Background on Frameworks for Policy Analytics

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Abstract Different frameworks related to policy-making analysis and policy modelling have been developed in the literature. These frameworks are generally spread across multidiscipline sciences like public policy; political science, computer science and social sciences. Policy Frameworks address general forms of theoretical analysis, by identifying the elements and their relationships. These elements can include for example: governance structure; policy process; stakeholders; and institutions structure. However, there is no standard categorization or classification for these frameworks. And with the growing development in the policy analytics and policy modelling, there is a rising need to review existing policy frameworks and develop categorization criteria able to classify frameworks concerned by policy-making analysis and policy modelling. This chapter will go through the main frameworks used in understanding the policy making process, in order to make a general overview frameworks for Policy analytics.

Introduction to Policy Frameworks

Policy makers are the persons who take decisions for the well-being of their communities. In order to take good decisions and extremely the better decisions, several frameworks and models have been developed in order to help them in their decision making process. To this end, public policy scholars and policy scientists have developed frameworks, theories and models to better understand policy and policy-making processes (e.g., Sabatier 1991, 2007; McCool 1995; Kraft and Furlong 2007; Smith and Larimer 2009; Birkland 2010).

A Framework refers to concepts to support structured and systematic analysis, design, implementation and assessment/evaluation of a solution. Specifically, a

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framework identifies elements, identifies the relationships between these elements, and provides a general set of variables that can be used to analyze a proposed solution. On the other hand, models are more precise than frameworks since a model uses specific assumptions about a limited set of variables, identified in the frameworks, to derive precise solutions when combining these variables (Ostrom 2011). Each developed model uses a set of tools. These tools vary from implementation tools like programming languages, to the graphical user interfaces, to the adopted technologies such as multi-agent systems.

This chapter will focus on two abstraction levels: policy-making analysis frameworks, and policy-making simulation tools. At the analysis level, this chapter classifies the frameworks into three main categories: (1) Frameworks focus on Policy Stage; (2) Frameworks focus on Institutions; and (3) Frameworks focus on Human factor and Collations. At the simulation level, this chapter discusses the main simulation tools and their related technologies used for policy-making.

Policy Analytics Frameworks Focusing on Policy Stage

This category of frameworks focus on the process of policy making and on different policy process stages like agenda setting, policy formulation, policy adoption, implementation, evaluation and termination (Lasswell 1956; Brewer 1974; Brewer and deLeon 1983; DeLeon 1999). We present hereafter two main frameworks that are the multiple streams theory of agenda setting by Kingdon in 1984, and Governance Analysis Framework (GAF) by Karim Hamza in 2013.

Multiple Stream Model

The multiple streams model of policy-making has been introduced by John Kingdon and extended by Robert W. Porter. Kingdon argues that for a specific policy to succeed, the following three streams of actions must occur: a problem must be clearly defined, feasible solutions must be offered and political consensus must be obtained (Porter 1995). Moreover, Kingdon and Porter argued that certain policies may fail because (1) problems were narrowly defined only by the government; (2) solutions were one-sided, primarily focusing on the financial aspect of issues and neglecting contextual and implementation problems; and (3) political will existed only at the highest level, whereas the actual capacities of the implementing units were far below the capacities that were needed for successfully achieving reform. The analysis of policies through the lens of the multiple streams model of policymaking is recommended for other policymakers (Kingdon 1984).

Kingdon's perspective claims that policy making can be conceptualised as three largely unrelated "streams": (1) a problem stream, consisting of information about real-world problems and the effects of past governmental interventions; (2) a

solution stream/community that is composed of researchers, advocates and other specialists who analyse problems and formulate possible alternatives; and (3) a political stream, consisting of elections, legislative leadership contests and similar data sources. According to Kingdon, major policy reforms are produced if "a window of opportunity" joins these three streams; in other words, in response to a recognised problem, the policy community develops a proposal that is financially and technically feasible and politicians find it advantageous to approve this proposal.

The problems stream denotes which social conditions are perceived by individuals as problems that require resolution by government action. Citizens, the mass media and interest groups often define problems and their potential causes only from their own viewpoint. Additionally, in many cases, it is too difficult to clearly define the problem and its history because many state or non-state actors may lobby for their own views regarding the concerned problem (Kingdon 1984).

The solutions stream consists of policy alternatives that are generated by state actors, state institutions, policy advocates and academics. Policy solutions must be well crafted, include sequence and content development and suggest the timing of reform. The solutions should include (1) the translation of policy directives into implementation programmes, (2) the generation of strategies for the adoption of the policy solution by different actors, (3) provide management strategies to address the solution's opponents and (4) take advantage of supporters of the reform to support the solution (Porter 1995).

The politics stream consists of political events that may or may not be favourable to the policy that is being implemented. Similar to state turbulence or important elections, changes in government ministers and public protests can powerfully influence whether a particular problem will be solved (Kingdon 1984).

The multiple streams model is useful because it argues that numerous real life contextual factors, such as political events, bureaucratic procedures and interest groups, largely shape the future of the political environment. This model forces all interested and involved actors to recognise the realities of policymaking and act pragmatically if they wish to successfully implement these policies. In addition, similarly to the traditional policy stages model, the multiple streams model allows for policies to be dissected and analysed in broad, generalised terms (problems, solutions and politics). This analysis can be highly valuable to policymakers who are faced with social problems that must be fixed in a given political environment.

Governance Analysis Framework (GAF)

Additionally; the Governance Analysis Framework (GAF) was introduced as an analysis framework to asses state stability and ensure that all aspects of governance are covered.The Governance Analysis framework (GAF) includes four main phases. Phase I is the scope and objectives map, which is based on Kingdom and Porter's multiple streams policymaking model, used to examine the problem stream, the solution stream and the political stream. Phase II is the stakeholders map, which

Table 1 Governance analysis framework (GAF)

Phase/component	Phase I Scope map	Phase II Stakeholders map	Phase III Process map	Phase IV Governance map
Objective	Describe the main streams: • Problem Stream • Solution Stream • Political Stream	Describe who are the main actors and their relation with each other inside the governance model: • Citizen Power • Executive Authority • Judicial Authority • Legislative Authority • Non-state Political Power	Identify policy networks collations and their usage of social media: • Identify Control level of main actors on social media • Identify confrontation level on social media	Describe the progress (or not) of the state transformation from transition state toward a state stability
Based on	Multiple Stream Model, (Kingdon 1984; Porter 1995)	Policy Network Analysis [PNA], (Rhodes 1996)	Advocacy Coalition Framework [ACF], (Sabatier and Jenkins-Smith 1999) and Social media	Circle of State Stability

describes the main actors in the policy-making process and how they interact with one another inside the governance model. This phase adapts Rhodes's policy network analysis (PNA) and Sabatier's advocacy coalition framework (ACF). Phase III is the process and tools map, which describes the policy-making process applied within the governance model and it is based on policy network analysis (PNA) school plus the advocacy coalition framework (ACF). Finally, Phase IV is the governance map, which focuses on the general governance structure of the state under study and represents graphically the state's status with respect to turbulence and stability, using the Circle of State Stability model (CSS) (Hamza 2013) shown below in (Table 1).

Phase I—Scope and Objectives Map: The first phase describes the main scope of the governance model under study, which helps break down the model into its main components. The scope of this governance model should reflect the way a society is governed, help create conditions for orderly rule, support collective action and maintain links between the main actors in the political environment (Kooiman 1993, 2003; Hamza 2013).

Additionally, the scope defined must balance certain key values. (1) Openness: working openly and communicating precisely the new policy in the governance model. The language should be accessible and understandable for the general public. (2) Participation: ensuring wide participation throughout the policy process from conception to implementation. Improved participation increases confidence in the end result and the institutions that deliver the new policies. (3) Accountability: the roles in the legislative and executive processes must be clearer. State actors must explain and assume responsibility for their decisions and there is a need for greater responsibility from all those who are involved in developing and implementing policy on all levels. (4) Effectiveness: policies must be effective and timely. (5) Coherence: the policies and actions performed in the governance model must be coherent and easily understood. Coherence requires political leadership and a strong sense of responsibility from the state actors to ensure a consistent approach within a complex system (European Commission 2001; Hamza 2013).

In this phase, Kingdom and Porter's multiple streams policy-making model will be used to examine the scope. The multiple streams model describes policy-making when sets of multiple nonlinear activities (the "streams") are pursued. These streams define the problem, suggest solutions and obtain political consensus, which should occur simultaneously, thus creating an opportunity to facilitate changes (Kingdon 1984; Hamza 2013).

Phase II—Stakeholder Map: Ideally, the governance model should apply to the entire range of stakeholders (actors) involved in the governing process. Thus, continuous two-way communication between the governors and the governed stakeholders can be maintained and the governance model can remain oriented toward the objective (the scope) for which it was designed. In this model, to avoid ignorance of the values inherent in stable governance mechanisms, the distribution of rights and responsibilities among the different stakeholders may require revision to balance the different actors, define the rules and procedures of decision-making and separate the main powers in a governance model, which are represented by the legislative, executive and judiciary powers (Daugbjerg and Fawcett 2010; Hamza 2013).

Therefore, a successful governance model should promote the role of non-state actors in society and public activities and increase the responsibilities of social actors outside the state boundaries (Galeotti and Josselin 2001). Thus, the government's responsibility for the provision of social services must be redefined (Chhotray and Stoker 2009; Hamza 2013).

This phase is inspired by the policy network analysis of (Rhodes 2006). The policy network refers to clusters of different types of actor who are linked in political, social or economic life, have an interest in a given policy action and can help determine a policy's success or failure (Rhodes 1997). This theory seeks to explain policy outcomes by investigating how networks, which facilitate bargaining between stakeholders regarding policy design and detail, are structured in a particular political environment. Additionally, the theory analyses variations in the interest patterns and thus helps map relationships between state and non-state actors and explain how the policy agenda is formed. This model consists of two basic elements: actors and the relations between them (Hamza 2013).

Phase III—Process Map: This phase examines the main process and tools used during the policy-making decisions implemented in the selected governance model to understand the relation between these process and different stakeholders and analyse the impact of technological tools, such as the social media, on this process. The main component of this phase includes the process section and the social media section and focuses on the use of ICT by different stakeholders (actors) of the society (Hamza 2013).

Inspired by Sabatier and Jenkins-Smith's advocacy coalition framework (ACF), the process section addresses problems that involve substantial goal conflicts, important technical disputes and multiple actors (Sabatier and Jenkins-Smith 1999). The ACF framework has found that stakeholder beliefs and behaviour are embedded in informal networks. To enforce coordinated behaviour in the networks, actors form groups. These groups are comprised of individuals from a variety of backgrounds who share a particular belief system and show a degree of coordinated activity over time. This section also pays close attention to collective-action issues (Hamza 2013).

Phase IV—Governance Map: The governance map aims to describe the progress of the governance transformation from the transition state toward a stable state, considering the relation between hierarchical and network governance control based on the Circle of State Stability model described above (Hamza 2013).

The Circle of State Stability model is designed to represent graphically the impact of network governance on state stability in a specific state or country based on the following assumptions. First, there are two main types of governance structure: hierarchy and network governance. These two structures seek to control the state or the country. Market governance is assumed to be part of both hierarchy and network governance because market governance focuses on efficiency, which is an important objective for any type of governance. Second, state instability appears due to four main categories of instability conditions: confrontation, dictatorship, anarchy and failure (Hamza 2013).

Policy Analytics Frameworks Focusing on Institutions

The second category focus on the institution performing the decision making or impacted by the policy making process. This institution can be government; sub-government or other organizations. The most famous framework that focuses on institutions is the Institutional Analysis and Development (IAD) framework developed by Ostrom in 1990.

Institutional Analysis and Development (IAD)

Institutional Analysis and Development (IAD) framework is developed by Elinor Ostrom and other scholars associated with the Workshop in Political Theory and Policy Analysis at Indiana University. This Framework tries to understand the

policy process, by outlining a systematic approach for analyzing institutions that govern action and outcomes within collective action arrangements (Ostrom 2011). Institutions are defined within the IAD Framework as a set of prescriptions and constraints that humans use to organize all forms of repetitive and structured interactions (Ostrom 2011). These prescriptions can include rules, norms, and shared strategies (Ostrom 1990). Institutions are further delineated as being formal or informal; the former characterized as rules-in-form and the latter as rules-in-use.

The IAD framework identifies key variables that should be used in evaluating the role of institutions in shaping social interactions and decision-making processes. The analytical focus of the IAD is on an "action arena", where social choices and decisions take place. Three broad categories of variables are identified as influencing the action arena: (1) institutions or rules that govern the action arena, (2) the characteristics of the community or collective unit of interest, and (3) the attributes of the physical environment within which the community acts (Ostrom 1990, 2011). Each of these three categories has been further delineated by IAD scholars into relevant variables and conditions that can influence choices in the action arena (Ostrom 1990, 2011).

The IAD further defines the key features of "action situations" and "actors" that make up the action arena. The action situation has seven key components: (1) the participants in the situation; (2) the participants' positions; (3) the outcomes of participants' decisions; (4) the payoffs or costs and benefits associated with outcomes; (5) the linkages between actions and outcomes; (6) the participants' control in the situation; and (7) information. The variables that are essential to evaluating actors in the action arena are (1) their information processing capabilities; (2) their preferences or values for different actions; (3) their resources; and (4) the processes they use for choosing actions (Ostrom 1999, 2005).

In addition to the types of relevant variables that may help explain collective choices, the IAD has identified multiple levels of institutional analysis: (1) operational level; (2) the collective-choice level; and (3) the constitutional level (Ostrom 1990). The operational level of analysis is where individuals collectively make decisions about day to day activities. The collective-choice level of analysis focuses on decisions about the choice of rules that govern operational activities. The constitutional level of analysis is concerned with the authorized actors for collective-choice decisions and the rules governing those decisions (Ostrom 1990, 2011). Also any one decision-making group or action arena may operate at more than one level of institutional action (Ostrom 1990, 2011).

Policy Analytics Frameworks Focusing on Human Factor and Collations

The third category explores processes from the perspective of the **actions of human agents** and their attainment of goals with respect to devising policies and institutions. For instance, the Advocacy Coalition Framework (ACF) developed by Sabatier and Jenkins-Smith in 1993, which emphasises the role of human agents,

considers processes that emerge through conflict or competition among multiple coalitions over long periods of time (Sabatier and Jenkins-Smith 1993). And the policy network analysis (PNA) school that focus on networks, the relationships among policy-making outcomes, the structure of a network and the inclusion or exclusion of certain individuals or groups from the network in question (Fawcett and Daugbjerg 2012).

Advocacy Coalition Framework (ACF)

The Advocacy Coalition Framework (ACF) is a framework of the policy process developed by Sabatier and Jenkins-Smith to address problems that involve substantial goal conflicts, important technical disputes and multiple actors from several layers of government; in other words, this approach seeks to address the entire policy process rather than merely agenda-setting (Sabatier and Weible 2007). This theory was developed as a response to perceived inadequacies in the "stages heuristic" and other traditional approaches to the analysis of the policy process. The ACF theory claims that stakeholder beliefs and behaviour are embedded within informal networks (Sabatier and Weible 2007). To enforce coordinated behaviour within these networks, actors form groups, which consist of sets of people from a variety of positions who share particular belief systems and demonstrate a degree of coordinated activity over time (Sabatier and Jenkins-Smith 1999). This framework also devotes a great deal of attention to collective action issues (Schlager 1999).

Sabatier and Jenkins-Smith note that real-world changes frequently occur in the aftermath of a specific situation and result in the redistribution of political resources and alliances among subsystems. ACF framework is used to enhance the available understanding regarding complex policy processes. The ACF includes the following four main assumptions: (1) the process of policy change and learning occurs over time; (2) the most useful way to consider policy change over time is to focus on policy subsystems, that is, the interactions among actors who seek to influence the policy-process outcome; (3) subsystems must include an intergovernmental dimension; and (4) public policies can be conceptualised in the same manner as belief systems, e.g., as sets of value priorities and causal assumptions about how to realise these priorities (Sabatier and Jenkins-Smith 1993).

As a framework, the ACF's policy subsystem is the primary unit of analysis. A long-term time perspective is needed to obtain an understanding of subsystem affairs; moreover, the expansive set of actors that are involved in policy systems may be aggregated into coalitions and policy designs are interpreted as translations of coalition beliefs. This interpretation will increase interest in understanding and explaining coalition formation, maintenance, stability and structure.

Within the ACF, policy formation and change are functions of competing advocacy coalitions within a policy subsystem. A policy subsystem consists of actors from 'public and private organizations who are actively concerned with a policy problem. The actors within a policy subsystem are grouped into a number of

advocacy coalitions that consist of individuals who share particular belief systems, e.g., sets of basic values, causal assumptions and problem perceptions and who exhibit a non-trivial degree of coordinated activity over time.

If coalitions manage to form a structure that different coalitions are likely to adopt (e.g., a loose structure with minimal coordination versus a well-defined structure with high levels of coordination), the stability and continuity of these coalitions will receive the highest levels of attention. One of the shortcomings of ACF is that this theory provides little conception of the strategies that coalitions are likely to pursue in pressing for preferred policies and confounding undesirable policies.

The initial condition for coalition formation is that individuals believe that they will benefit from acting collectively to change policy; once this condition is met, a number of other factors come into play. These factors are characteristics of individuals and the situation that are mutually supportive and promote stable relationships. (Ostrom 1990) suggests the following set of conditions that support the stability and continuity of coalitions: (1) individuals who benefit from the collective goods that are provided by the coalition have clearly been identified; (2) the benefits that individuals receive from these collective goods are related to these individuals' contributions to the provision of the goods in question; (3) the individuals who are most affected by the rules can participate in changing the rules; (4) monitors who actively audit coalition members' behaviours are either accountable to the coalition members or are coalition members themselves; (5) members who violate the coalition rules are likely to be punished or isolated by other members; (6) coalition members have rapid access to low-cost local methods of resolving conflicts among members or between members and officials; and (7) the rights of individuals to form coalitions and to devise policy have not been challenged by external governmental authorities (Ostrom 1990).

These conditions centre on fairly allocating the benefits and costs of collective action and on monitoring and enforcing agreed-upon behaviours. For a coalition to maintain itself over a period of time, it must not only be able to capture the benefits that it produces but also allocate these benefits and their production costs in a fair manner. In addition, the behaviours of group members must be monitored and actions that violate the agreed-upon standards must be punished. Monitoring is critical because individuals continually face incentives to defect by pursuing their own self-interests at the expense of the larger group. Finally, according to Moe, once a coalition gains control of public authority, its intent is to design and implement public agencies and policies that will effectively achieve its policy goals (Ostrom 1990; Sabatier and Weible 2007).

Additionally, Sabatier and Weible identify six categories of coalition resources: (1) formal legal authority to make policy decisions; (2) public opinion, (3) information, (4) the mobilisation of troops, (5) financial resources and (6) skilful leadership. These resources can be hierarchically arranged with respect to their usefulness to coalitions for the purpose of generating policy change (Sabatier and Weible 2007).

Finally, the ACF views policy change over time as a function of three sets of factors. The first of these three sets of factors is the interaction of competing advocacy coalitions within a policy subsystem or community; typically, the advocacy coalition

subsystem consists of actors from many state and non-state institutions that share a set of basic beliefs and that seek to manipulate the rules of various governmental institutions to achieve their goals over the course of time. The second set of factors comprises external changes to the subsystem that are caused by other policy subsystems or socioeconomic conditions; these changes may affect advocacy coalitions and may influence the decisions that emerge from the advocacy coalition subsystem. The third set of factors involves the importance of a stable legal system and constitutional rules to regulate the relationships between different actors in the aforementioned coalitions (Sabatier and Weible 2007).

Policy Network Analysis (PNA)

The policy network analysis (PNA) school focus on networks; however, the PNA school are more concerned with micro-level examinations about the relationships among policy-making outcomes, the structure of a network and the inclusion or exclusion of certain individuals or groups from the network in question (Fawcett and Daugbjerg 2012).

The term 'network' is frequently used to describe clusters of different types of actors who are linked together in political, social or economic capacities. Networks may be loosely structured but remain capable of spreading information or engaging in collective action. The literature on networks is often vague or abstract. However, the growing interest in network governance structures reflects the increasing shift of modern societies and economies towards mutuality and against hierarchies (Peterson and O'Toole 2001).

The policy network analysis tries to examine how national policies can emerge from sector networks that link authorities across different levels of government and join public and private actors. Rhodes observes the difficulties that governments experience in attempting to steer disaggregated structures of interdependent organisations and perceives the emergence of network interactions as a common response to these challenges in advanced and industrialised societies. He mentions the term 'policy network', which refers to interest intermediation between public and private actors, a topic that has received considerable interest in the political science literature in recent years (Rhodes 2006; Jordan and Schubert 1992). In addition, Peterson and Bomberg define a policy network as 'a cluster of actors, each of which has an interest in a given policy action and the capacity to help determine policy success or failure' (Peterson and Bomberg 1999). Recently, analysts of governance have sought to explain policy outcomes by investigating how networks, which facilitate bargaining between stakeholders over policy design and detail, are structured in a particular sector. The policy networks theory attempts to define how networks are structured in any policy sector and thereby help explain and predict policy outcomes (Scharpf 1999).

According to Adam and Kriesi, a policy network consists of two basic elements: actors and the relationships among these actors (Adam and Kriesi 2007).

Importantly, actors of regulation are institutionalised actors (Peterson 2003); thus, institutionalised actors constitute the unit of analysis in most governance studies. Institutionalised actors are formally organised and have resources that are distributed within the organisation according to hierarchies or majorities (Scharpf 1989). Policy network analysis begins from three basic assumptions. First, modern governance is frequently non-hierarchical. Few policy solutions are simply imposed by public authorities. Governance involves mutuality and interdependence between public and non-public actors and among different types of public actors. Second, the policy process must classify relationships between various groups and the government; these relationships are dependent on the relevant policy areas that are examined (Rhodes 1996). Third, governments ultimately remain responsible for governance. Policy networks can help to narrow options and shift agendas by pursuing strategies that generate new political and economic forces (Thatcher 1998).

The Rhodes model of policy networks has most likely been employed more often than any other model for the purpose of examining EU governance (Peterson and Bomberg 1999). This model assumes that three key variables determine what type of policy network exists in a specific sector: (1) the relative stability of a network's membership, which refers to whether the same actors tend to dominate decision-making over time or whether network membership is fluid and dependent on the specific policy issue that is under discussion; (2) the network's relative insularity, which refers to whether the network is a cabal that excludes outsiders or a structure that is highly permeable by a variety of actors with different objectives; and (3) the strength of resource dependencies, which refers to whether network members depend heavily on each other for valued resources, such as money, expertise and legitimacy, or whether most actors in a network are self-sufficient and are therefore relatively independent of one another.

This framework help in describing and analysing variations in the patterns of interests and thereby facilitates the mapping of relationships between state and non-state actors and the determination of how the policy agenda is shaped (Rhodes 1996). However, this approach has shortcomings in that it does not explain the changes inside networks; moreover, it does not sufficiently account for the roles of structure and strategic interaction within networks. Policy network analysis is increasingly used to make sense of policymaking environments. A frequent primary aim of this analysis is to determine which interests dominate bargaining within networks (Coleman and Perl 1999).

This school of analysis is primarily concerned with how networks affect power and how these power relationships can privilege certain interests more than others during the making and delivery of public policy (Rhodes 1996). The approach disaggregates the analysis of networks to the sectorial or sub-sectorial level. Accordingly, the state is perceived as fragmented; therefore, the interest of the state varies among different policy sectors (Rhodes 1996) and it is not unusual for various state authorities to hold conflicting views on policy. State capacity also varies significantly across the various agencies of the state (Atkinson and Coleman 1989).

Simulation Tools

In the previous section, different policy frameworks have been presented. These frameworks provide guidelines for the development of a policy. However, one of the main issues that policy-makers are facing is the possibility to simulate the impacts of a policy before its adoption. Doing so, policy makers can ensure, at some extent, that they are taking good decisions. To this end, several policy simulation tools have been proposed in the literature. In this section, we present some of these tools from the following perspectives: Name of the tool, the authors, the objective of the tool, and the related technologies used in the tool.

Literature Review Strategy

Different policy-simulation tools have been propsed in the literature. In order to identify these tools, we conducted a preliminary search on the ABI/inform database. We recognize that this is not an exhaustive literature review of tools used for policy simulation. Our research was on two steps: the first step is on the ABI/inform database then a second step validation with an expert to see if there are other tools that can be added to this literature review. From the first step, we obtained nine tools and then, in the second step, four other tools have been added by an expert in the domain.

For the ABI/inform database, we searched for publications between 2000 and 2016 with the key word: "policy simulation tool". We looked at peer-reviewed articles. The search returned 1487 papers. Then, using ABI/inform options, we refined our search to look only at simulation tools. The refined results gave 373 papers. Finally, using also ABI/inform tools, we refined the categories of these 373 papers to look only on papers related to policy, public policy, government, and public administration. With this final refinement, we obtained 14 English written papers. We went through these 14 papers to only study those related to policy simulation tools. From the 14 papers, only 9 papers were retained. We found that one paper is out of the scope of policy simulation; it was dealing with genetically modified corns. A second paper was about policy simulation but it was totally theoretic with no results or implementations. A third paper wasn't about simulation but more about poverty in Kosovo. A fourth paper was about the importance of simulation tools and how simulation tools can improve policy development but also with no implementation or results. Finally, a fifth paper wasn't electronically available.

The meeting with the expert led us to add four other tools that weren't found in the ABI/Inform search that we conducted. These four tools are: OCOPOMO, Virsim, Urbansim, and Skin.

When looking at the different tools, we found that these tools are applied in different domains such as energy, transportation, or urbanism. In addition, we found that there are three main technologies used in these tools: multi-agent systems, mathematical models, or developed software that combines different tools and

Table 2 Tools, technologies, and application domains

Paper title	Technology	Application domain
A multiregional model of China and its application	Mathematical equations	Economy
Mobilizing for change: simulating political movements in armed conflicts	MAS	Conflicts
Are cash transfers a realistic policy tool for poverty reduction in Sub-Saharan Africa? Evidence from Congo-Brazzaville and Côte d'Ivoire	Ex ante simulation	Economy
"Using a Simulation-Based Learning Environment for Teaching and Learning About Complexity in Public Policy Decision Making"	Learning environment	Policy
OCOPOMO Model (Scherer et al. 2013)	Multi-agent systems	Energy
The Simulating Knowledge Dynamics in Innovation Networks (SKIN) (Ahrweiler et al. 2004)	Agent-based model	Behaviour
"The DH Accident and Emergency Department model: a national generic model used locally"	Discrete event simulation	Health
Improving maintenance decision making in the Finnish air force through simulation	Discrete event simulation	Aviation
System Dynamics Approach as a Risk Management Tool in Analyzing Pension Expenditure: The Case of Malaysian Employees Public Pension	Systems dynamics	Economy
"Gaming and Simulation for Railway Innovation: A Case Study of the Dutch Railway System"	A multi-actor environment	Innovation
"Transportation Modeling as a Didactic Tool: Human Settlement and Transport"	VISUM software	Transport
VirSim (Fasth et al. 2010)	Multi-agent systems	Health
UrbanSim (Waddell 2002)	Python	Urbanism

technologies. The following table summarizes the different tools, their related technologies, and their related application domains (Table 2).

Multi-Agent Based Tools

We present hereafter four policy simulation tools using the multi-agent yechnology. The first tool, called Security Community (Altaweel et al. 2012), is developed in the context of conflicting zones and it was applied in conflicts in Central Asia. It mainly supports policy makers when they decide to move populations in conflicting zones. It simulates the impacts of these movements to explore unknown behavioral qualities relevant to mobilization.

Thes second tool is OCOPOMO (Scherer et al. 2013). It was applied in the context of the energy domain and it was developed in order to simulate the behaviour of key stakeholders and the process of decision making. It provides a basis for testing the

effectiveness of various government policies under different conditions such as abnormal climatic phenomena. The simulation takes into account the inter-relations between stakeholders, the economic conditions of the energy domain, and the social dynamics of the relations between the stakeholders. OCOPOMO is developed based on the Declarative Rule-based Agent Modelling system (DRAMS) (Lotzman et al. 2011).

The third tool is the Simulating Knowledge Dynamics in Innovation Networks (SKIN) (Ahrweiler et al. 2004). It is used to simulate the behaviour of agents, who act and interact in a large-scale complex and changing social environment. It was applied for example in industry where agents have to buy and sell goods. SKIN has the advantage to consider the knowledge dynamics in and between the agents.

The fourth tool is VirSim (Fasth et al. 2010). It has the objective to simulate the spread of a pandemic influenza. The simulation is based on real population data in Sweden. It provides policy-makers with tools to evaluate the effect of different measures connected to school closure and vaccination. These tools use advanced reasoning methods considering the population characteristics and its exposure to infection. The main goal is to help policy-makers find the most optimal policies to, for example, the starting time and the duration of school closure as well as the pace and the coverage of population with vaccination. VirSim is developed using the AnyLogic tool (a muti-agent based simulation tool), and different Graphical User Interfaces tools.

Mathematical Based Tools

We present hereafter five policy simulation tools that are based on mathematical models. The first paper is applied in the contxt of China. It presents a tool to simulate the interactions among the provincial economies and the dynamic relationship between the centre and local governments in China (Gu and Chen 2005). It aims to study the impact of fiscal recentralisation in the 1990s that the Government of China has decided. The tool consists of over 1200 equations, and has used a database of annual data from 1985 to 1998 for variables at both national and provincial levels.

The second tool addresses the issue of reducing waiting time at emergencis in UK (Fletcher et al. 2007). The tool was developed as an analytical support to the Departement of Health in UK. The department had the objective in 2002 that by December 2004, 98% of patients arriving at Accident and Emergency (A&E) departments in England should be completed, that is, admitted, discharged or transferred, within 4 h. It was important that targets such as this were seen to be delivered as evidence that NHS performance was being modernized and improved to meet patients' expectations. The tool is based on a discrete event simulation to see the impacts, on waiting times, of any decision that can be taken at any stage from admission, discharge, or transfer.

The third tool is a simulation model to improve the maintenance decision-making in the Finnish Air Force through simulation (Mattila et al. 2008). It helps to see the impacts of maintenance operations on existing resources. It allows then to optimize

maintenance operations according to the context of the operations (normal or conflicting conditions). The proposed tool is based on event-driven simulation that describes the flight operations and maintenance of fighter during normal and conflict conditions.

The fourth tool studies the potential role of cash transfers as instruments for poverty reduction and human development in (Hodges et al. 2013) Sub-Saharan Africa. The tool was applied on data collected from two different countries with two different contexts Congo-Brazzaville (middle-income oil producer) and Côte d'Ivoire (low-income country) (Hodges et al. 2013). The simulation is based on the evaluation of different criteria such as efficiency, impacts, cost, cost-effectiveness and affordability of different cash transfer options. Simulation results show that cash transfers would have more impact on monetary poverty reduction than on human development.

The fifth tool simulates pension expenditure for the Malaysian employees (Sapiri et al. 2014). The tool simulates the impact of changes and policy decisions based on demographic and salary risks. The tool is developed using risk management and System Dynamics methodology.

Software Tools

We present in what follows four simulation tools that were developed in the form of a complete software solution. The first software solution is a simulation-based learning environment to teach public managers and decision-makers about dynamic systems and decision making in such complex systems (Minyoung et al. 2012). The objective is to prepare future and current public decision makers for a rapidly changing, complex world. The tool was applied in the case of natural disasters preparedness.

The second software tool builds a framework related to innovation of complex systems in a multi-actor environment (van den Hoogen and Meijer 2015). This software is used to assess innovation processes in the context of future development of railroads. Future innovation means that railways companies need to figure out new ideas to upgrade their infrastructures and improve their performances. The software tool will evaluate these innovations since they need to be invented, explored, tested, and implemented in an incumbent system.

The third software tool is a learning environment (Ohnmacht et al. 2015) to simulate the complexity that actual urban planning committees might face when building transportation plans. The results of this learning environment showed that participants revealed that they unearthed interrelations between settlement, transportation, and society.

The fourth software tool is UrbanSim. It is a decision support system for urban transportation investments (Waddell 2002). The software is now available as an open source software that can be downloaded and deployed by governments. The software deals with different issues from building a new light rail system, to changes

in land use policies. UrbanSim integrates a simulater to evaluate the impact of the decisions at the long-term economic, social, and environmental levels.

This preliminary literature review on policy simulation tools, we haven't found any reference to any policy analytic framework. This shows, that there still exists a gap between the framework level and the implementation level. Research is still required in the way to bridge the gap between policy framework and policy tools assuming that tools nave to support frameworks.

Conclusion and Discussion

Most of the frameworks concerned by policy making analysis and policy modelling, are spread across multidiscipline sciences like public policy; political science, computer science and social sciences. Frameworks address general forms of theoretical analysis, by identifying the elements and general relationships among different components and provide a general set of variables that can be used to analyse specific arguments. These elements can include: governance structure; policy process; stakeholders; and institutions structure. It also uses different political models and technological tools, to analyse or explain or predict specific political behaviour.

These frameworks have in common three main elements with different degree of depth in analysis. These elements are: (1) People or the actors, who do what like collation and influence; (2) the process either it is related to agenda setting or one of the stages of the policy cycle; (3) political environment or what are the conditions surrounding the policy making process like political; social or economic conditions. Second is the depth of the analysis either it is Macro-Level like Nation or whole government or whole society; or the Micro-Level like specific sector of society or organization; or sub-government.

The primary frameworks classification is divided into: **First**; Frameworks focusing on Policy Stage. This category focus on the process of policy making and Different policy process stages like agenda setting, policy formulation, policy adoption, implementation, evaluation and termination (Lasswell 1956; Brewer 1974; Brewer and deLeon 1983; DeLeon 1999). The main frameworks can be in this category is the multiple streams theory of agenda setting by Kingdon in 1984 and Governance Analysis Framework (GAF) by Karim Hamza in 2013. **Second**; Frameworks focusing on Institutions. This category focus on the institution performing the decision making or impacted by the policy making process. This institution can be government; sub-government or other organizations. The most famous framework that focuses on institutions is the Institutional Analysis and Development (IAD) framework developed by Ostrom in 1990. **Third**; Frameworks focusing on Human factors and Collations. This category explores processes from the perspective of the actions of human agents and their attainment of goals with respect to devising policies and institutions. The most common framework in this category is the Advocacy Coalition Framework (ACF) developed by Sabatier and Jenkins-Smith

in 1993 (Sabatier and Jenkins-Smith 1993), and the policy network analysis (PNA) school (Fawcett and Daugbjerg 2012).

At a second stage, the chapter presented a set of policy simulation tools. The tools were grouped into three families related to the adopted technologies in the tools: multi-agent based tools, mathematic based tools, and package software tools. The presented tools have been applied in different application domains.

This chapter presented different policy-analytics frameworks. It also presented different policy simulation tools and their related technologies. Even if models are used to implement frameworks, the different presented models are not related to frameworks. Hence, this chapter identifies the following future research directions. The first direction is related to the development of new tools that can support existing policy-making frameworks. Doing so, the tools will be considered as a real support to policy-makers since it will support their ways of operating. The second direction is related to the technologies adopted in these models. In fact, nowadays, policy-makers are mobile persons who are always traveling. Hence, new mobile technologies need to be integrated within the models in order to support and reflect this reality. Finally, new methodologies need to be developed to support the development of these models while coping with policy-makers needs so that the tools can provide the required functionalities to policy-makers in order to coordinate their activities.

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