needs of the cheap rich with good quality and can easily be bought by poor people. In the PLASMA model, the stated-owned enterprises provide support to the farmers' groups to produce premium type of rice which its trade and selling price follows market mechanism. To support the market operation of rice trading, Surjasa et al. (2011) presented an early warning system for supply and price of rice using an artificial neural network model, which can give over 90% accuracy of forecasting prices at the main rice market center in Jakarta.

While one of the strategies to achieve self-sufficiency of rice is by reducing rice consumption with more healthy substitute such as vegetables, its supply chain is actually not much benefitting the farmers. This applies particularly vegetables for export. Perdana et al. (2011) proposed a model of vegetables supply chain that is efficient and benefits small-sized farmers. Using a system dynamics model, they analyzed two models of supply chain, one that involves independent farmers, farmers' groups and co-op, and one that only involves traders. It is shown that the first model is efficient and fairer than the second model that only benefits traders. Some needs are also identified, including special region of production for export, a consortium consisting of vegetables multi stakeholders to reduce the risk of the

business, access to financing production and trade in order to accelerate the cash flow, and information systems to facilitate the flow of information between production centers and markets.

In addition to rice production, sugar is also of concern. Self-sufficiency of sugar production is highly affected by the supply of sugar cane and its quality. The Riset and Development Agency, Ministry of Agriculture (2012) developed a system dynamics model of sugar self-sufficiency. Some recommendations are obtained, including using superior seeds, implementation of optimal cultivation technology, increasing yield through improved methods of determining the yield of and the expansion of sugar cane field. To self-fulfilled nation's consumption, state-owned sugar companies' production also requires performance improvement (Rohmatullah et al., 2011). Using a system dynamics model, the dynamics of crystal and yield production performance are studied using various scenarios. It is found that the key performance indicators are the size of areas under cultivation and its productivity, process of Cut, Load and Transport and human resource.

3.3. Environment

Environment is a major area of concern that requires serious attention by the government and other stakeholders. Nirmalasari (2011) proposed a dynamic model of mangrove crab management that is sustainable for the mangrove habitat at Kutai National Park in East Borneo. Mangrove crab is one of the resources in the mangrove ecosystem, which can be utilized for the sylvofishery cultivation as an alternative livelihood for local residents without affecting the mangrove forest. Air pollution is of major concern especially the effects of greenhouse gases that contribute highly to the global warming. Sofyan (2011) proposed a system dynamics model to develop air pollution control and greenhouse gas reduction strategies utilizing the concept of co-benefit. It is shown in a case study of Bandung that strategies for air pollution control and greenhouse gases reduction shall be in an integrated manner so that maximum benefit can be obtained.

Water pollution that comes from the discharge of domestic, industrial and agriculture activities to the rivers requires well-organized control and monitoring by the government. A case study is conducted on the Surabaya river (Suwari, 2012) and it is found that there are five important factors that affect the pollution control, including (a) population growth and community awareness, (b) community perception, (c) implementation of regulations, (d) commitment/local government support, and (e) system and institutional capacity. Taking into account these factors, three scenarios are developed and incorporated in a system dynamics model: pessimistic, moderate and optimistic. The simulation shows that moderate and optimistic scenarios are the realistic ones that may occur in future for Surabaya River water pollution control.

3.4. Fuel subsidy

Fuel price is an important element of Indonesia economy, especially due to the huge subsidy of fuel given by the government. The increase of world's oil price surely affects the nation's budget so that one of ways to survive the deficit is by raising fuel price. Fishermen community is among the lowest paid communities in Indonesia and the increase of fuel price is expected to affect their income and welfare. Wirjodirdjo and Fudla (2011) developed a system dynamics model to investigate the effect of fuel or other subsidies on the fishermen community and found that special fuel subsidy for them is required and is better than giving a cash allowance.

3.5. Transportation and logistics

Transportation as a major problem in this country due to its underperformed public transport and severe traffic congestion situation especially in the capital is still underrepresented so far in the series of workshop. Alamanda and Putro (2011) presented a conflict analysis case study of Trans Metro Bandung, a new public transport service introduced in Bandung, that has created social conflict between its stakeholders due to differences of perceptions and interests. The study offers a resolution that gives higher benefits than the existing condition. Contribution of systems modelling in disaster management also require further steps to identify best research projects in this area with only one paper being presented so far. Hadiguna (2011) presented a preliminary model of a decision support system of humanitarian logistics taking into account social and environmental issues.

3.6. Other sectors (finance, industry, defense)

In financial sector, a study by Koesrindartoto and Novanto (2011) produced an agent-based model of the banking system to analyze the effect of banks' decision maker's behavior to systemic risk in economic downturn condition. While in industry sectors, Eunike et al. (2011) studied the behaviour and effect of market demand, innovation, and government incentive in increasing the cluster size in ICT-based creative industries using a system dynamics model. From an evaluation by scenarios, this study confirms that a policy in enhancing market demand will give higher effect to the cluster size as compared to a direct incentive policy.

In a strategic industry of aerospace, Juniarti and Tasrif (2011) studied the importance of knowledge management in industrial aerospace supply chain development in Indonesia. The study using a system dynamics model identified the need for assistance mechanism for the small and medium enterprises (SME) learning process in improving their quality control, which is essential to enable the outsourcing partnership between PT. Dirgantara Indonesia, a state-owned aerospace company, and the SMEs. An interesting study by Muhammad (2012b) focused on re-designing the structure of the nation's defense using system thinking approach. This study gives input to the re-structuring the organization of the national defense.

4. Thematic workshops on priority sectors

Following up the regular workshops that address various national development sectors, thematic workshops were conducted on rather comprehensively studied and high priority sectors (e.g. food security and environment) to closely connect academics, industry and policy makers in formulating policies in those specific sectors.

The first thematic was run on 25 February 2012 focusing on food security with theme "Achieving 10 Million Tons Rice Production Surplus in 2014", which involved relevant ministries (e.g. Ministry of Agriculture, Ministry of Public Works, Ministry of Trade and Ministry of State-Owned Enterprises), agencies, state-owned enterprises, academics and other related stakeholders.

The first thematic workshop discussed the strategies, requirements and challenges to achieve the 10 millions tons surplus. Haryono (2012) highlighted at least six operational policies to achieve the target, including (a) increased availability of water through irrigation network rehabilitation; (b) utilization of sub-optimal land, including the utilization of tidal wetlands; (c) revitalization of seed production systems; (d) reduction of harvest losses and yield; (e) food diversification and rice consumption's reduction campaign; and (f) acceleration of technology transfer so that as new robust varieties can be more quickly utilized by farmers. Hermanto et al. (2012) studied the impact of rice surplus and suggested that the surplus would increase the rice output but lowering the price of rice but mixed impact on other types of food, while it would also increase household income and reduce poverty level. Perdana and Avianto (2012) stated that the formulation and implementation of rice industry policy has to be comprehensive, thus covering all supply chain network of (a) farmers who cultivate the rice; (b) unhulled rice agent trader, (c) rice miller, (d) rice trader in production area and (e) in urban market. Using systems dynamic model, they found that the impact of the partial policy is that farmers, collector traders, rice traders and rice mill gets unstable profit and also prior to production policy and strategy applied, the profit they get is lower, while rice traders in urban market tends to have increasing profit.

Conservation of paddy fields is an important requirement to achieve the required rice production level. Firmansyah et al. (2012) found several factors that caused conversion of paddy fields to other uses, which are the low land-rent price, low control from government and inapplicable policy that collides with the economic interests of farmers (e.g. land holdings is only 0.17 ha / household), so that spatial alignment and clarity needs to be improved through evaluation of policy and regulation on development and land-use. Limited availability of fields may also hinder the effort to reach the surplus target. Sarwani et al. (2012) stated if land conversion can be reduced to 60,000 ha/year and the development of new rice field can reach 67,700 ha/year, then the land needed to maintain self-sufficiency of rice and other food needs will be about 1.614 million ha cumulatively by 2020 or about 6.1 million ha cumulative until 2050. Based on soil biophysical characteristic, the land area suitable for agriculture and is currently unutilized (abandon) covers 30.7 million ha, and 8.3 million ha of that area are suitable for paddy fields. The status or ownership of these abandoned lands is still unknown, but the majority of it (20.4 million ha) is located in forest areas (production forest, conversion forest, concession forest), thus cross-ministries coordination (e.g. agriculture, forestry, environment) is required.

Another important issue is irrigation, especially due to a reported 52% damage in the irrigation network, which is now being rehabilitated by the Ministry of Public Works and the Public Works Local Agencies (Ministry of Public Works, 2012). From 1.34 million ha targeted for 2010-2014, now they have rehabilitated 0.577 million ha. A good irrigation

system does not depend only on well-built infrastructure, but also on the availability of water itself. Suprapto et al. (2012) developed a GIS-based drought early-detection system, which is able to predict when, where and how large the effect of drought is.

Paddy yield monitoring is a key in predicting the output of rice production. Mulyono and Sulaiman (2012) developed a model to predict rice crop production using a remote sensing technology called hyperspectral imagery. The model produces maps of the distribution yield of rice plants with high accuracy to inform the production of rice. Strategies to reduce yield losses are also required to increase rice production efficiency. Using systems dynamic approach, Somantri et al. (2012) concluded that technical and cultural approaches are required. Technical approach can be done by implementing a quality management system, whereas the culture approach can be done by creating new job. Implementation of quality system will also encourage the revitalization of the mill that eventually increase the yield of the mill and contribute to the production of dry-milled grain.

The Ministry of State-Owned Enterprises (2012) also has a role to play in achieving the rice surplus target, for example with corporation-based partnership of state-owned-enterprises in agriculture sector with rice farmers through capital funding support, production needs support (e.g. seeds, fertilizers, pesticides) and cultivation and technology support. The development of food estates outside Java is also offered by the ministry. Another important move is the establishment of a holding SOE as the result of restructuring and integration of three SOEs.

A discussion on food security paradigm was also presented in the workshop by Ananta (2012), who argued that food security can be achieved either by self-sufficiency (e.g. consumption efficiency and/or production increase) or free-market (e.g. export and import) with each has both advantages and disadvantages.

5. Triple Helix interaction in policy development

Identification on the studies presented in the workshops found that they were developed through for several possible ways, including:

a) Studies conducted by universities/academics.
b) Studies conducted by government agencies or R&D agencies within ministries.
c) Studies conducted by collaboration between university and ministries or government agencies
d) Studies conducted by collaboration between universities and industries, including consulting groups.

Analyzing this finding and interactions that occurred among stakeholders during the workshops, a model of Triple Helix interactions is formulated. Modifying a model presented by Resosudarmo (2012), the interactions between university, industry and government (policy makers) on policy development are proposed as in Figure 2.

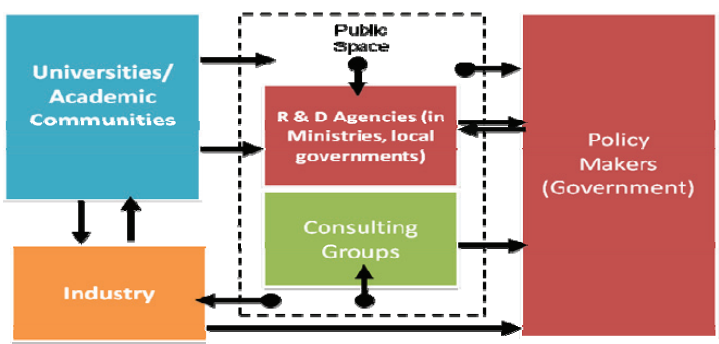

Figure 2: Academic, industry and government interaction in policy development

In addition to commonly known interaction between university and industry, it could be identified an interesting interaction between university and government on policy development through the channel of state-owned research and development agencies (e.g. agencies in ministries, local government, independent), in addition to public space (e.g. publications). The agencies' interaction with policy makers is two-way as the agencies shall focus the research and development in response to the needs of policy makers. Together with consulting groups, the agencies produce recommendation to the policy makers. Support from university to the agencies would strengthen the agencies competences and capabilities to developed recommendation based on systematic, structured and accountable analysis.

Industry can also provide input to the policy makers (e.g. through chamber of commerce, associations) on the required conditions that will foster economic development.

6. The steps forward

To take the effort in facilitating the consensus space further and initiating innovation space, there are at least three activities that have been and will be executed, which are holding international workshops to initiate international collaborations, establishing group-based modelling activities and capacity building for policy makers.

6.1. Extending the effort through collaboration with international institutions

To initiate international collaborations, two international workshops have been held in 31 March 2012 and 28 April 2012 with focus on Agent Based Modelling and Simulation for Polcy Development and Systems Analysis and Modelling in Green Economy, respectively. The first international workshop invited two keynote speakers from the Tokyo Institute of Technology who presented papers on agent-based simulation in service policy development (Kijima, 2012) and agent-based modelling in social system (Deguchi, 2012), along with six other papers presenting the applications of agent-based modelling in various sectors. The second international workshop that focused on green economy was opened by a keynote speech on climate adaptation under uncertainty (Kabat, 2012) that set clear understanding of the audience on the complex issue of climate change and the strategies to adapt to the changes. This was followed with further eight presentations and discussions on models and analyses of various aspects of green economy.

As a further step in the international collaboration effort, UKP-PPP and SBM ITB, with the collaboration with Ministry of Research and Technology, Ministry of Foreign Affairs and other state-owned research agencies, have pushed through Indonesia membership at the International Institute for Applied System Analysis (IIASA), which is an international research organization that conducts policy-oriented research into large or complex problems that need multi-disciplinary approach and international cooperation (IIASA, 2012).

6.2. Establishing group-based modelling activities on priority sectors

One of the follow up steps in the effort is by establishing group-based modelling activities that involves modellers, practitioners and policy makers for the priority sectors (e.g. food security, environment/green economy, energy). Group-based modelling is an approach where a group of stakeholders gathers in one or more sessions and is guided by a modelling team in constructing the model, with the goal is to increase insight into a problem, create alignment and develop a robust strategy to improve system performance (Vennix, 1996). In systems analysis and modelling involving all stakeholders in the process of model is important and necessary due to (a) the need to capture the knowledge in the mental models of stakeholders group; (b) the opportunity to enhance the stakeholders' learning process; (c) the need to validate the model; and even more importantly is (d) to increase the chances that the results of the model are to be implemented as policies. With the involvement of whole related stakeholders, it is expected that the policies will be robust ones, which produce desirable behaviour under various conditions of uncertainty.

6.3. Capacity building for policy makers

To develop policy makers' capacity on systems modelling and to better prepare prior to the group-based modelling activities, a capacity building activity with the guidance of academics through a training program may be required. As the first effort in capacity building, a training program on systems modelling was held by a group of academics from various institutions for Ministry of Agriculture to better prepare them for developing models on food security.

7. Conclusion

This paper presented an innovative joint effort SBM ITB and UKP-PPP in facilitating a consensus space for the development of policies based on systems modelling approaches. At the time this article is being written, three general workshops and one thematic workshop have been done to facilitate communication and cooperation among researchers in academic institutions, practitioners in industries and businesses, and decision makers in government.

Policy development in Indonesia was usually a domain that seldom involves the three stakeholders in Triple Helix Model in such an open and public way as shown in the workshops. This gave opportunities to potential strategic initiatives as outputs of research conducted by university, which might contribute to the formulation of public policies, to be known by policy makers. Having representatives from ministries and government agencies, in fact some high level decision makers such as vice ministers, director generals and head of agencies attended the workshops, in the same venue with universities and industries for discussing national policies were also rare opportunities.

Not only promoting systems modelling as a methodology in policy development, the workshops also provided evidence on the importance of having a holistic or systemic approach in formulating policies to address a complex national problem that requires interactions among stakeholders. Interactions between universities, government agencies, ministries and industries are required in order to contribute to the development of policies in all stages, starting from the process of identifying problem, getting clear understanding the decision context up to the utilization of systems approach to find solutions and formulate policies.

Further steps have been identified and initiated to follow up the rapid development of the Systems Modelling for Policy Development effort, including holding international workshops to initiate international collaborations, establishing group-based modelling activities and capacity building for policy makers. Led by the Ministry of Agriculture, innovation space has been initiated in the food security sector with the collaboration between research and development agencies in the ministry and researchers in universities to work together in developing comprehensive and well-built model that will support the ministry in formulating the strategies and plans to achieve the national priority on food security. This is to be followed by other sectors that have been sufficiently explored and are prioritized for further collaboration effort of policy makers, academics and industry.

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