Understanding development trajectories for biotechnology governance frameworks in sub-Saharan Africa: the policy kinetics model

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ABSTRACT

Using case studies on development and implementation of biotechnology governance frameworks in four African countries, we introduce and build the case for a policy kinetics *(PK) approach to analysing and unpacking complex policy processes. The PK approach proposes a comprehensive approach to understanding how various 'pieces of the policy puzzle' interact in arenas to facilitate or constrain attainment of desired outputs. Borrowing from reaction kinetics in chemistry, which is the study of rates of chemical processes, our argument is that complex policy processes can indeed be broken down into reactants, processes, catalysts and outputs, all*

KEYWORDS

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policy kinetics
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interacting at various levels in space and time. We also bring attention to the presence of various intermediate outputs of processes with the potential to facilitate or constrain the process, including bringing a shift to the direction, duration and pace of the overall process. The presence or potential emergence of components that mimic process catalysts is another area that this approach brings to the attention of policy actors. By engaging with what happens at the level where the various components of a policy process interface with each other, we argue that this model is a useful tool for unpacking, understanding and influencing not only the development and implementation of biotechnology governance mechanisms in Africa, but other policy arenas elsewhere.

INTRODUCTION

For policy-making in general, the contention and indeed the evidence is that processes are invariably too long and tend to move in multiple, uncoordinated directions, resulting not only in delays or failure to accomplish targets and desired policy change, but in dissipation of resources and diverging outputs. In studies of processes around development and implementation of frameworks for governing modern gene-based biotechnologies in four African countries namely Kenya, South Africa, Uganda and Zimbabwe, we sought to understand exactly how long the 'long' processes were and whether being long was an exception or a rule. We also sought to identify and understand the underlying causes of these long trajectories. The process and results of the studies inspired us to advocate for a 'policy kinetics' (PK) approach to understanding policy trajectories.

There is an old adage attributed to Germany's nineteenth-century Chancellor, Otto von Bismarck, which says, 'there are two things you never want to see being made – sausage and legislation'. Although Alan Rosenthal wrote in 2001 after examining the sausage-making process at an Ohio factory, and policy-making in four US states… that 'when you get right down to it, making sausage is a lot different than making laws, no matter what the old saw says'…, there is widespread consensus that the common thread of being 'messy' still connects the two (Rosenthal 2001; Harvard Family Research Project 2007). Without delving much into the similarities or differences between sausage making and policy-making, this article wades into the admittedly dynamic area of public policy analysis, with the objective of adding an analytical lens to the policy analyst's tool kit. The focus of this article resides under the broader umbrella of policy analysis, building on strengths and gaps alike in other policy analysis theories and methodological frameworks. While, and as summarized by D. L. Weimer (2008), traditional policy analysis is a step-wise process concerned with problem identification, the setting of policy goals and alternatives, projected potential impacts and then making recommendations from among the alternatives, this article looks at how the dimensions of pace, direction and duration of policy processes could be better measured or predicted.

Policy scholarship is divided into two main strands: knowledge *in* the policy process and knowledge *of* the policy process (James and Jorgensen 2009; Weimer 2008). Knowledge *in* the policy process largely refers to knowledge produced through analysis and evaluation (James and Jorgensen 2009), whereas knowledge *of* the policy process is 'focused on the how and why of

policymaking' (Smith and Larimer 2009). This article straddles both strands of analysis in an effort to answer our key research question, which was:

> what determines the pace, duration and direction of policy processes in the area of biotechnology in Sub-Saharan Africa?

Following this brief introduction, the article proceeds with a look at the role of biotechnology as a component of a much larger national, regional and international toolkit of innovations for addressing food insecurity and broader livelihood challenges in developing countries. The next section introduces and discusses some policy analysis theories and frameworks, followed by a section that presents the PK model being advanced by this article. Empirical evidence from the study countries is then presented, as analyzed by the PK model, before conclusions and recommendations are drawn.

ROLE OF TECHNOLOGY

In Sub-Saharan Africa (SSA), like elsewhere in the developing world, the quest for new technologies and new ways of working together across disciplines, sectors, countries and regions is now widely seen not as an option but an imperative in the pursuit of socio-economic stability (Juma and Serageldin 2007). There is a new and rising reality that new and old problems alike have become increasingly pervasive, defying disciplinary, sectoral, national or regional boundaries. Within these arenas exist opportunities and solutions to the problems, and avenues for magnification of the problems (Mugwagwa et al. 2010). Challenges have increasingly become unusual in their magnitude, in the way they spread and in the way they combine with others to present even bigger challenges. Innovation is seen as one way of breaking new ground, breaking barriers and doing business away from the beaten path, and ensuring that effective technologies, products and services do indeed reach the millions of people who need them. With respect to addressing food security challenges, the role that new technologies can play is widely recognized the world over, including in SSA (FAO 2004; UNCTAD 2010). Admittedly, efforts to effectively access and exploit technological knowledge face various context-specific economic, political, social and cultural realities. The mechanisms that are developed for technology governance thus reflect a myriad of complex realities.

In SSA, a number of efforts have been made at various levels to harness and deploy technologies to reign in food insecurity and other socio-economic challenges bedeviling most of Africa (Kingiri 2010). For example, biotechnology, viewed as a continuum of both traditional and modern biological techniques, is one of the technologies that has been at the centre of many efforts and largely seen to (yet) have a significant role to play in mitigating some of the challenges and leapfrogging Africa to higher levels of development and self-sufficiency.

Biotechnology is a pervasive technology, which brings together interests from many sectors including research and development, product development, manufacturing, commercialization and downstream delivery. Management of this technology at the policy and regulatory levels is therefore inherently multi-level and multi-actor, and this brings both challenges and opportunities for policy actors. In the SSA region, there have been many efforts since the late 1990s towards developing and implementing systems for

managing biotechnology. There are many individual, institutional, sectoral, national, regional and international players in these efforts and their multiplicity and varying levels of involvement in the issue in space and time bring many dynamics to these efforts for developing countries. The ways in which biotechnology is governed not only determine its ability to achieve socially desired aims but also give important signals about the direction of technology development (Paarlberg 2000).

This article explores the emergence of effective policy environments, in particular seeking to understand what causes delays in developing and implementing effective regulatory systems. Typically, policy processes in a number of economic sectors in Africa are lengthy, often marred by confusion with respect to the processes to follow and the desired outputs. Looking at the area of biotechnology governance in four countries, we sought to understand exactly how long the long processes were, whether being long is an exception or a rule and the underlying causes of these long trajectories. In seeking to understand this, we borrow from chemical kinetics in chemistry to advocate for a PK approach to understanding these policy trajectories.

ANALYSING POLICY PROCESSES – A REVIEW THEORIES AND ANALYTICAL TOOLS

Numerous frameworks are currently being used to analyze policy processes, and these have many divergences and overlaps, depending on the unit of analysis and intended objectives of the analysis. The following section presents a brief overview of some of these key policy process theories and methodological frameworks. M. C. Nowlin (2011) weaves through the terrain of policy research and unravels a number of issues that are as surprisingly informative as they are coincidentally and serendipitously in tandem with the thinking we had when we set out to understand exactly 'how long policy processes always labelled to be too long were, and why?'. Some of the frameworks and theories included in that article, and that we also analyze here are the Institutional Analysis and Development framework (IAD), Multiple Streams (MS), the Advocacy Coalition Framework (ACF), Policy Diffusion, Punctuated-Equilibrium (PE) and Social Construction and Policy Design.

The IAD framework (Kiser and Ostrom 1982) grew from the institutional rational choice literature. It examines the impacts of institutional arrangements on human behaviour, focusing on institutional arrangements in collective action settings where actors are dealing with common pool resources. It identifies groups involved, rules followed and the impact of these on the collective action problem. Guided by the concept of institutional grammar and a coding scheme for legislation, the framework identifies levels of rule-making authority, including how individuals can create self-governing rules. However, a close examination of how groups interact is missing, together with the impact of process outputs on groups and policy objectives or targets. There is also little attention to multiple policy-making institutions and overlapping institutions and multi-jurisdictional institutions, as is the case in most policy settings, not least the biotechnology governance arena.

The MS framework is discussed by John Kingdon (1984) in the book *Agendas, Alternatives and Public Policies*. It posits three separate and independent streams to policy-making: the problem stream (issues to be addressed),

the policy proposals stream (ideas and solutions) and the politics stream (national political environment). A revised model expands policy stream into a policy field that contains politics and problem streams. According to this framework, policy change occurs when streams merge. The MS framework also advances the concept of 'problem surfing' (Boscarino 2009), where policy entrepreneurs or advocates attach[1] their proposals to salient problems. One problematic assumption of this framework though is that each stream operates independently of others and that participation in one stream limits participation in another.[2] In the biotechnology governance arena, nothing could be further from the truth than this, not least because of limited human resource and institutional capacities, which result in actors playing different and often conflicting roles in the different streams.

The ACF (Sabatier 1988) focuses on policy learning and policy change within a policy subsystem. Focus is on subsystem dynamics. The framework posits that changes occur from both internal[3] and external shocks. Central to the ACF are coalition stability and homogeneity due to shared policy core beliefs, especially among principal members. The reality in biotechnology governance and indeed other areas though is that some subsystems and coalitions are difficult to identify because of shifts in beliefs and interests. In addition, strategic concerns may override interests. Macro-level (e.g. public opinion) or trans-subsystem interactions[4] are more important in many cases, and the influence of auxiliary members, all these and more acting singly or collectively to shape policy trajectories (Muraguri 2010).

The policy diffusion framework (Walker 1969; Berry and Berry 2007) is about the spread of similar policy innovations across jurisdictions. The mechanisms through which innovations spread are said to include learning, economic competition, imitation and coercion. Admittedly, there are various actors involved e.g. bureaucrats, policy entrepreneurs and knowledge brokers. More clarity remains to emerge though with respect to causal mechanisms that explain diffusion and adoption, including exact ways through which actors exert influence.

The PE or policy choice model (Baumgartner and Jones 1991) focuses on two facets – periods of policy stasis and periods of large-scale policy change. Subsequently developed into a theory of information processing, attention and policy choice by governments, this model works beyond subsystem dynamics. It posits that information works as signals from the external environment, signals that are then collected, assembled, interpreted and prioritized through selective attention (in bounded rationality and cognitive limitation). There is also institutional friction (limited ability of institutions to process information). Oversupply of information is a noted reality[5], while the model also highlights the importance of political attention.[6] Two realities come to the fore for many policy arenas, including biotechnology governance, that stability or equilibrium between periods is difficult to observe in some policy subsystems and that stasis may not necessarily denote equilibrium. There will be several activities within the arena, consuming resources and policy attention.

The social construction and policy design model (Schneider and Ingram 1993, 1997) focuses on the way in which attitudes towards target populations[7] influence the type of policy created. It also looks at how policy impacts on the ways in which target populations are viewed, highlighting these as being key to determining whether or not a policy is developed and whether it will work. Positive construction is helpful. The framework looks at both problem and target population definition, and how policy designs can create target populations (e.g.

1. Lock and key hypothesis therefore not alien... sometimes to the extent of applying same solutions to different policy problems in different times, or only slightly altering proposals to higher issues such as climate change, economic crises, gender, water quality, etc.
2. Our empirical evidence counters this assumption.
3. There is an important mention from recent iterations of the ACF of outputs from subsystem as potential shocks.
4. The PK model, through operating at macro, meso and micro levels, seeks to address some of these gaps.
5. Said to result from pluralistic, redundant, parallel, competing and hence inefficient processes of gathering information.
6. E.g. that popular issues tend to benefit from large increases in macro-political attention. It is intriguing though that unpopular issues also benefit from decreasing attention. There is contention also that public opinion can mediate the impacts of political attention.
7. E.g., the entry of many civil society actors and representatives of multinational players into the biosafety terrain brought with it certain perceptions from government officials (c.f. the fear of regulatory capture). Instead of catalysing, in some cases this resulted in processes being inhibited.

through resource allocation). One reality though is that the fluidity in target populations poses a challenge to how the impact of attitudes can be identified. The framework also falls short with respect to how exactly the attitudes impact on policy design or how policy design can create target populations.

The foregoing review has brought up the utility of and overlaps between various policy process analysis theories and frameworks currently in use. One major limitation identified across all the frameworks is that they do not bring out exactly how the different facets of the policy process interact with one another and with the environment in which they operate. The frameworks, however, all lay firm foundations for further analysis into what happens at the interface between the policy problem, the actors, the policy options and the potential policy impact, among others. The PK model aims to build on these various frameworks to yield a closer analysis into how the various pieces of the policy puzzle interact, and with what impact on policy objectives, policy outcomes and impacts.

RESEARCH METHODOLOGY

This article presents the results of a four-country study that sought to understand the factors that influence the duration, direction and pace of debates in biotechnology policy-making processes and the effect these have on policy outputs. Looking at four countries in SSA, namely Kenya, South Africa, Uganda and Zimbabwe, the study examined policy-making in the area of agricultural biotechnology, with a particular focus on development of biosafety frameworks (regulatory and administrative mechanisms for governing biotechnology) in the four countries. Among others, the study explored the separate and overlapping roles of government and non-governmental actors in the emergence of the regulatory frameworks. The role of the overarching national contexts was also explored.

This study was carried out between 2009 and 2010, followed by further updates between 2011 and 2012, using multiple methods that encompassed document reviews, open-ended interviews with key policy-makers in the study countries and observation of discussions and interactions in various meetings and conferences. Most of the data collected were qualitative, the aim being to collect evidence to address the key question posed by the research on the pace, duration and direction of policy processes in the area of biotechnology in SSA.

A number of venues rendered themselves important in the quest for answers to the key question, and these included the documents, actors and policy arenas that formed part of the data sources. On average, ten key informants were interviewed in each country, while major policy documents reviewed in each country included workshop reports, media reports, various drafts of biosafety and biotechnology policies, legislation and guidelines, agricultural policies, science and technology policies, among others.

The four countries chosen for this study have had long involvement in biotechnology and biosafety issues, and have over time been at different but comparable stages in their processes for harnessing the technology and putting in place mechanisms for regulating it. They also form part of various clusters of countries that we have studied in different projects, and for this, they lend themselves amenable to a systematic analytical comparison. More details on the status of regulation and use of the technology in these countries are given in the results section.

PK MODEL – BORROWING FROM CHEMISTRY

In chemistry, the study of rates of chemical processes is known as chemical kinetics, or reaction kinetics, and it encompasses investigations of how different experimental conditions can influence the speed of a chemical reaction (Carr 2007). Reaction kinetics studies provide an understanding of what happens in an encounter between two reagent molecules, and this is important for development of theories that can predict not only the rate but also

8. E.g. how flexible are the policy ideas/interests/positions – fluid or 'cast in stone'?

9. One does not start a fire with large logs, but with small sticks!

Attribute or component of a reaction	What is it?	Key facts about component
Reactants	The substances that are reacting or interacting	Nature of substances reacting determines reaction rates. Larger reactants with strong internal bonds react slowly.
		Agitation or mixing increases rate of chemical reaction through increasing number of collisions
Catalyst	A substance that speeds up the rate of reaction, itself remaining unchanged afterwards	A catalyst does not make a reaction happen; it only speeds up a reaction that is already feasible
		It opens up a different reaction pathway, with lower activation energy, thus increasing the reaction rate
		In autocatalysis, the product of a reaction is a catalyst for that reaction, leading to positive feedback
Physical state[8]	Denoting whether reactants are in a solid, liquid or gaseous state	Reaction occurs at the area of contact between reactants. The more finely divided the reactants, the greater the surface-area-to-volume ratio and the faster the reaction[9]
Concentration	The quantities of reactants in a given space	According to the collision theory, molecules must collide in order to react. Collision increases with concentration
Temperature	Degree of hotness or coldness, which determines the amount of energy available to the reaction	Reactants collide more in higher temperatures and have more energy to react
Pressure	Compression force applied on the reaction medium	For gaseous reactions, increasing pressure increases the number of collisions between reactants, thereby increasing the rate of a reaction. Similar to the effect of increasing the concentration of a solution
Equilibrium	State of balance	This happens when rates of forward and reverse reactions are equal and concentrations of reactants and products no longer change

Source: Table created by authors from various sources e.g. R. W. Carr (2007) and http://highered.mcgraw-hill.com/sites/dl/free/0073402680/931039/Chapter_13.pdf.

Table 1: Components and attributes of a chemical reaction.

the outcome of reactions. Knowledge of reaction rates and outcomes forms the basis of many industrial applications especially in the food processing and pharmaceutical sectors. There are a number of key facets to chemical kinetics, starting with the law of mass action formulated by Peter Waage and Cato Guldberg in 1864, which states that 'the speed of a chemical reaction is proportional to the quantity of the reacting substances' (Carr 2007). Other key facts are that the main factors that influence the reaction rate include the physical state of the reactants, the concentrations of the reactants, the temperature at which the reaction occurs and whether or not any catalysts are present in the reaction. Every reaction needs 'activation energy' to be initiated. Meanwhile, for consecutive reactions, the slowest step is usually the rate-determining step for the overall reaction. The table below presents further details on key components and attributes of reactions.

OUR ARGUMENT

Our argument for a PK approach to understanding policy processes recognizes the complexity and messiness of policy processes, and that, within this complexity the processes can be broken down into reactants, processes,

Actors	Kenya	South Africa	Uganda	Zimbabwe
Researchers	Local and international academic and applied natural and social scientists	Mainly local researchers	Local and international academic and applied natural and social scientists	Local and international academic and applied natural and social scientists
Policy-makers	Elected officials and senior government officials	Elected officials and senior government officials	Elected officials and senior government officials	Elected officials and senior government officials
Policy implementers	Government agencies, with facilitation from local and international partners	Mainly government agencies with local support	Government agencies, with facilitation from local and international partners	Government agencies, with facilitation from local and international partners
Policy users and beneficiaries	Farmers, agric extension workers, researchers, civil society, private seed companies	Companies, farmers, researchers, civil society	Farmers, agric extension workers, researchers, civil society, companies	Farmers, agric extension workers, researchers, civil society, companies
Funding agencies	Mainly international sources, also government	Mainly government and other local sources	Mainly international sources, also government	Mainly international sources, also government

Policy watchdogs	Regulators, civil society, funders and multinational companies, industry associations	Regulators and civil society, multinational companies, industry associations	Regulators, civil society, funders and multinational companies	Regulators, civil society, funders and multinational companies

Table 2: Biosafety policy processes – the actors.

catalysts and outputs, which all interact at various levels in space and time. The PK model proposes a comprehensive approach to analysis and understanding of the duration, direction and pace of policy processes, through understanding how the various pieces interact within the arena to facilitate or constrain attainment of desired outcomes. We also bring attention to the presence of various intermediate outcomes of processes and the potential that these have to facilitate or constrain (autocatalysis) the process, including bringing a shift

10. The Kenyan GM sweetpopato researchers' case.

11. The use of influential farmers from SA's Makhathini GM cotton area to market the technology to other farmers.

Process	**Kenya**	**South Africa**	**Uganda**	**Zimbabwe**
Demand articulation and priority setting	Led by regulators	Led by scientists and industry representatives	Led by regulators	Led by scientists
Stakeholder mobilization	Led by government and civil society	Led by government and academia	Led by government and civil society	Led by academia and government
Workshops and networking	Broad based, across the country and with wide array of stakeholders	Mainly scientists, private sector and academia and in urban settings	Broad based, across the country and with wide array of stakeholders	Mainly scientists, government and other technocrats
Capacity building and consolidation	Government and academia; also private sector[10] and civil society	Government and academia; also private sector[11] and civil society	Government and academia	Government and academia
Monitoring, evaluation and review	Government, private sector and civil society	Government, private sector and civil society	Government, private sector and civil society	Government, private sector and civil society
Information dissemination and feedback	Multiple stakeholders including government, civil society and private sector	Multiple stakeholders including government, civil society and private sector	Multiple stakeholders including government, civil society and private sector	Multiple stakeholders including government, civil society and private sector

Table 3: Biosafety policy processes – the processes.

Catalysts	Kenya	South Africa	Uganda	Zimbabwe
Interaction venues	Print and electronic media, workshops, other formal and informal platforms	Print and electronic media, workshops, other formal and informal platforms	Print and electronic media, workshops, other formal and informal platforms	Print and electronic media, workshops, other formal and informal platforms
Institutions	Legal platforms and allied legislation	Legal platforms and allied legislation	Legal platforms and allied legislation	Legal platforms and allied legislation
Resources (human and institutional)	Disciplinary specialists, limited numbers	Disciplinary specialists, large numbers	Disciplinary specialists, limited numbers	Disciplinary specialists, fair numbers
Process facilitation	Led by interested parties (scientists, regulators and civil society)	Led by interested parties (scientists and private sector)	Led by interested parties (scientists, regulators and civil society)	Led by interested parties (scientists and regulators)
Feedback mechanisms	Multiple but uncoordinated channels	Multiple but uncoordinated channels	Multiple but uncoordinated channels	Multiple but uncoordinated channels
Political will	Verbal	Verbal and in practice	Verbal	Verbal and in practice but declining
Economic instability	Significant negative impact on policy processes	Little impact	Significant negative impact on policy processes	Significant negative impact on policy processes
Information	Oversupply	Oversupply	Oversupply	Oversupply
Unforeseen circumstances	Civil society backlash	Civil society backlash, drought and food emergency	Civil society backlash	Civil society backlash, drought and food emergency

Table 4: Biosafety policy processes – the catalysts.

to the direction, duration and pace of the process. The presence or potential emergence of components (e.g. interim products) that mimic what would catalyse the process is another area that this approach brings to the attention of policy actors. In other words, the PK approach identifies such components and seeks to understand their fate or impact in the processes, including what becomes substrate for allied reactions and what gets thrown away. We envisage the PK model proving useful at micro, meso and macro levels, thus linking to some predictions that future work in policy process research will look

Outputs	Kenya	South Africa	Uganda	Zimbabwe
Baseline and priorities reports	Several	Several	Several	Several
Workshop reports	Several	Several	Several	Several
Interim legislation	Several government drafts and one by civil society	Nil	Several government drafts	Nil
Institutional arrangements	Several Interim NBCs	Quickly established legal NBC	Several Interim NBCs	Quickly established legal NBC
Other biosafety bodies	e.g. Kenya Biodiversity Coalition	Biowatch, African Centre for Biosafety, Biosafety SA, AfricaBio	Local and regional NGOs	Ad hoc civil society coalitions, regional programmes
Interim admin and implementation arrangements	Interim drafts at national, sectoral and organizational levels	Mainly sectoral and organizational level	Interim drafts at national, sectoral and organizational levels	Mainly sectoral and organizational level
Biosafety capacity	Now extensive	Always been extensive	Now extensive	Always been at appreciable levels
Legal biosafety framework[12]	From[13] 1996 to 2008 (twelve years)	From 1993 to 1997 (four years)	From 1993 to date (twenty years)	From 1993 to 1998 (five years)

Table 5: Biosafety policy processes – the outputs.

at multiple and interconnected institutions, overlapping and often operating in multiple jurisdictions (Nowlin 2011). The PK model will be able to untangle the similarities and differences in the images that emerge when these institutions' work is refracted in different contexts. The next section presents and analyzes the biosafety processes in the study countries, as analyzed using the PK model.

ANALYSIS AND DISCUSSION

Reactants/actors

At the beginning of the processes, the homogeneity among actors was key to moving processes ahead. This was the case in South Africa and Zimbabwe (see Tables 2 and 3). Numbers of biosafety experts or allied professionals were appreciably high in all countries, but homogeneity within the groups taking a

12. By length of process we mean the period from when formal/institutionalized biotech activities started in the country to the time when the country enacted a legal biosafety framework.

13. For each country before this date there were processes that happened behind the scenes in preparing the countries to develop and adopt frameworks (debates, capacity building, lesson

drawing, lobbying, resource mobilization, among others).

lead proved critical. In Kenya and Uganda, processes were delayed right from the start because of the inclusion of many voices. However, as increasingly more actors came on board at various stages of the processes in Zimbabwe and South Africa, new experiences with different actors had to be learnt, resulting in some hurdles, e.g., in revision of policies and appointment of new biosafety committee members. Attitudes towards scientists were for a long time positive, while other groups were viewed with suspicion or as peripheral members, e.g. beneficiaries such as farmers, extension workers and civil society. Funders of processes were also given high regard. There were also simmering suspicions, especially in South Africa, that there was something to hide from and/or that government had been 'captured' by industry. This fear persists across all countries today and is also raised with respect to the civil society influence. Extensive and continuous interactions amongst groups have reduced the fears somewhat, although it also brings both demystification and contempt, especially where biased or inefficient facilitation is suspected. Collision therefore does not necessarily increase the rate of reaction.

Application of pressure on the actors to deliver seemed to bring impetus to the policy processes. The pressure came in the form of targets sets by governments, from international processes (e.g. the Cartagena Protocol on Biosafety), from product trials and imminent releases, but it seemed as though for every push towards the policy outputs, there were other forces and realities pushing in the opposite direction, resulting in deadlocks or equilibrium. In Kenya and Uganda, this came in the form of anti-GM coalitions that either championed alternative bills or simply vigorously campaigned against the policy proposals. International agendas and policy lessons played a huge role in such cases, asking many questions of local policy actors' ability to refract policy innovations into their own systems.

Catalysts

Availability of skilled and committed personnel in key organizations helped considerably in driving processes forward, especially where they interacted with those like-minded. There were problems where disciplinary specialisms were not easily surmounted. Use of various media channels as shown in Table 4 also helped facilitate policy processes, especially when consensual messages were being passed. However, moderation was often a problem, including the challenge of simplifying and distilling 'take-home' messages for the lay public. Meanwhile dead-end processes, an oversupply of information, interim documents and poor feedback served as hindrances to further progress with policy processes in a converse way to how clear, structured and successful accomplishment of certain facets of the policy process spurred on subsequent processes. Unforeseen circumstances, such as backlash from civil society and the 2002/2003 food crisis in southern Africa, brought renewed attention to the policy processes, albeit temporarily, for a number of reasons, not least the lack of clear directions on how to assimilate lessons from these 'policy irritants'. Institutional friction and cognitive limitations certainly played a huge part here.

Processes and outputs

Each country has several levels/categories of products from the policy processes as shown in Table 5. A number of issues come to the fore in terms of these products. Their sheer numbers and length of time taken to establish them had a huge bearing on further progress with the processes. A large

number of interim measures (particularly in Kenya and Uganda) reflected uncertainty with final goals and how to reach them, while lengthy processes resulted in actor fatigue and disillusionment. Meanwhile, the presence of the interim documents meant that they were occupying spaces intended for final outputs (in the physical and cognitive sense), and this slowed down further progress. Some actors also became attached to results of their efforts, stifling new thinking. The level within the policy trajectory at which the interim measures were also had a bearing on the magnitude of impact that the measure had on the policy processes. For example, too many interim measures at the 'top' (i.e. nearing completion, e.g. enactment in parliament) were seen to have a higher impact than interim measures at lower levels[14]. On the other hand, limited utilization of some of the outputs, e.g. the interim measures or human resource capacities, also negatively affected further progress in the policy processes (negative feedback). The suitability and appropriateness of some processes (e.g. use of meetings, workshops and consultations) to deliver the policy process objectives was an issue that escaped constant appraisal in some cases, depriving the processes of opportunities to follow routes of lower activation energy, this resulting in 'complication of simple issues' or 'the simple becoming impossible'. Facilitation and continuous monitoring, evaluation, review and feedback are necessary to address such issues.

14. Resulting in a product pile-up or gridlock.

CONCLUSIONS

Policy processes are indeed lengthy and complex and a lack of systematic analysis of these processes does not help in our quest for knowledge *in* the process and knowledge *of* the policy process. Several theoretical frameworks and methodologies are in use for trailing various aspects of the policy process, from the problems being addressed, the actors involved, the options being proposed, to the envisaged impact. This is useful and necessary, but our contention in this article has been that many of these frameworks do not engage with what happens at the level where the various components of a policy process interface with each other. Using the cases of development and implementation of biotechnology governance frameworks in four African countries, we have introduced and built a case for use of the PK model to unpack what happens at these various interfaces, and we believe that within the limits set by the broader operating environment and embedded policy process cultures, the PK model brings us to a closer understanding and possible prediction of direction, duration and pace of policy processes. Further analysis of the evidence presented in this article and more empirical studies will help examine the utility of this model further.

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