T01P10 / Systems Theory and Modelling for Public Policy: System Dynamics, Agent-based Models, and Other Approaches

Topic : T01 / Policy Process Theories

Chair : Inna Krachkovskaya (SOAS University of London)

Second Chair : Alberto Asquer (School of Oriental and African Studies, University of London)

GENERAL OBJECTIVES, RESEARCH QUESTIONS AND SCIENTIFIC RELEVANCE

The panel aims to raise attention to the systems theory approach. The approach notoriously originates in the 1950s at least and gained some attention in various disciplines in the following decades. The role of systems theory in social science generally, and in public policy in particular, however, remained relatively modest. At the theoretical and methodological level, the concepts of systems theory have been relatively under-utilised when theorising about the policy process. Some methodologies for operationalising the systems theory approach - like systems dynamics and agent-based models - gained some attention but they have remained somehow limited to specific applications.

The expected results from the panel consist of a fresh view onto the ways systems theory is used in the study of the policy process. Studies that relate the systems theory approach to public policy would be helpful to critically assess the potential contributions of the former to the latter. Studies that show how principles of systems theory can result in pieces of policy analysis, policy design, guidelines for policy implementation, and policy evaluation, are also welcome because they can help forming and consolidating a literature around the approach.

CALL FOR PAPERS

Systems theory - that is, the interdisciplinary study of systems in general and of the dynamic properties that they exhibit - has been long applied in many fields of scholarly inquiry, including biology, ecology, and engineering. Yet, the use of a systems theory approach to public policy has been relatively modest so far. In part, it would be fair to acknowledge that theories of the policy process are systemic in nature, in the sense that they build on an ontology of component parts (including policy-makers, constituencies, lobbies, target groups, and various other stakeholders) and on an epistemology that posits attention to mutual influences between them. Theories of the policy process, however, make relatively little use of the conceptual resources of systems theory, such as the importance of feedback loops, the cascading effects of small perturbations, and the emergence of aggregated behaviour out of interactions between component parts.

This panel aims to bring together scholars who are interested in the application of systems theory to the policy process. We welcome works that:

- Develop the use of systems thinking for the policy process
- Critically assess the role of systems thinking with respect to the study of public policy
- Discuss methodological approaches for the study of the policy process from a systems theory perspective
- Illustrate policy findings through the use of systems theory modelling, including for example system dynamics, agent-based models, and complex adaptive systems in any policy area including health, transport, security, and the environment.

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Session 1Theoretical perspectives

Friday, June 30th 08:15 to 10:15 (Block B 2 - 3)

Discussants

Alex Marsh (University of Bristol)

Tony Casey (University College Dublin (UCD))

The uncertainties of complexity in policy studies

Alex Marsh (University of Bristol)

The exploration of complexity is an intriguing contemporary development in the field of public policy. While undoubtedly still a specialist interest, there have been several notable recent contributions to the literature, including the publication of a handbook devoted to the topic of complexity and public policy. Yet, the concept of “complexity” enters the literature in different ways and in rather different guises. Some take their cue directly from complexity science and the modelling of complex adaptive systems. This carries with it significant ontological commitments. Indeed it poses some challenging questions regarding the aspirations for the control and direction of social systems that are typically seen as underpinning public policy. Others invoke the idea of complexity either metaphorically or in loose analogy to thinking about complexity in natural systems, without seeking to make the claim that comparable causal mechanisms are in operation in social systems. Still others self-consciously seek to synthesize concepts drawn from the complexity literature with older strands of thinking in social science, focused on the way in which social institutions shape social interaction or the operation of power in shaping both policy and its contexts. Here the challenge of the reflexive agent needs to be addressed directly.

The aim of this paper is, first, to approach these debates from the perspective of ontology and epistemology in a bid to map out more explicitly the positions being adopted in the literature. Second, it seeks to reflect upon the roles for, and potential of, public policy that are implied by the different positions taken in this debate. Finally, it returns to a question explored by Paul Cairney (2012) and considers whether drawing on complexity concepts does - or, in principle, could - substantially advance our understanding of public policy, or does little more than represent some well-established ideas in a new framing.

Ontological Meta-Analysis and Synthesis for Public Policy

Arkalgud Ramaprasad (University of Illinois at Chicago)

Thant Syn

We present ontological meta-analysis and synthesis (Ramaprasad & Syn, 2015) as a method for public policy analysis, formulation, and assessment. It is a systemic, systematic, and symmetric method that can be applied to public policy research, analysis, and practice. The method encapsulates the combinatorial complexity of the policy problem with little simplification, selectivity, and skewness.

Public policy research, analysis, and practice are text-data rich. The logic of these domains, expressed in the natural language of their discourse, can be mapped to the structured natural language of the ontology using the method. The mapping will reveal the ‘bright’ – heavily emphasized, ‘light’ – lightly emphasized, and ‘blind/blank’ – not emphasized elements and themes in the three domains. A ‘bright’ spot may be so

because it is important or easy; a ‘light’ one because it is unimportant or difficult; a ‘blind’ spot may have been overlooked, and a ‘blank’ spot may be infeasible. The method will reveal the gaps within the domains and between them. Knowing the gaps, one can develop roadmaps for the three domains to bridge the internal gaps, and the translational gaps between them. The method has been applied to the analysis of India’s higher education policy (Ramaprasad, Singai, Hasan, Syn, & Thirumalai, 2016), and national healthcare policies of Chile, India, China, and Australia. (Dai, Deng, Ramaprasad, & Syn, 2016; Núñez Mondaca, Ramaprasad, & Syn, 2015; Ramaprasad, Win, Syn, Beydoun, & Dawson, 2016; Sastry, Madhumitha, Ramaprasad, & Syn, Forthcoming)

Moreover, the method does not require all text to be translated into English or any other language of inquiry. The ontological framework can be translated into the domain language with minimal loss of fidelity, and adapted to its grammar. Thus, the text documents can be mapped in the native language without the losses likely from their translation and retranslation. China’s national healthcare policies, for example, were analyzed in Chinese. (Dai et al., 2016). Last, the method also provides a common framework for comparative analysis.

Dai, G., Deng, F., Ramaprasad, A., & Syn, T. (2016). China’s National Health Policies: An Ontological Analysis. Online Journal of Public Health Informatics, 8(3), e196. doi:10.5210/ojphi.v5i3.4933

Núñez Mondaca, A., Ramaprasad, A., & Syn, T. (2015). National Healthcare Policies in Chile: An Ontological Meta-Analysis. In I. N. Sarkar, A. Georgiou, & P. Mazzoncini de Azevedo Marques (Eds.), MEDINFO 2015: eHealth-enabled Health (Vol. 216, pp. 1105).

Ramaprasad, A., Singai, C. B., Hasan, T., Syn, T., & Thirumalai, M. (2016). India’s National Higher Education Policies since Independence: An Ontological Analysis. Journal of Educational Planning and Administration, 30(1), 5-24.

Ramaprasad, A., & Syn, T. (2015). Ontological Meta-Analysis and Synthesis. Communications of the Association for Information Systems, 37, 138-153.

Ramaprasad, A., Win, K. T., Syn, T., Beydoun, G., & Dawson, L. (2016). Australia’s National Health Programs: An Ontological Mapping. Australasian Journal of Information Systems, 20, 1-21. doi:10.3127/ajis.v20i0.1335

Sastry, N. K. B., Madhumitha, M., Ramaprasad, A., & Syn, T. (Forthcoming). National Healthcare Programs and Policies in India: An Ontological Analysis. International Journal of Community Medicine and Public Health.

Do effective systems processes make effective governance networks?

Tony Casey (University College Dublin (UCD))

The interchange of ideas from systems theory and the study of public administration and the policy process was once common (Easton, 1953). The advent of the modern age of computing accelerated the trend. Herbert Simon, for example, not only won the Noble prize for Economics in 1978 for his theory of the ‘bounded rationality of administrative man’ (Simon, 1976) but he also won the Turing award in 1975 for his pioneering work in computer chess and artificial intelligence. The ‘garbage can model of organisational choice’ was at its heart a computer simulation (Cohen et al., 1972). The internet’s core architectural design principle of ‘loose coupling’ was borrowed from the field of public administration (Weick, 1976).

Leveraging the internet age’s advances in systems theory and modelling tools, unavailable to the public administration and policy process systems pioneers of the 1950’s, I take a fresh systems oriented approach to answering the question: what are the determinants of effective public governance networks? My core claim is that because public governance is best conceptualized as a process (Torfing et al., 2012), it can be subjected to formal systems analysis using the process modelling tools developed at the intersection of organisation and information science. Using European Regulatory Networks (ERNs) as a case study (cf. Levi-Faur, 2011), I proceed by symbolically deconstructing ERN processes so that they can be subjected to analysis using systems metrics such as coupling, cohesion and complexity familiar to information science. Hypothesizing that large governance networks share structural features with large systems networks, I provide by this means a testable theory of EU-wide governance network effectiveness.

This proposed paper will provide a fresh systems based theory of public governance effectiveness, and a new set of systems metrics and process modelling techniques of wide applicability to public administration, policy process and networked governance studies.

COHEN, M. D., MARCH, J. G. & OLSEN, J. P. 1972. A Garbage Can Model of Organizational Choice. Administrative Science Quarterly, 17, 1-25.

EASTON, D. 1953. The political system : an inquiry into the state of political science, New York, Knopf.

LEVI-FAUR, D. 2011. Regulatory networks and regulatory agencification: towards a Single European Regulatory Space. Journal of European Public Policy, 18, 810-829.

SIMON, H. A. 1976. Administrative behavior: a study of decision-making processes in administrative organization, New York;London;, Free Press.

TORFING, J., PETERS, B. G., PIERRE, J. & SØRENSEN, E. 2012. Interactive Governance: Advancing the Paradigm, Oxford, Oxford University Press.

WEICK, K. E. 1976. Educational Organizations as Loosely Coupled Systems. Administrative Science Quarterly, 21, 1-19.

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Session 2Complexity in infrastructure and utilities

Friday, June 30th 10:30 to 12:30 (Block B 2 - 3)

Discussants

Jos Timmermans (Delft Unniversity of Technology)

Ching Leong (National University of Singapore)

A SYSTEM DYNAMIC ANALYSIS OF THE LEVEE EFFECT ON THE BRAHMAPUTRA RIVER AND POLICY IMPLICATIONS

Robert Wasson (Institute of Water Policy, Lee Kuan Yew School of Public Policy, National University of Singapore)

Leong Ching (Institute of Water Policy, Lee Kuan Yew School of Public Policy, Singapore)

Joost Buurman (Institute of Water Policy, Lee Kuan Yew School of Public Policy, NUS)

Levees, and other flood protection devices, may increase flood losses because they spur new development in the floodplain, which incurs catastrophic losses when flood protections fail. This has become known as the ‘levee effect’. A causal loop analysis of the levee effect, involving public pressure for protection and compensation for losses, experience of floods and community readiness,and floodplain development suggests that vulnerability to large floods will increase when levees are constructed. Empirical results from Upper Assam (India) in the vicinity of the Brahmaputra River show that the hypothesis captures the essence of the levee effect. This suggestion in turn implies that death and damage from floods will be restricted to large floods. Time series analysis of damage and death data from 1953, when levee construction began in earnest, shows no trends. Although there is no way of knowing if damage and deaths would have been worse without the levees, the results do not confirm either a decline of losses or that large floods are the only source of loss. The policy implication is that structural works alone have done little if anything to reduce losses and non-structural measures are required to offset the negative consequences of levees, given that the removal of levees is politically unlikely and people have become dependent on them.

Game theoretic study on methods for measuring costs of decision-making and effects of consensus building

Nakamura Naoki (Tokyo Institute of Technology Graduate School of Decision Science and Technology (in training) / Secretariat of the House of Councillors)

Takehiro Inohara

Game theoretic study on methods for measuring costs of decision-making and effects of consensus building

Naoki Nakamura, Takehiro Inohara

In this study, we propose a method to measure costs of decision making. Buchanan and Turlock classified

the costs of decision-making into two types: “decision-making costs” and “external costs” (Buchanan, J. M. and Tullock, G. “The calculus of consent”. Vol. 3. Ann Arbor: University of Michigan Press, 1962, pp.37-58). Decision-making costs are the costs which an individual expects to incur as a result of his/her participation in an organized activity. Meanwhile, external costs are the costs which the individual expects to endure as a result of the actions of the others over which he has no direct control. To the individual, these costs are external to his/her behavior. Since these costs are in a trade-off relationship similar to the relationship between supply and demand, it is desirable to make decisions at equilibrium points that minimize the total of these costs. It is convincing that these costs are required for decision-making, but little attention has been given to these costs and, in particular, a method of measuring these costs in actual decision-making situations. This study deals with this problem.

We analyze decision-making situations using “simple games” as in the previous studies (e.g., Peleg, B. “Game Theoretic Analysis of Voting in Committees”. Cambridge University Press, 1984 ; Inohara, T. “Self-consistency of decision rules for group decision making”. European Journal of Operational Research, 180, 3, 2007, pp.1260-1271 ; Maaser, N. F. “Decision-making in committees : game-theoretic analysis”. Springer, 2010), and propose a method to measure costs of decision making. By applying the method, in particular, the method to measure the external costs, we also propose a method to measure the effect of consensus building by using the concept of “voters’ permission” in Yamazaki et al. (Yamazaki, A., Inohara, T. and Nagano, B. “New interpretation of the core of simple games in terms of voters’ permission”. Applied Mathematics and Computation. 108, 2-3, 2000, pp.115–127). These methods newly developed in this study by using game theory can be applied to the evaluation of the degree of consensus in many actual decision-making organizations, including Congress and some public committees.

In general, participants in a decision-making organization have mutual relationships. Therefore, each decision-making organization such as a parliament and a committee can be regarded as one political system. In the system, the importance of fundamental elements such as preferences of each participant and the decision-making rule adopted in the system is emphasized. From this point of view, we propose a method to model and analyze decision-making situations in public policy. Our approach is consistent with the direction of the panel (T01P10 - Systems Theory and Modelling for Public Policy: System Dynamics, Agent-based Models, and Other Approaches) and can contribute to the theoretical development and practice of public policy.

A MODEL BASED APPROACH TO SUPPORT URBAN WATER SECURITY PLANNING

Febya Nurnadiati (TU Delft)

Jos Timmermans (Delft Unniversity of Technology)

Hadihardaja Iwan Kridasantausa (Institut Teknologi Bandung)

Because of its international comparative character, the concept of water security is promising in attracting attention and investments in (urban) water management. Water security can be assessed at national, river basin, city, and local scales (Van Beek and Arriens 2014). For example, the Asian Water Development Outlook (Asian Development Bank 2013) compares and ranks the status of urban water systems based on four criteria: 1) piped urban water supply access, 2) urban wastewater collection, 3) economic damage due to floods and storms, and 4) river health.

However for attracting investment, the indexes are not developed to support the planning and implementation of these investment. To strengthen water security approaches in this respect, we propose to combine the urban water security indicators with modeling water system development, taking future uncertainties into account. The questions of this research are:

1. What factors determine the urban water security?

2. How to model the development of urban water security?

a) What are the requirements of the model?

b) What are the key elements and the interrelations between them?

3. How can the model be used to explore the consequences of a wide set of assumptions and policies, and what are these consequences?

There are two approaches to assessing water security, which are the developmental approach and risk-based approach. The research will adopt developmental approach and use the Asian Water Development Outlook (AWDO) index, because it is more generic and facilitates dynamic modelling of the water security index over time. Moreover AWDO excludes governance valuation, giving the policy makers the opportunity for objective, structured, and replicable evaluation of system performance.

The key indicators of the AWDO water security framework are related and interdependent. These relations

and the integrations between these indicators and various water system factors are therefore developed using the System Dynamic (SD) approach. The System Dynamic approach is applicable because it can help to better understand the system under study, the behavior of the resulting model, and the real-world effects of potential solutions (Akhtar 2011). It also allows to conduct multi-scenario, multi-attribute analyses that resulting in relative comparisons over time of many strategies (Sehlke and Jacobson 2005, Akhtar 2011)).

The outputs of the model are transient scenarios of the urban water security index that describe numerous plausible futures including policy, investment, and autonomous responses. These scenarios can be created in different ways (adopted from (Haasnoot 2009); without response, with response of individual users, with response of groups in a participatory setting in the form of an interactive “game”, or with automatic response by using response rules. The actions and responses are explored through literature review, interviews, and discussion with related parties.

This research fits to the topic of “Policy Process Theories”, especially for the Panel 10 (P10) of “Systems Theory and Modelling for Public Policy: System Dynamics, Agent-based Models, and Other Approaches”. It develops a model to support the planning and implementation process of investments and policies required to increase urban water security using system dynamic (SD) approach.

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Session 3Complexity across policy domains

Friday, June 30th 13:45 to 15:45 (Block B 2 - 3)

Discussants

Carlos Potiara Castro (Universidade Federal do Pará)

Mitchell Young (Charles University)

Regulatory Arbitrage and the development of a Nimobsian Regulatory Achitecture

Patrick Bell (Jean Monnet Center for European Excellence/Florida International University)

Current regulatory policy is steeped in the political economy of the 1950's. Using the tools of the behavioral revolution in social science regulatory policy has a specific view of the relationship between government and business. Namely that regulatory processes are fundamentally linear relationships that can be modeled between agencies and those they regulate. However, this is not always the case. Policy makers are increasingly confronting issues that are display non-linear dynamics. Hybrid warfare, systemic financial risk, and terrorism are a couple of the policy issues that necessitate a new method to model the increasingly complex relationships between agencies, the individuals and institutions the regulate and the organizations that participate in the process of "regulatory arbitrage". Until very recently these interactions could only be modeled with great difficulty due to the vast amounts of data needed.

In this theory, each regulation has fingerprint that is composed of an action network that functions as a scale invariant network. The dynamics of this system can be modeled based on the systemic risk created by the interactions of the actors. The resulting structure of the is constantly changing; displaying emergent behavior. The key to understanding this new system lies in the balancing and quantifying of the "risk arbitrage" that takes the form of a three by three pay off matrix which actors in the system in engage in as they interact with other actors in the system. The key to balancing and quantifying systemic risk lies in the realization that there are not one but many possible Nash equilibrium points; some positive and some negative with respect to systemic risk. This paper details a theoretical model that explicates what this new regulatory architecture would entail.

The university as a resilient actor: A complex systems perspective on the university and its policy environment

Mitchell Young (Charles University)

Romulo Pinheiro (University of Agder)

There has been a tendency in the extant literature on university systems to adopt reductionist (linear) perspectives in an attempt to tackle the complexity inherent to both institutions and the policy systems in which they are embedded. In this paper, we base our analysis on the European continent, in light of recent policy efforts, on national and supra-national levels, to modernize university systems through increasing competition and pressures towards vertical and horizontal differentiation. While policy pressures for vertical differentiation, i.e. excellence and prestige, have succeeded, those pressing for horizontal differentiation have most often not. To understand this puzzle, we turn to complex systems theory.

Both internally (through management) and externally (through policy pressures), the university is becoming

more tightly coupled so as to embody the role of a ‘strategic actor’ that rationally creates and follows strategic plans (Pinheiro and Stensaker 2014). In contradistinction, we present a model of the university as a ‘resilient actor’, one which behaves more according to biological models of evolution and niche-seeking than to Newtonian physics. In this paper we introduce a set of conceptual building blocks (slack, requisite variety, and decoupling) by which to initiate that exploration.

Our primary aim is to provide an alternative conception of university systems and the policy environment in which they exist in an attempt to comprehend the ways in which such institutions and systems emerge, self-organize, and (co-)evolve (Padgett and Powell 2012). Complex systems are non-linear, dynamic and are characterized by many sub-entities and multiple connections or linkages between them (Morçöl 2013), and thus describe well the university and its environment. Conceptually, we build on systems theory, most notably critical insights from the study of complexity (Byrne and Callaghan 2014). Recently this literature has been applied to social scientific phenomena (Urry 2005) such as organizations and markets (Padgett and Powell 2012), public policy and institutions (Morçöl 2013, Room 2011), and governance systems (Teisman et al 2009), but little has been done with it in the field of higher education policy. In conclusion we show how complex systems theory provides an alternative way to answer the fundamental question of how to foster horizontal differentiation.

From a closed to an open system: asymmetric communication, local micro institutions and development policies

Carlos Potiara Castro (Universidade Federal do Pará)

This paper aims to discuss the flow of information as a relevant element in the effort to implement policies and other actions focusing in human development and executed by small local institutions. Those organizations have some special characteristics as the capacity to perform actions with local legitimacy and to have good capillarity (Putnam, 2001). As such, they could be used to coordinate and implement decisions, increase social capital and engage in dialogue with isonomy with stronger and resourceful stakeholders.

Public policy and organizational theory establishes a typology of institutions (Robbins et al., 2008) and generally express less interest in small organizations, which are usually less complex. However, new literature shows that they may have a relevant role in implementing policies devoted to the promotion of human development in poor localities. The relationship of local communities and other stakeholder, acting with an economic rationality, is designed in this paper as information flux in a rather closed system, where an asymmetric communication capability outline the players strategies. For the communities, coping with the lack of inputs - and therefore of processing and decision making, is a fundamental systemic element. In other words, placed in a semi autarchy position relatively to more robust and connected stakeholders, opening up the community as an independent system, sustaining it’s own information processing capability would be strategic. Thus, research as two concepts of interest: of self-regulation, brought from the system theory (Watzlawick, 2000; Winkin, 2014) and that of collective action, in the terms of Mancur Olson (2000) and later authors.

As to support the intellection of this research, a game of imperfect information will be discussed. The middlemen game will show that for the weaker stakeholder, the local community, it is indispensable a) to achieve a rupture in the economic culture, through strategic information sharing, and b) to systematize rules of engagement with external stakeholders. Thereby, by using the system theory and the game theory, some general interpretation have been made, as to interpret trends and propose the contour of policies aiming to improve quality of life among vulnerable communities.