# A Methodology for Information System Formation and Performance

Temel, Tugrul and Kinlay, Dorjee

ECOREC Economic Research and Consulting

26 October 2012

# A Methodology for

# Information System Formation and Performance

Tugrul Temel and Dorjee Kinlay

## Abstract

This study seeks to develop a comprehensive methodology for assessing information system formation and performance. Our conceptual framework incorporates three complementary methods, which constitute the methodology developed. The first method proposes an approach to analyze the effects on the information system formation and performance of macro-level institutions that directly or indirectly shape information activities; the second method, to characterize system linkages and identify critical, causal information flow patterns at the meso-level; and the third method, to assess the effectiveness of these linkages and flow patterns considering the organization-level learning and dissemination capacities. With the design of a workshop and a questionnaire, the study fully operationalizes the methodology. The workshop aims to identify priority information flow patterns, while the questionnaire seeks to qualitatively measure the organizational learning and dissemination capacities. Finally, we present a roadmap for a full-fletch assessment of information system. This map puts the assessment in perspective, linking the findings from the three methods with the structure-conduct-performance (SCP) approach. This way, the proposed methodology incorporates the SCP approach that allows the assessment of system performance.

# 1   Introduction

Information is the first and foremost input required in any policy priority setting exercise and in the design of the associated plan of actions aimed to achieve the policy goal. However, to be able to use the information, at least two elements should be in place. First, there needs to be an information system that is capable of generating the desired information; and second, users of the information should have the capacity to utilize it. Recently, a wide range of donors, international development and research organizations have initiated capacity building programs in support of informed policy making processes in developing world, including the European Commission (EC), the World Bank (WB), the Food and Agriculture Organization (FAO) of the United Nations, Consultative Group on International Agricultural Research (CGAIR), Organization for Economic Co-operation and Development (OECD), World Health Organization (WHO) among others. They have adopted a two-tier strategy aimed to promote the creation of information systems on the one hand and to improve human resource capacities of organizations in the systems concerned on the other. Agricultural, market and food security information systems advocated by the FAO (2000, 2011), (agricultural) knowledge and information and (agricultural) innovation systems advocated by the WB (2012), FAO (2012) and OECD (1997, 1999, 2011) and health information systems advocated by WHO (2006, 2008) are only few examples of a growing number of information system initiatives.

Methodological developments go hand in hand with these initiatives. They seek to enrich the tool box of practitioners for designing effective and sustainable information systems on the one hand and for monitoring and evaluating the performance of the evolving systems on the other. The present study intends to contribute to this tool box, offering a methodology that can be applied in the formation of information systems and in the analysis of the related policy making processes. The study is not about computer-based information systems, but rather about information systems that are subject-specific in its coverage, multi-sectoral in its organizational domain and policy making-oriented in its use. Examples of such systems include, but not limited to, health information systems, agricultural information systems, food security information systems, market information systems, environmental information systems among others.

The methodology the current study develops incorporates three complementary methods. The first method proposes an approach to analyze the effects on the information system formation and performance of macro-level institutions that directly or indirectly shape information activities. The second method can be used to characterize system linkages and identify critical, causal information flow patterns at the meso-level. The third method can be applied to assess the effectiveness of these linkages and flow patterns considering the component-level learning and dissemination capacities. The focus here is on the effects of these capacities on the fluidity and accumulation of information. With the design of a workshop (see Temel 2004a) and a questionnaire (see Dibbon 1999), the study fully operationalizes the methodology. The workshop aims to identify priority information flow patterns, while the questionnaire seeks to qualitatively measure the organizational learning and dissemination capacities. Finally, we present a roadmap for a full-fletch assessment of information system. This map puts the assessment in perspective, linking the findings from the three methods with the structure-conduct-performance (SCP) approach. This way, the

proposed methodology incorporates the SCP approach that allows the assessment of system performance (Caves, 1992; Kizito, 2008, 2011).

Our methodology can be applied to analyze an information system from four dimensions: its institutional set up, information flow patterns, effectiveness in generating and circulating information, and performance. Research questions that fall within the reach of the methodology include, but are not limited to:

- What are the key institutional elements to support the creation of an adequately operating information system?
- Which institutions stimulate or provoke the connectedness of the system components?
- Which institutional interventions are required to shape the system structure in such a way to improve the system performance?
- Does the system evolve within an enabling policy environment with adequate resources (financial, human) and ICT infrastructure?
- What characteristics of the enabling policy environment help motivate the system components to be organized around the system goal?
- What kind of strategies, mechanisms and means can promote the production of relevant, quality and timely information and the exchange of information resources?
- What organizational capacities are required to improve information flow, absorption and accumulation?
- What is the system structure - what type of organizations leads in the production, what type in the dissemination and what type in the use of information?
- Which information flow pathways are critical for the achievement of the system goal?
- Which priority system components suffer from weak linkages and what strategies are to be followed for strengthening the priority linkages?

A critical review of the literature on information systems has generated a voluminous number of studies, a large majority of which are about computer-based information systems. Excluding the studies on computer-based information systems, the review identified four regularities regarding the characteristics of the type of information systems we are interested in.[1] The first regularity is that the government coordinates and facilitates the entire process of the creation of an enabling policy environment, with regulatory arrangements, governance and enforcement rules and regulations (that is, "rules of the game") at all levels. Second, owing to public goods characteristics of information, there is ample scope for public-private partnership arrangements motivated by the presence of both private and social benefits. Third, the priority policy issue is cross-sectoral in its solution and cannot be satisfactorily addressed from a limited perspective of a single sector. Stakeholders of the information of interest are aware of this and willing to join forces around a common system goal. Fourth, stakeholders recognize that system performance is

---

[1] The reader is referred to Aldridge (1992) for alternative models of market information system; Pan American Health Organization (1998), Lippeveld, Sauerborn, and Bodart (2000), Lafond and Field (2003), WHO (2006, 2008) and Aqil, Lippeveld and Hozumi (2009) for a review of health information system frameworks; Shepherd (1997), Diarra, Traoré and Staatz (2004), Staatz et al (2010), Kizito (2011) and FAO (2011) for market information systems; FAO (2000) for food security information systems; WB (2012), FAO (2012) and OECD (2011) for information and knowledge systems; Connor, Thomson, Flasse and Perryman (1998) for environment information systems among others.

conditional not only on the capacities of producers but also on the capacities of the final users of information. The presence of comparable capacities on both sides of the scale is in fact necessary for an effective and sustainable information system to emerge. Our proposed methodology embodies all of these regularities. In addition, the methodology brings to the fore the idea that linking stakeholders in the system should by itself be considered a critical factor for quality information generation. Facilitating the growth of linkages of a wide range of stakeholders would not only increase the flow of the existing information but also offer a way for better representation of different information sources, which would otherwise be ignored. Therefore, linking stakeholders should not be left to markets as it needs a continuous nurturing from the policy environment.

The rest of the study is organized as follows. Section 2 develops the methodology, with a detailed conceptual framework for information system analysis. Following the definitions of the critical concepts used throughout the study, three interconnected methods are described. In Section 3, the structure-conduct-performance approach is integrated into our conceptual framework. This section further elaborates on how to operationalize the methodology. Finally, Section 4 concludes the study.

## 2 Methodology Development

### 2.1 Conceptual framework

The methodology is designed to carry out an assessment of information system with respect to its underlying institutions, organizational linkages and information flow patterns, and capacities. Three methods are introduced: (1) a method for the institutional analysis of the system, which warrants clear understanding of such concepts as data, information, knowledge, information system and institutions; (2) a method for the analysis of organizational linkages and information flow patterns in the system; and (3) a method for the analysis of the effects of organizational capacities on the flow and accumulation of information.

**Figure 1** presents our conceptual framework, mapping the links between the three methods, as well as their association with the components of the SCP approach. The framework is shown as a (3, 3) matrix. The first row (grey color) indicates the level of analysis (macro, meso and organization), while the first column (grey color) shows the subjects (content, method and impact). The elements of this matrix framework read as follows. The term "institutions" placed in ($1^{st}$ row – $1^{st}$ column) suggests a macro-level institutional analysis of the system concerned. The element placed in ($2^{nd}$ row -$1^{st}$ column) indicates the method, which is explained in Section 2.2, to be applied at the macro level. The findings from the macro-level institutional analysis should provide inputs into the characterization of the system structure in terms information policy, governance, resources (financial and human), ICT infrastructure-policy-regulations, and rules for engaging in partnership agreements.
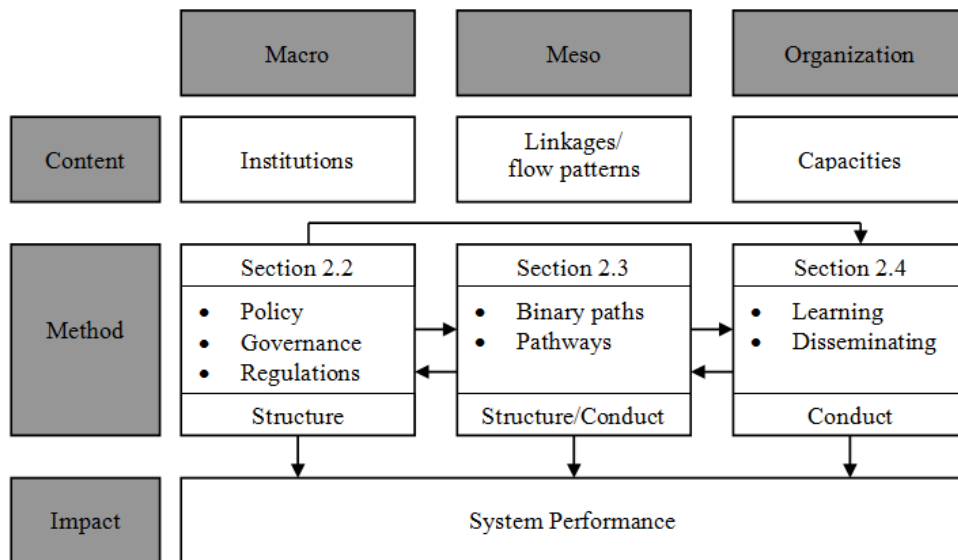
The last element in the $1^{st}$ column of the matrix refers to system performance. It should be noted that system performance depends not only on the structure at the macro level but also on the structure and conduct at the meso and organizational levels. Approximated by the degree of effective generation, distribution and use of the relevant information, the

performance is a multi-dimensional issue. It has four groups of determinants. Macro determinants (Type I) relate to policies, regulations and the information culture within a country. Meso determinants (Type II) concern the structure of system components, the roles of and resources available to these components. Organizational determinants (Type III) relate to the behavior of organizations and actors, such as the capacities, attitudes, values, and motivation of those involved in the production, collection, analysis, use and dissemination of information. Finally, technical determinants (Type IV) include adequate use of information means and mechanisms or data and information quality. Consistent with the premise of our methodology, the term "impact" is defined by the degree of: (1) linkage between relevant, quality and timely information and policy makers and (2) policy makers' internalization and use of the information concerned. It should be pointed out that a system with high performance does not alone ensure high impact unless and until policy makers have access to and are willing and able to absorb and use relevant and quality information in the design of policy interventions.

The 2$^{nd}$ column of the matrix presents a similar structure at the meso level (i.e, the component level), which maps linkages and information flow patterns in the system. The corresponding method is given in Section 2.3, in which given individual components, the component-level linkages (pathways and binary paths) and component behavior are characterized. In fact, this characterization provides an evaluation of the component structure and conduct, which in turn implies a certain level of system performance. Finally, the 3$^{rd}$ column in the matrix maps an organization-level capacity analysis based on the method given in Section 2.4. Given individual organizations (stakeholders) in the system, organizational capacity development strategies for the improvement of learning and disseminating capacities are analyzed. This provides an evaluation of the organizational as well as component level conduct, which in turn implies a certain contribution to the system performance.

**Figure 1**

A Conceptual Framework for Information System Analysis



Source: Authors

5

*Information*

Information is the subject of this study; therefore, better understanding its meaning and association with and differences from data and knowledge, which are often referred to, is necessary. The literature offers a large number of definitions, many of which underline more or less the same characteristics. In this study we adopt the following definitions. Data are symbols not yet interpreted; information, as data with meaning; and knowledge, as the subjectively interpreted information.[2] It is commonly assumed that data inherently contain no meaning. Pure data in a database, for example, does not have any inherent structure. For data to become information, it is shaped or structured from the raw material by the receiver. The transformation of information into knowledge takes place through a process of information accumulation. Knowledge is generally personal, subjective and inherently local – it is found in the minds of human beings rather than existing objectively without. It can be internalized by the knower, and as such is 'shaped' by their existing mental constructs, perceptions and experiences. Tacit knowledge refers to the type of knowledge that is hard to encode and communicate because it is personal, context-specific and hard to formalize, whereas explicit and external knowledge can be stored and shared.

*Information system*

An information system, denoted by **S**, is defined as a set of organizations – evolving around a common system goal – that jointly and/or individually generate, collect, analyze and distribute data and information to help achieve the system goal. The type of information systems we are interested in consists of *n* components. A component is a sub-set of organizations with comparable objectives, and this sub-set can further be organized around a component-level objective. In line with this hierarchy of objectives, **S** can then be defined as a set of *n* components, each of which has a component-level objective consistent with the system goal. In our case, **S** is a soft system, the organizational domain of which is arbitrarily determined by policy issue/problem at hand as well as the qualifications of policy makers and the participating organizations. From a policy making perspective, the system goal can be defined as the timely provision of critical policy information in a highly summarized and convenient form.

Putting **S** into operation requires a clear-cut distinction between formal and informal information. This study uses the term "information" to mean formal information only. As Wolf et al. (2001) argue, the distinction lies in the communication medium and the intentions underlying specific interpersonal contact. Formal information is defined as being derived through structured channels generally in the form of text, but also including conferences, phone calls and other forms organized for the explicit purpose of information exchange. Conversations and social interactions among family, friends, and business associates including colleagues, customers, suppliers and competitors constitute informal information. Of course, the distinction between social interaction and explicit information exchange is not clear-cut as personal, family, community, and economic spheres overlap. Furthermore, the information in **S** should be highly variable and context-sensitive, the

---

[2] See Ackoff (1989), King (1993), Nonaka and Takuchi (1995), Gallup, Dattero and Hicks (2002), Awad and Ghaziri (2004), Ahsan and Shah (2006) and Bellinger, Casstro, Mills (2006).

meaning and the value (or utility) of this information depends on the competencies of the interacting organizations.

**S** can also be considered a kind of information market in which organizations – information producers and users – engage in information transactions. But such a market is intrinsically different from markets for commodities. Stiglitz (2000) points out three main differences. Firstly, information is fundamentally different from other commodities. It possesses many of the properties of a public good—its consumption is *non-rivalrous*, and so, even if it is possible to exclude others from enjoying the benefits of some piece of information, it is socially inefficient to do so; and it is often difficult to exclude individuals from enjoying the benefits. Appropriating the returns to investments in information is thus the central issue. Secondly, each piece of information is different from others, and if the properties of the information concerned are known before purchasing it, then there would be no reason for the buyer to pay for it. This implies that every piece of information in the market should be new. In this connection, markets for information are inherently characterized by imperfections of information concerning what is being purchased; and mechanisms like *reputation*—which played no role at all in traditional competitive theory—are central. Thirdly, in commodity markets, prices convey all the relevant information reflecting, for example, the scarcity value of resources; however, prices in information markets convey information other than that about scarcity. Producers and consumers realize that their actions convey information, and this affects actions, so that the simple theory of consumer and producer behavior does not describe the behavior of consumers or producers in several central aspects. All together, these unique characteristics of information as a commodity point to the need for special institutional interventions to improve efficiency and effectiveness in information markets.

It should be stressed that public goods characteristics of information, such as non-appropriability and non-rivalry, as well as other characteristics, such as indivisibility, quality uncertainty and perishability, lead to market failure, justifying the government involvement in securing the full recovery of benefits by information producers and helping to reveal the actual demand for information. The same characteristics also provide rationale for public-private partnerships/collaborations in areas including funding, context and network generation. The collaboration of the government, universities and networks of firms or businesses is one such arrangement where university research activities are partly funded by private sector, while the government makes the necessary legal arrangements to facilitate this collaboration.

*Institutions*

Adopting North's (1990) demarcation between institutions and organizations, we define institutions as the rules of the game, consisting of both the formal legal rules and the informal social norms that govern individual behavior and structure social interactions. Organizations, by contrast, are defined as those groups of people and the governance arrangements they create to coordinate their team action against other teams performing also as organizations. Universities, professional associations, firms, clubs, unions are some examples. On the methodology development account, principles and criteria of institutional analysis show convergence. Williamson's (1975, 1985) view of institutions concentrates primarily on transaction costs and their role in mediating interaction between social

entities. North, on the other hand, takes Williamson's view one step further by moving beyond the transaction cost argument into evolving social attributes, such as conventions and roles that shape the meaning and importance of transaction costs. He underlines the importance of institutions as *regulatory* devises as well as devises that help *influence* transaction costs and uncertainty in exchange. In this framework, institutions are viewed as formal rules (constitutions, laws, property rights) as well as informal constraints (sanctions, customs, traditions, and codes of conduct) that structure political, economic and social interaction.

Studies in the literature on innovation systems draw attention to the roles that institutions play in the functioning of such systems. Following King, Gurbaxani, Kraemer, Raman and Yap (1994), the current study re-considers those roles from an information system perspective. Emphasis is given to regulatory and influence aspects of the institutions concerned. In line with Kimberly (1979), we define *regulation* as the direct or indirect intervention aimed to modify the behavior of organizations through formal sanctions or other affirmative means. We further define *influence* as the exerting of control over the practices, rules and belief systems of the organizations concerned. Education and socialization processes of individuals and the systematic articulation of particular points of view (e.g., propaganda) are examples of institutions through which influence can be exercised over organizations.
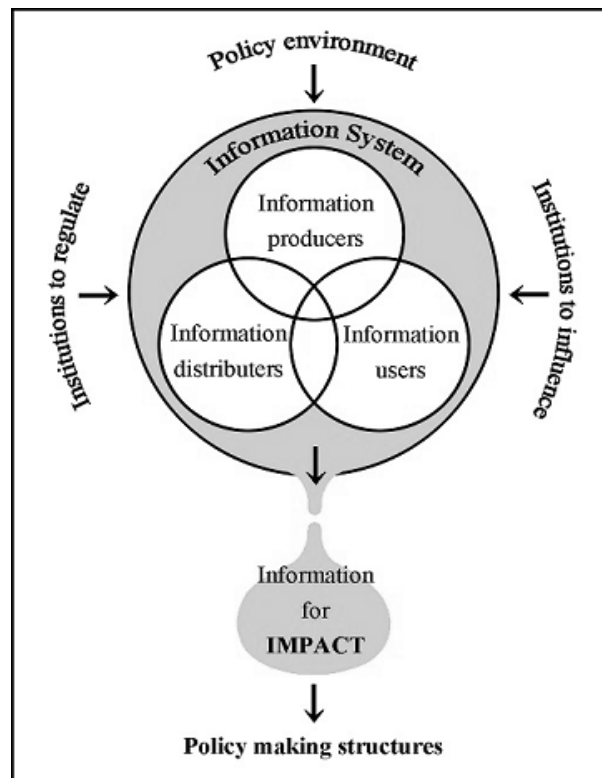
2.2    Institutional analysis of information system

For an information system to work adequately, the key elements of policy environment (**E**) need to reach a certain level of maturity. The first and foremost element is information policy and governance structure that refers to the existing legislative and regulatory framework for public and private providers and use of standards. The second is resources: financial resources for investment in the processes for the production, use and dissemination of the desired information; and human resources (i.e., adequately trained personnel) for management of information at different levels. The third is ICT policy and infrastructure for transfer and management or storage of information. The fourth element is coordination and leadership to effectively lead the information system (Lafond and Field, 2003).

The framework in **Figure 2** spells out the idea that, given **E**, regulatory and influence-creating institutional interventions simultaneously affect the form (i.e., pluralistic versus centralist, flexible versus rigid, formal versus informal) and the performance (i.e., depth, fluidity, efficiency and effectiveness of information) of the system in generating the information required for policy making. **Table 1** provides the content for the framework in **Figure 2**. In a broad sense, Braman (2011) defines information policy as a set of laws, regulations, and doctrinal positions - and other decision making and practices with society-wide constitutive effects - involving information creation, processing, flows, access, and use. Information policy is comprised of several fundamental issues, including intellectual property, economic regulations, freedom of expression, confidentiality of information, information security, access management, regulating the dissemination of public

information among others.[3] It is multi-disciplinary, including the information science, economics, law and public policy. Hence, its scope may differ depending on the disciple. For example, the information sciences may be more concerned with technical advances and their effects on information policy, while from a law perspective, issues such as privacy rights and intellectual property may be of greatest focus. From the economics perspective, rules and regulations that relate to information markets and the formation of value of information may take the front seat in policy research. Its scope may further differ with respect to the context. For example, in the context of health, information policy is the means by which public and private employees, institutions, and information systems adjust themselves to a changing environment and use information for decision-making.

**Figure 2**

A Framework for
Linking Institutions to Information for Policy Making



The design of a governance structure is also fundamental for establishing an enabling policy environment. With various responsibilities and roles, the government is a natural candidate to assume this task. Providing accurate information, producing and maintaining information that meets the specific needs of the public, protecting the privacy and confidentiality of personal and sensitive information, and making informed decisions on the dissemination and distribution of information are among others. In principle, policy governance makes sure that the policy implementation and enforcement mechanisms are in

---

[3] The reader is referred to Rowlands (1996) and Braman (2011) for exploring information policy with concepts, frameworks and tools to analyze it.

place to solve conflicts among information actors by adopting decisions, facilitating proper functioning of institutions and their acceptance by the public and exercising authority based on the traditions and institutions.

Information policy and policy governance structures should reflect upon characteristics of information. First of all, information is cumulative, and the degree of cumulativeness can be approximated by the complementarity between the existing stock of information and the flow of new information. Highly cumulative information would induce organizations to invest in the improvement of learning capacities, which would in turn pave the way for the internalization of information. Therefore, information policies should promote private investment in organizational capacity building. Moreover, complementarity can bring about free-riding problem if intellectual property rights are not established nor enforced. Good governance would then be desirable especially in areas where free-riding possibility is likely to arise. Second, information is fungible, and the degree of fungibility can be measured by the scope of possible applications of a given piece of information. Fungible information leads to increasing returns in the usage of the same stock of information and hence would also induce organizations to invest in the learning capacity development. Third, information is complex, and the degree of complexity can be measured by the variety of complementary unit of information used to generate a new unit. Complex information cultivates the will for cooperation in information exchange. Networking, for instance, emerges as an appropriate governance structure especially when information is collective and exhibits high levels of complexity and fungibility (Spulber, 1999; Antonelli, 2003). Information policy may then encourage networking through special incentives and guide its development by setting standards and requirements. Finally, information is sticky, and the degree of stickiness can be measured by the degree of embeddedness of information in human capital and routines. When information is highly sticky, information flow will be slow. Therefore, information policies aimed to speed up the flow should support the economy-wide growth of an information exchange and sharing culture, which will unavoidably influence individual organizations.

In **Table 1**, maps three groups of institutional interventions (denoted by $\mathbf{A}_i$, $i$=1,2,3) are mapped onto three kinds of information activities[4] – generation, dissemination and use of information (denoted respectively by $\mathbf{I}_i$, $i$=1,2,3) . In mathematical terms, the framework hypothesizes that, given **E**, institutional interventions determine the conduct of information activities:

$$\mathbf{I}_i = f(\mathbf{A}_i; \mathbf{E}) \quad \text{for} \quad i = 1,2,3$$

where $\mathbf{A}_1$ stands for the interventions listed in Cells I and IV; $\mathbf{A}_2$, those in Cells II and V; and $\mathbf{A}_3$, those in Cells III and VI. These interventions target the generation, dissemination and use of information through their effects on the information market, resource mobilization and public-private partnerships or collaborations. Regulatory arrangements – which are listed in Cell I – represent those requirements and standards that organizations are obliged to satisfy. Intellectual property rights and enforcement rules are the basic

---

[4] In this study, the terms "generation", "dissemination" and "use" are interchangeably used as "supply", "flow" and "demand", respectively.

elements of a legal structure to support the socially optimal investment in the information sector since this structure is to ensure the appropriation of returns to the investment made. Property rights would also accelerate information flow in the system because such rights are expected to increase the tradability of information (Cowan and Foray, 1997; Cowan, David and Foray, 2000). With weak property rights, secrecy would be practiced more substantially, and the assistance of information holders to perspective customers would be at risk. With strong property rights, however, the owners of information have a clear incentive to sell it to perspective customers, within the context of contracts which define properly the conditions of usage. Intellectual property rights should further be regarded as a signaling means. For example, patents help the identification of the available bits of complementary information and their owners so as to reduce search costs. An adequately working property rights system is fundamental to facilitate the interactions among holders of complementary information.

One can hardly deny socio-economic benefits that pluralistic and transparent information systems offer. However, the establishment and adequate performance of such systems is an outcome of complex interactions between formal and informal institutions. Formal rules can be adopted and put into effect in a short period of time but their society-wide acceptance and effective implementation calls for changes in the mind-set of citizens, and this takes long periods of time. Time inconsistency relating to the society-wide internalization of formal institutions, such as law of freedom of information, suggests that pluralism and transparency are not absolute principles. Their degree of acceptance strongly depends on the general education and literacy rates of the society concerned. As a result, the design of laws and regulations regarding pluralism and transparency in information systems should be coupled with investment plans for the improvement of literacy as well as the state of ICT infrastructure.

Regarding the dissemination of information, the establishment and enforcement of formal rules or protocols are necessary for governing media access or communication between public and private bodies. When the rules for governing media access to information do not exist or exist but poorly observed or reinforced, informal networking plays a critical role in accessing information. When the rules or protocols of communication between public and private organizations are not clearly established, the public organizations are excessively empowered due to asymmetries in information and tend to withhold information from being publicized. Understandably, national security, international relations and socio-economic stability constitute exemptions for freedom of information. The grey area between what is an exemption and what is not needs to be defined clearly; otherwise, power on the side of information holders can be misused. In this regard, setting transparency and self-censorship laws should resolve the issues related to classifying, publishing and managing information.

On the resource mobilization account, the goal of the interventions is first to establish a legal framework governing the funding and subsidy of information generation and dissemination activities. Arrangements in immigration laws to attract skilled labor to the ICT sector and setting standards for liability reduction in ICT investment are some of the institutional interventions that might be considered to support the information generation activities. The provision of information can also be promoted by the interventions governing public-private-partnership arrangements. For this, a regulatory framework is

necessary that governs the relations among the government bodies, entrepreneurs, universities, research organizations, private information providers and international organizations when they are engaged in partnership agreements. For example, for the creation and financing of information and knowledge centers, boards of directors of universities or research centers may include entrepreneurs representing perspectives of the business sector. This kind of intertwined relation between research and business sectors may offer a win-win situation for the targeted generation and use of information and knowledge. On the one hand, the perspective and expectations of the business sector will be reflected upon the universities' research programs; on the other, universities are very likely to receive financial support for producing the information and knowledge economically useful to the business sector. Similar partnerships can also be established by the government and NGOs in the generation and collection of market information.

The institutional interventions in Cell I set the legal framework with its specific regulations and laws, while the interventions in Cell IV bring the policy context to the fore. Legal rules for tax exemptions and subsidies are examples of the regulatory interventions setting the requirements for eligibility and the rules for implementation, whereas the levels of actual tax exemptions and subsidies represent the policy interventions that influence information activities. The regulatory interventions are forceful, while the policy interventions are suggestive or problem-solving. Promoting a culture that values information, supporting an economic and political environment where citizens and organizations can claim rights to produce and disseminate and have access to information, making resources available for professional or social networks to produce, disseminate and use information are only few examples of the policy interventions. The key institutions in **Table 1**, both regulatory and policy-oriented, are not exhaustive and can be extended at will depending on the context of the information system under investigation.

So far, we have only elaborated on selected institutional interventions which are most likely to affect information generation (i.e., those listed in Cells I and IV). The other interventions given in Cells II and V concern information dissemination activities and those in Cells III and VI are connected with information use activities. In spite of elaborating on those interventions one by one, we give a brief account of their critical implications for the workings of an information system. Consider, for example, those institutional interventions which are about effective information flow. Obviously, for the same reasons discussed above, property rights and principles of pluralism and transparency (like self-censorship) exert influence on the dissemination of information. Eligibility requirements for access to public resources, standards and protocols for access to and exchange of information, incentives and mechanisms to benefit from them (such as incentives for private investment in learning activities) and policy interventions to promote networking are only few examples of forceful and problem-solving institutional interventions that should enhance the fluidity of information.

Institutional interventions in Cells III and VI are bout the factors that affect information use or demand. The issue here is to identify salient characteristics of information demand. Regulatory elasticity of information demand, the role of networking in access to substitutable and complementary information, characteristics (mandate, resources, learning capacity, ethical and quality standards, etc.) of user organizations, standards and rules for

accessing to public and semi-public information sources, advocacy for context generation, special training and resource availability are among others.

## 2.3 Analysis of information flow[5]

With a set of $n$ components, $\mathbf{S} = \{S_i\}_{i=1}^{n}$ denotes an information system elaborated in Section 2.1.

$$\mathbf{S} = \begin{bmatrix} \mathbf{S_1} & S_{12} & . & . & . & S_{1n} \\ S_{21} & \mathbf{S_2} & . & . & . & S_{2n} \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ S_{n1} & S_{n2} & . & . & . & \mathbf{S_n} \end{bmatrix}.$$

Each component is placed in a diagonal cell in $\mathbf{S}$. Following clock-wise convention, information flow between any two components is represented by the off-diagonal cells, while that within a component is represented by the diagonal cells of $\mathbf{S}$. The term $S_{12}$ in the $1^{st}$ row – $2^{nd}$ column of $\mathbf{S}$ stands for the information flow from $S_1$ to $S_2$, while $S_{21}$ defines the flow in the opposite direction. Each off-diagonal cell in $\mathbf{S}$ represents a binary (i.e., one-to-one) flow of information between two components, meaning that the two components concerned are linked without any intermediary component(s). Therefore, $S_{12}$ is said to be a binary linkage between $S_1$ and $S_2$. The off-diagonal cells, $S_{12}$ and $S_{21}$, differ not only with respect to the direction of information flow but also the content of the information flowing. Obviously, the type of information $S_1$ makes available to the system cannot be the same as the type of information $S_2$ supplies to the system because each component comprises a group of comparable organizations. Following the same notation, one can denote within-component information flow (i.e., information loops), for example, by $S_{11}$ or $S_{22}$, etc. $S_{11}$ represents the information flow among the comparable organizations within $S_1$. Linkage between any two components can also be established indirectly through a pathway of interactions, like $S_1 \rightarrow S_3 \rightarrow S_4 \rightarrow S_2$ (denoted also by $S_1 S_3 S_4 S_2$). This is called a three-edge pathway of linkages.[6]

Binary coding of $\mathbf{S}$ – 0 for absence, 1 for presence of information flow – makes it easy to characterize the flow patterns in the system. Let $\mathbf{S}[c]$ denote an arbitrarily coded system:

---

[5] This section heavily draws on the methodologies developed by Temel (2004b) and Temel, Janssen, Karimov (2006).

[6] As discussed in Section 2.2, institutional interventions such as those shaping public-private collaborations and partnerships would affect the growth of linkages and interactions between individual organizations.

$$
\mathbf{S}[c] = \begin{bmatrix}
S_1 & 1 & 1 & 1 & . & . & . & 1 & 0 \\
1 & S_2 & 0 & 0 & . & . & . & 0 & 0 \\
0 & 1 & S_3 & 0 & . & . & . & 0 & 0 \\
0 & 0 & 0 & S_4 & . & . & . & 0 & 0 \\
. & . & . & . & . & . & . & . & . \\
. & . & . & . & . & . & . & . & . \\
. & . & . & . & . & . & . & . & . \\
0 & 0 & 0 & 1 & . & . & . & S_{n-1} & 0 \\
1 & 1 & 0 & 0 & . & . & . & 1 & S_n
\end{bmatrix}
$$

$\mathbf{S}[c]$ maps out binary information gaps, which are represented by 0's. Take, for example, $S_{1n}=0$ denoting the absence of information flow from $S_1$ to $S_n$. The reasons for this may be various, including the absence of interactions between organizations in components $S_1$ and $S_n$ or the absence of organizational human, financial and technical capacities or the intellectual ignorance of the linkages.[7] Whatever the reasons are, 0 reveals that information does not directly flow from $S_1$ to $S_n$. However, as shown in $\mathbf{S}[c]$, information flow takes place in the opposite direction denoted by $S_{n1}=1$, suggesting that the coded system at hand is not necessarily symmetric. An advantage of representing the system in a matrix format like $\mathbf{S}[c]$ is that pathways of information flow can be identified to fill the binary information gaps. For example, the binary information gap represented by $S_{n4}=0$ can be partially recovered by the information obtained from the pathway $S_n \rightarrow S_{n-1} \rightarrow S_4$ since $S_{n,n-1}=1$ and $S_{n-1,4}=1$. Similarly, the pathway $S_n \rightarrow S_2 \rightarrow S_1 \rightarrow S_4$ would also recover partial information on $S_{n4}$ as $S_{n2}=1$, $S_{21}=1$ and $S_{14}=1$.

$\mathbf{S}[c]$ is a format which can be used to identify critical qualitative research hypotheses to be investigated further. By construction, clock-wise flow of information in $\mathbf{S}$ implies that a component is likely to exert "influence" on another through the provision of information that is likely to benefit the receiver. In this connection, a binary path can be regarded as a simple causal relation (or simple hypothesis) to be tested. For example, $S_{14}=1$ suggests that component $S_1$ (exogenous) influences component $S_4$ (endogenous). $\mathbf{S}[c]$ can also be used to identify complex causal relations (or complex hypotheses) such as $S_1 \rightarrow S_3 \rightarrow S_2$ or $S_n \rightarrow S_1 \rightarrow S_3 \rightarrow S_2$.[8] The first step in deriving all the complex hypotheses contained in $\mathbf{S}[c]$ is to collect information on all the binary relations. Questionnaires, structured interviews with representatives of relevant organizations, and workshops for open discussion of binary linkages between components are among commonly applied methods to gather the required information. Below is a description of a workshop structure organized in such a way to gather that information.

---

[7] A pathway is said to be fully identified if all the binary paths defining it contain information. For example, $S_2 \ S_1 \ S_{n-1} \ S_4$ is fully identified as $S_{21}=1$, $S_{1,n-1}=1$ and $S_{n-1,4}=1$, while $S_1 \ S_3 \ S_2 \ S_4$ is not identified because $S_{24}=0$.

[8] The reader is referred to Temel (2004a) for the presentation and application of the method portrayed in what follows.

**S** has *n* components; therefore, we organize a workshop with *n* working groups (WG). Each WG is formed by randomly choosing one representative from each component. This way each component is fully and equally represented in all WGs. Representatives in WGs have 5 types of votes: a "high-value" vote which is worth of 5 points; an "above mediocre-value" vote, worth of 4 points; a "mediocre-value" vote, worth of 3 points; a "below mediocre-value" vote, worth of 2 points; and a "low-value" vote worth of 1 point. This multi-voting scheme allows the representatives to rank their preferences (utilities) over the binary causal information flow in **S**. Voting is actually over the "use-value" or "importance" of the information flow for the receiver.[9] The concept of "use value" refers to the utility of using or the want-satisfying power of the information. In this sense, a "high-value" vote of 5 points for the binary relation $S_{12}$ in **S** implies that data and information flowing from organizations in component **1** to those in **2** occupy an important place in the utility function of organizations in **2** (i.e., information receivers). It should be noted from the outset that voting is neither about the availability nor the actual flow of such information, but it is about the expected utility that organizations in component **2** can attaine from the use of such hypothetical information. Using **S**, each WG prepares a map of the causal relations that the WG thought to be critical. The resulting *n* maps are in turn consolidated. Finally, the WG members vote over the causal relations in the consolidated map by following the "expected utility principle." An important point that needs to be clarified is that the degree of "influence" of component **1** on component **2** is expressed in terms of "utility" that component **2** expects to obtain from the information coming from component **1**.

For illustrative purposes, suppose that such a workshop leads to the following system **S**[v]:

$$
S[v] =
\begin{bmatrix}
S_1 & 6 & 3 & 12 & . & . & . & 3 & . \\
9 & S_2 & . & . & . & . & . & . & . \\
. & 15 & S_3 & . & . & . & . & . & . \\
. & . & . & S_4 & . & . & . & . & . \\
. & . & . & . & . & . & . & . & . \\
. & . & . & . & . & . & . & . & . \\
. & . & . & . & . & . & . & . & . \\
. & . & . & 12 & . & . & . & S_{n-1} & . \\
9 & 12 & . & . & . & . & . & 9 & S_n
\end{bmatrix}
$$

where "dots" stand for zero. This system implies that $S_{14}$ placed in the 1st row-4th column received 12 points. Placed in the 3rd row-2nd column, $S_{32}$ received 15 points and occupied the top priority causal relation to be studied, followed by $S_{14}$, $S_{n-1,4}$ and $S_{n2}$ with 12 points each. By construction, **S**[v] has an underlying cause-effect structure in which *Cause* (C) of a component is defined as the sum of the points in the corresponding row; and *Effect* (E), as the sum of the points in the corresponding column. A component with a very high C and a very low E, denoted by C>>E, suggests that that component strongly dominates over other

---

[9] see Stigler (1961), Arrow (1986), Stiglitz (2000), Wolf, Zilberman, Wu and Just (2001) and Orna (2008) for a discussion of the issues that concern the determination of a monetary value or use-value (utility) of information.

components in the system. A component with a very low C and a very high E, denoted by $C \ll E$, suggests that that component is strongly subordinate. A component with $C=E$ suggests that that component is interactive. **Table 2** gives the $(C, E)$ coordinates of $\mathbf{S}[v]$. The structure of the $(C, E)$ coordinates in **Table 2** helps us uncover at least five hypotheses to be tested. First, with 30 points, $S_n$ is the *dominant source* of information, which is followed by $S_1$, $S_3$ and $S_{n-1}$. This means that component $n$'s information is expected to provide the maximum total utility with the rest of the system. Secondly, with 33 points, $S_2$ is the *subordinate user* of information, followed by $S_4$ and $S_1$. Thirdly, $S_{n-1}$ is the most *interactive* component with 12 points. The $(C, E)$ coordinates further reveal the hypotheses that $S_n$ is an exogenous component of $\mathbf{S}$, implied by $(C, E) = (30, 0)$ and that $S_4$ is an endogenous component of $\mathbf{S}$, implied by $(C, E) = (0, 24)$. In fact, one can continue to identify many more hypotheses using $\mathbf{S}[v]$. Some examples of complex hypotheses, for example, include $\{S_1 \rightarrow S_3 \rightarrow S_2, \quad S_n \rightarrow S_1 \rightarrow S_4, \quad S_n \rightarrow S_2 \rightarrow S_1, \quad S_3 \rightarrow S_2 \rightarrow S_1 \rightarrow S_4,$ $S_2 \rightarrow S_1 \rightarrow S_{n-1} \rightarrow S_4$, etc$\}$.

The identification of dominant and subordinate components has several implications for the design of policy and institutional interventions. Since the dominant component is by definition the main source of valuable information, the constraints and the needs of this component should be taken into account in the design of the interventions. Specifically, these interventions need to pave the way for this component not only to be more and more productive but also help improve its capacity to disseminate information in a useful format. In other words, the interventions should focus on the supply side factors. In the case of subordinate components, however, the interventions concerned should focus on the ways to enhance system information flow and capacity to learn from the available information. Removing barriers to information use and other demand side factors should occupy the top priority in the policy agenda.

### 2.4 Analysis of capacity-adjusted information flow and accumulation

### 2.4.1 The model

The processes of organizational learning and information dissemination capacity development are extensively studied from a variety of theoretical perspectives.[10] With a synthesis of definitions in the literature, we define *capacity to learn* ($\lambda$) at the organizational level as the ability to acquire new or modify existing or synthesize different types of information.[11] Learning may occur as part of education, personal development, schooling and training and may be aided by motivation or promotion. At the system level, we define learning as the capability of the system to acquire new information from its environment. Regarding dissemination capacity, there is also a large body of the literature offering alternative definitions. We define *capacity to disseminate* ($\delta$) as the ability of an organization to transform its own information into value for potential recipients and

---

[10] For a review of definitions of learning capacity, the reader is referred to Dodgson (1993), Lenox and King (2004), Zahra and George (2002), Bosch, Frans, Volberda and de Boer (1999), Lane and Lubatkin (1998), Cohen and Levinthal (1990); for definitions of dissemination capacity, see Szulanski (1996), Gupta and Govindarajan (2000), Martin and Salomon (2003), Parent, Roy and St-Jacques (2007), Joshi and Sarker (2007), Kuiken and Sijde (2011).

[11] For a review of the determinants of organizational learning, see Senge (1990) for the role of leadership, collaborative work culture and shared vision, Fiol and Lyles (1985) for strategy and learning, Berg v.d. and Sleegers (1996) for experimental mind-set and Marquardt (1996) for technology and structure.

communicate it to them. At the system level, we define dissemination capacity as the ability of the system to make information available to organizations in its immediate environment. Effective dissemination of information depends on the value of the provider's information stock, the motivation of the provider, the existence and variety of dissemination channels and mechanisms, the motivation and absorptive capacity of the recipient.

Learning and dissemination capacities are assumed to be influenced by three groups of factors: organizational characteristics ($\mathbf{V}_\lambda, \mathbf{V}_\delta$), macro-level institutions ($\mathbf{A}$) and features of policy environment ($\mathbf{E}$). At the organization level, given $\mathbf{A}$ and $\mathbf{E}$ – which indirectly set the direction for organizational capacity development activities – organizational capacity is expressed as:

$$\lambda = f_\lambda(\mathbf{V}_\lambda; \mathbf{A}, \mathbf{E}) \text{ and } \delta = f_\delta(\mathbf{V}_\delta; \mathbf{A}, \mathbf{E})$$

where $\mathbf{V}_\lambda$ represents factors that influence organizational learning capacity, including organizational culture of information sharing, professional learning and the creation of new ideas, organizational strategy for information acquisition, availability of resources (human, financial and technical) and investment in resource development; $\mathbf{V}_\delta$ stands for factors that influence organizational dissemination capacity, including the work culture of cross-organization information sharing, degree of connectedness with other organizations, strategy for information dissemination in general and for new information in particular and availability of resources (human, financial and technical) and investment in resource development. Macro-level institutional interventions also affect the organizational capacity building strategy and the associated activities. $\mathbf{A} = \{\mathbf{A}_i\}_{i=1}^{3}$ denotes the set of interventions that affect information activities listed in **Table 1**. $\mathbf{A}_1$ refers to the interventions that affect information supply; $\mathbf{A}_2$, information dissemination; and $\mathbf{A}_3$, information use. The third explanatory factor $\mathbf{E}$ representing the features of an enabling policy environment also affects the organizational capacity development strategy.[12] (The questionnaire in Annex II captures all the factors related to organizational learning and dissemination capacities.)

We model the *effective* information flow in $\mathbf{S}$ as an endogenous process, endogenous to organizational capacities:

$$\mathbf{I}_{t+1} = \mathbf{\Omega}\,\mathbf{I}_t \text{ where } \mathbf{\Omega} \equiv \mathbf{S}'\,\mathbf{C}(\delta, \lambda) \tag{1}$$

where $\mathbf{I}_{t+1} \equiv \begin{bmatrix} \mathrm{I}_{t+1}^1 \\ \mathrm{I}_{t+1}^2 \\ . \\ . \\ . \\ \mathrm{I}_{t+1}^n \end{bmatrix}$, $\mathbf{I}_t \equiv \begin{bmatrix} \mathrm{I}_t^1 \\ \mathrm{I}_t^2 \\ . \\ . \\ . \\ \mathrm{I}_t^n \end{bmatrix}$, $\mathbf{\Omega} = \begin{bmatrix} \Omega_{11} & \Omega_{12} & . & . & \Omega_{1n} \\ \Omega_{21} & \Omega_{22} & . & . & \Omega_{2n} \\ . & . & . & . & . \\ . & . & . & . & . \\ \Omega_{n1} & \Omega_{n2} & . & . & \Omega_{nn} \end{bmatrix}$, $\mathbf{S} = \begin{bmatrix} \mathrm{S}_{11} & \mathrm{S}_{12} & . & . & \mathrm{S}_{1n} \\ \mathrm{S}_{21} & \mathrm{S}_{22} & . & . & \mathrm{S}_{2n} \\ . & . & . & . & . \\ . & . & . & . & . \\ \mathrm{S}_{n1} & \mathrm{S}_{n2} & . & . & \mathrm{S}_{nn} \end{bmatrix}$

---

[12] Note that $\mathbf{V}_\lambda$ and $\mathbf{V}_\delta$ cover Type III and Type IV determinants of system performance, while $\mathbf{A}$ and $\mathbf{E}$ include Type I and Type II determinants discussed in Section 2.1.

$$\mathbf{C}(\delta,\lambda) = \begin{bmatrix} C(\delta_1,\lambda_1) & C(\delta_1,\lambda_2) & . & . & C(\delta_1,\lambda_n) \\ C(\delta_2,\lambda_1) & C(\delta_2,\lambda_2) & . & . & C(\delta_2,\lambda_n) \\ . & . & . & . & . \\ . & . & . & . & . \\ C(\delta_n,\lambda_1) & C(\delta_n,\lambda_2) & . & . & C(\delta_n,\lambda_n) \end{bmatrix} = \begin{bmatrix} C_{11} & C_{12} & . & . & C_{1n} \\ C_{21} & C_{22} & . & . & C_{2n} \\ . & . & . & . & . \\ . & . & . & . & . \\ C_{n1} & C_{n2} & . & . & C_{nn} \end{bmatrix}$$

$$\Omega = \begin{bmatrix} S_{11}C_{11}+S_{21}C_{21}+...+S_{n1}C_{n1} & S_{11}C_{12} + S_{21}C_{22} + ... + S_{n1}C_{n2} & . & . & S_{11}C_{1n} + S_{21}C_{2n} + ... + S_{n1}C_{nn} \\ S_{12}C_{11} + S_{22}C_{21} + ... + S_{n2}C_{n1} & S_{12}C_{12} + S_{22}C_{22} + ... + S_{n2}C_{n2} & . & . & S_{12}C_{1n} + S_{22}C_{2n} + ... + S_{n2}C_{nn} \\ . & . & . & . & . \\ . & . & . & . & . \\ S_{1n}C_{11} + S_{2n}C_{21} + ... + S_{nn}C_{n1} & S_{1n}C_{12} + S_{2n}C_{22} + ... + S_{nn}C_{n2} & . & . & S_{1n}C_{1n} + S_{2n}C_{2n} + ... + S_{nn}C_{nn} \end{bmatrix}$$

Eq. (1) describes the evolution of $\mathbf{I}_t$ by mapping $\mathbf{I}_t$ into $\mathbf{I}_{t+1}$ (see **Table 3** for the description of the elements of $\Omega$). $\mathbf{I}_{t+1}$ is a vector of component-level total expected utilities (or use-values) from the information accumulated within components at period t+1; $\mathbf{S}'$, the transpose of $\mathbf{S}$; and $\mathbf{C}(\delta,\lambda)$, the matrix of component-level capacity parameters. Since quantitative measurement of information is not possible, the concept of "utility" is employed to approximate the use-value of a piece of information. Hence, the element $S_{21}$ in $\mathbf{S}$, for example, refers to the utility of the information flowing from Component 2 to Component 1. Since Component 1 is the user of the information concerned, $S_{21}$ refers to the utility that Component 1 is expected to attain from the information supplied by Component 2. Accordingly, Component $i$'s total utility is defined as the sum of the elements in the $i^{th}$ column in $\mathbf{S}$.

The term $(S_{ij}C_{ij})$ for $i = j = 1,...,n$ defines the effective utility that Component $j$ obtains from the information disseminated by Component $i$. Applying the *Hadamard product* (also known as the *entry-wise product* and the *Schur product*) results in:

$$\mathbf{S}\text{o}\,\mathbf{C}(\delta,\lambda) = \begin{bmatrix} S_{11} & S_{12} & . & . & S_{1n} \\ S_{21} & S_{22} & . & . & S_{2n} \\ . & . & . & . & . \\ . & . & . & . & . \\ S_{n1} & S_{n2} & . & . & S_{nn} \end{bmatrix} \text{o} \begin{bmatrix} C_{11} & C_{12} & . & . & C_{1n} \\ C_{21} & C_{22} & . & . & C_{2n} \\ . & . & . & . & . \\ . & . & . & . & . \\ C_{n1} & C_{n2} & . & . & C_{nn} \end{bmatrix} = \begin{bmatrix} S_{11}C_{11} & S_{12}C_{12} & . & . & S_{1n}C_{1n} \\ S_{21}C_{21} & S_{22}C_{22} & . & . & S_{2n}C_{2n} \\ . & . & . & . & . \\ . & . & . & . & . \\ S_{n1}C_{n1} & S_{n2}C_{n2} & . & . & S_{nn}C_{nn} \end{bmatrix}.$$

The sum of the elements in column $i$ of $\mathbf{S}\text{o}\,\mathbf{C}(\delta,\lambda)$ represents the net total utility that Component $i$ gains from learning taking place within Component $i$ and the rest of the system. Likewise, the sum of the elements in row $i$ of $\mathbf{S}\text{o}\,\mathbf{C}(\delta,\lambda)$, except the first element, represents the net total utility that Component $i$ makes it available to the rest of the system. The difference between conventional matrix multiplication $\mathbf{S}'\mathbf{C}(\delta,\lambda)$ and the *Hadamard matrix product* $\mathbf{S}\text{o}\,\mathbf{C}(\delta,\lambda)$ should be noted. The former encompasses all the direct and

indirect utility *pathways*, while the latter considers *binary utility paths* only. The diagonal elements in $\mathbf{S}'\,\mathbf{C}(\delta,\lambda)$ correspond to column-wise sums of the elements in $\mathbf{S}\mathbf{o}\,\mathbf{C}(\delta,\lambda)$.

The crux of the idea elaborated in the present study is to link policy component of the information system to the information produced and disseminated by others in the system. The linkage needs to be effective in the sense that organizations comprising the policy component should have adequate learning capacity to internalize the available information. The diagonal elements of $\mathbf{\Omega}$ represent the total in-coming information (measured in terms of expected utility from it) to the component represented by the respective diagonal element. Let $\Omega_{11}$ stand for policy component. The elements in the $1^{st}$ column of $\mathbf{\Omega}$, excluding $\Omega_{11}$, represent the linkages through which information flows into the policy component. However, learning capacity of the organizations within the policy component and dissemination capacity of the organizations in the rest of the system determine the effective amount of information that would be accumulated in the policy component. Hence, the state of effective component-connectivity determines the "impact": the degree of linking information to the policy making component.

2.4.2   Estimation of average component capacities

The effective utility attained by Component *i* depends on the fluidity of information from other components in the system to Component *i*. The fluidity from component *j* to *i* depends on Component *i*'s learning capacity as well as Component *j*'s information dissemination capacity. To measure this fluidity, a matrix of composite indices, denoted by $\mathbf{C}(\delta,\lambda)$, is calculated using a geometric mean of the two sub-indices: one for learning ($\lambda$) and another for dissemination capacity ($\delta$).

Questionnaires, structured interviews and workshops are among commonly used means of collecting data and information for the measurement of the organizational learning and dissemination capacities. In this study we propose to use the questionnaire in **Annex B**, adopted from Dibbon (1999), to gather data for the approximation of the two sub-indices.

Each question in the questionnaire has five choices: weak (choice a) worth of 1 point, below-average (choice b) worth of 2 points, average (choice c) worth of 3 points, above-average (choice d) worth of 4 points and strong (choice e) worth of 5 points. The capacity represented by choice (a) is lower than that represented by choice (b); the capacity implied by choice (b) is lower than that implied by choice (c) and so on. This means that choice (e) reflects the maximum capacity activity. Since the questionnaire in Part 1 attempts to measure organizational learning capacity with 8 questions and each question has 5 choices ordered in a monotonically increasing-capacity manner, the maximum (minimum) score is 40 (8), which is the highest (lowest) observed value. In addition, the questionnaire in Part 2 intends to measure organizational dissemination capacity with 10 questions, and the maximum (minimum) score is 50 (10), which is the highest (lowest) observed value.

Having defined the minimum and maximum scores, the sub-indices for learning and dissemination capacities are calculated as follows:[13]

$$\lambda = \left( \frac{\text{actual learning score - minimum learning score}}{\text{maximum learning score - minimum learning score}} \right)$$

$$\delta = \left( \frac{\text{actual dissemination score - minimum dissemination score}}{\text{maximum dissemination score - minimum dissemination score}} \right)$$

Using the geometric mean[14] of these sub-indices,

$$\mathbf{C}_{ij} \equiv \mathbf{C}(\delta_i, \lambda_j) = \delta_i^{0.5} \lambda_j^{0.5} \text{ for } i = j = 1,...,n,$$

we define the matrix of information flow indices as:

$$\mathbf{C}(\delta, \lambda) = \begin{bmatrix} \delta_1^{0.5}\lambda_1^{0.5} & \delta_1^{0.5}\lambda_2^{0.5} & . & . & \delta_1^{0.5}\lambda_n^{0.5} \\ \delta_2^{0.5}\lambda_1^{0.5} & \delta_2^{0.5}\lambda_2^{0.5} & . & . & \delta_2^{0.5}\lambda_n^{0.5} \\ . & . & . & . & . \\ . & . & . & . & . \\ \delta_n^{0.5}\lambda_1^{0.5} & \delta_n^{0.5}\lambda_2^{0.5} & . & . & \delta_n^{0.5}\lambda_n^{0.5} \end{bmatrix}.$$

The estimation of this matrix offers at least three advantages. First, the areas with poor information flow can be projected, and this would allow policy/decision makers to take measures to release the constraints on the areas concerned before policies/decisions are implemented. Second, the effective information flow can be projected with the identification of dominant and sub-ordinate components in the system. Specific policies/programs and institutions can target the dominant sources (i.e., components) and subordinate users of critical information. Third, the estimated matrix together with the underlying institutional structure can provide us with information on the type of the system: flexible versus rigid. A system is said to be flexible (rigid) if the organizational capacities

---

[13] The data are gathered from each stakeholder organization using the questionnaire in Annex B. Since each component consists of several stakeholder organizations, the capacity score for one component refers to the average of the capacity scores of all the organizations in that component.

[14] The geometric mean can give a meaningful "average" to compare two organizations which are each rated at 0 to 5 for their learning capacity, and are rated at 0 to 10 for their dissemination capacity. If an arithmetic mean was used instead of a geometric mean, the dissemination capacity is given more weight because its numeric range is larger- so a small percentage change in the dissemination capacity rating (e.g. going from 8 to 10) makes a much larger difference in the arithmetic mean than a large percentage change in learning capacity rating (e.g. going from 2 to 5). The use of a geometric mean "normalizes" the ranges being averaged, so that no range dominates the weighting, and a given percentage change in any of the capacity ratings has the same effect on the geometric mean. So, a 20% change in learning capacity from 4 to 4.8 has the same effect on the geometric mean as a 20% change in financial viability from 6 to 7.2. Although our questionnaires have the identical rating of learning and dissemination capacities, both are rated at 1 to 5, it is important to keep in mind the distinction between the arithmetic and geometric means. The geometric mean of $n$ number is calculated as $G_x = \sqrt[n]{x_1 x_2 ... x_n}$ and hence $\log G_x = (1/n)\sum_{i=1}^{n} \log x_i$. That is, the log of the geometric mean is the arithmetic mean of the logs of the numbers.

are highly developed (undeveloped) and institutions such as property rights and enforcement rules are in place (at embryonic stage). Flexible systems should promote public, private and public-private partnership investments to improve the learning and dissemination capacities through regulatory institutions such as intellectual property rights and enforcement rules. These institutions ensure the appropriation of the benefits of the private investment in the information sector, and hence the socially optimal information generation.

### 2.4.3 Estimation of capacity-adjusted information flow

For illustrative purposes, we set arbitrary pairs of capacity index values as: $\{\delta_1, \lambda_1\}=\{0.6, 0.7\}$, $\{\delta_2, \lambda_2\}=\{0.4, 0.8\}$, $\{\delta_3, \lambda_3\}=\{0.7, 0.5\}$, $\{\delta_4, \lambda_4\}=\{0.7, 0.3\}$, $\{\delta_{n-1}, \lambda_{n-1}\}=\{0.4, 0.4\}$, and $\{\delta_n, \lambda_n\}=\{0.9, 0.7\}$. This yields the following information flow matrix:

$$
\mathbf{C}(\delta,\lambda) = \begin{bmatrix}
\mathbf{0.65} & 0.69 & 0.55 & 0.42 & . & . & . & 0.49 & . \\
0.53 & \mathbf{0.57} & . & . & . & . & . & . & . \\
. & 0.75 & \mathbf{0.59} & . & . & . & . & . & . \\
. & . & . & \mathbf{0.46} & . & . & . & . & . \\
. & . & . & . & . & . & . & . & . \\
. & . & . & . & . & . & . & . & . \\
. & . & . & . & . & . & . & . & . \\
. & . & . & 0.35 & . & . & . & \mathbf{0.40} & . \\
0.79 & 0.85 & . & . & . & . & . & 0.60 & \mathbf{0.79}
\end{bmatrix}.
$$

In order to calculate $\mathbf{\Omega}$, the diagonal elements of $\mathbf{S'}$ need to take numerical values. A diagonal element defines the utility that a component expects to attain from the information produced by individual organizations that belong to that component. Utility is a measure of the degree to which the information generated serves the needs of the intended users. The utility is in fact the average expected utility over the assessment of individual user organizations in that component. An arbitrary array $\{\mathbf{S_1}, \mathbf{S_2}, \mathbf{S_3}, \mathbf{S_4}, ..., \mathbf{S_{n-1}}, \mathbf{S_n}\}=\{12, 20, 5, 16, ..., 12, 16\}$ of components' assessments of their own utility is placed in the diagonal elements of $\mathbf{S'}$, which yields:

$$
\mathbf{\Omega} = \begin{bmatrix}
\mathbf{20} & 21 & 7 & 5 & . & . & . & 11 & 7 \\
24 & \mathbf{37} & 12 & 3 & . & . & . & 10 & 10 \\
2 & 6 & \mathbf{5} & 1 & . & . & . & 1 & . \\
8 & 8 & 7 & \mathbf{17} & . & . & . & 11 & . \\
. & . & . & . & . & . & . & . & . \\
. & . & . & . & . & . & . & . & . \\
. & . & . & . & . & . & . & . & . \\
9 & 10 & 2 & 5 & . & . & . & \mathbf{12} & 7 \\
13 & 14 & . & . & . & . & . & 10 & \mathbf{13}
\end{bmatrix}
$$

A comparison of the capacity-adjusted (C-E) structure of $\mathbf{\Omega}$ with that of $\mathbf{S}[v]$ shows that accounting for the organizational capacities results in a completely different structure. As shown in **Table 2**, for example, $S_1$, which is dominant under $\mathbf{S}[v]$, becomes a strongly interactive component in $\mathbf{\Omega}$; $S_3$, which is dominant under $\mathbf{S}[v]$, becomes subordinate in $\mathbf{\Omega}$, and so on.

## 3    Summing up: Roadmap for Qualitative Analysis of Information System

*Linkages with the SCP approach*

Reflecting upon the three complementary methods of analysis that we have developed in Sections 2.2, 2.3 and 2.4, we propose a roadmap for qualitative analysis of information system. This map puts the assessment in perspective (see **Table 4**). First, the methods are separately used to characterize the system in terms of institutional factors, system structure factors such as organizational linkages and information flow patterns, and system capacity factors. Second, all these different factors are reorganized around three dimensions – structure, conduct and performance of the system. Finally, various indicators are derived for the assessment of system performance.

Traditional structure-conduct-performance (SCP) approach assumes that the performance of an information system depends on the conduct of organizations in its immediate domain, which then depends on the system structure. It dictates three steps in analyzing an information system. First, it stresses properly characterizing system structure according to (*a*) the number of active organizations (or stakeholders or actors), (*b*) institutions (that is, rules of the game) concerning the participation of organizations in information activities and (*c*) the extent of standardization of information products. Second, it underlines that certain organizational strategies and decisions (conduct) with respect to information production and distribution are driven by system structure. Finally, it suggests that the conduct of organizations determines the optimal level and type of information to be produced given the system goal. Specifically, the approach seeks to find the answer to: (i) how organizations interact and compete with each other in different situations, (ii) the results of these interactions and (iii) do these results lead to an optimal system performance. That way, an argument can be supported on whether or not action should be taken to alter the system structure or influence system conduct.

Basic hypothesis of the traditional SCP approach treats system structure as an exogenous (explanatory) and performance as an endogenous (dependent) factor. It suggests a linear relationship from structure to conduct and then to performance. However, in reality, the relationship is more complex and shows non-linearity because system structure itself is likely to be affected by organizations' conduct and by system performance through feedback mechanisms. **Table 4** lists the key issues that fall within the reach of the three methods and associate them with the structure and conduct dimensions of the SCP approach. Our framework assumes a non-linear relationship between system structure and performance.[15] Take, for example, the institutional analysis method developed in Section 2.2. This analysis should address the key issues listed in the first row of **Table 4**, but these

---

[15] The reader is referred to Kizito (2011) for a through analysis of market information systems applying the structure-conduct-performance approach.

issues are mixed and have implications for both system structure and conduct at the macro level. Examples of the key issues to be studied include policy environment (information and supporting policies), regulations and standards for information activities, enforcement, infrastructure, resources, incentives and networking. Obviously, the issues concerned simultaneously have both direct and indirect effects on system structure as well as conduct at the macro level. Likewise, the 2$^{nd}$ row in **Table 4** lists the key issues that can be examined by the linkage analysis method developed in Section 2.3. Again, the issues of concern have implications for both system structure and conduct, but this time, the implications are examined at the meso-level. Furthermore, the 3$^{rd}$ row in **Table 4** lists the key issues that should be examined by the capacity analysis method developed in Section 2.4. The issues concerned have implications for organizational conduct. All together, the issues given in **Table 4** directly or indirectly affect system performance.

As is shown in Figure 1 and detailed in **Table 4**, our point of departure from the traditional SCP approach can be summarized in two assertions. First, the relationship between structure, conduct and performance is non-linear, capturing the effects of feedback mechanisms. Second, the relationship needs to be explored separately at the macro, meso and organizational levels as each level of analysis has its own peculiarity in the assessment of system performance.

*Operationalization: indicators for measurement*

A very important issue that warrants special attention is the operationalization of the methodology. To achieve it, we use three terms consistently: goal, impact and indicator. *Goal* is a broad statement of the ultimate target of the system. *Impact* is the degree the system channels information to the areas needed most. *Indicator* is the specific, measurable information collected to track whether an impact has actually occurred. We need to construct a series of indicators that relate to the determinants of: (1) system *goal*, including socioeconomic, structural and behavioral determinants or risk factors, resources used in the production, distribution and use of information, (2) component *linkages*, including structural and behavioral determinants such as strategic decisions, networking and motivations; (3) organizational *capacities*, including motivations, resource use decisions, networking or collaboration strategies. These relations can be specified as:

$$g = \mathbf{F}(x) \quad \text{and} \quad x = \mathbf{M}(y) \implies g = \mathbf{F}(\mathbf{M}(y))$$

where *g* is a vector of targets, including system goal, component linkages and organizational capacities; *x*, a vector of the determinants of the targets; and *y*, a vector of the indicators with direct effects on the determinants of the targets. **Table 4** provides a list of critical determinants (*x*) and factors that can be used in the specification of the relevant indicators (*y*).

In our case, system performance does not have a one-to-one relation with impact. The reason is that system performance is measured by the degree of system's generation and dissemination of quality and timely information products, whereas the impact is measured by the degree of "linking the quality and timely information products with policy making." The system may perform adequately, in spite of low impact due to policy making structures' poor capacity in absorbing the available information. To measure the impact, we need to identify its characteristics as a way of deriving possible indicators. For example,

the characteristics of "increased use of the quality and timely information by policy making structures" could include: (i) the increased use of quality and timely information products, such as scientific (applied or theoretical) research findings, in the processes of decision making or designing policy interventions, (ii) the number and percent of public bodies who use quality and timely information this year as compared to last year, and (iii) an increase in the number of information sources and users aiming to generate the desired information on policy oriented issues.

The last element that deserves significant attention is to characterize the information and organizational linkages. To do so, we should gather data on the following questions (see WHO, 2006) and use it in the construction of $S[v]$, which is the basic input for the operationalization of the methodology.

1) <u>What is the context and structure of information system?</u>
- Type, level and frequency of information collected and reported
- Producers of information
- Disseminators of information
- Users of information

2) <u>Are information quality-check and flow procedures standardized?</u>
- Information classifications and flow procedures
- Information quality control mechanisms

3) <u>What is the quality of organizational linkages?</u>
- Level of cross-organization dialog
- Level of cross-organization sharing of information
- Status of laws organizing information flow
- Cross-organization coordination of work to avoid duplication of efforts
- Degree that different organizations use the same standards for quality assurance
- Degree that all organizations use a standardized coding for information means, mechanisms and resources

4) <u>What is the quality of information collection?</u>
- Is there a gap between when information is collected and when it becomes available to a higher level or is published? (Timelinees)
- To what extent information adequately respond to the needs of the relevant stakeholders? (Representation)
- Is information classified by sub-issues of the overall system goal? (Disaggregation)
- Do revisions follow a regular, well-established and transparent schedule and process? (Consistency and transparency of revisions)
- To what extent practices are in accordance with guidelines and standards for storage, backup, transport of information and retrieval? (Confidentiality, information security, and information access)

# 4  Conclusions

This study develops a methodology for a qualitative assessment of information system. On the conceptual account, three methods are proposed to analyze the effects of institutional interventions, information flow patterns and organizational capacities on information activities. On the operational account, the structure-conduct-performance approach is adopted to organize the system characteristics that are identified by the three methods around system structure, conduct and performance. This way, the three methods and the associated system assessment issues are mapped onto the structure, conduct and performance dimensions, providing a fully operational roadmap for a through analysis of information systems.

The methodology developed needs to be further refined to overcome four weaknesses. The first weakness is that it deals with information, the value of which is both context and organization (or person)-specific. Therefore, the concept of "use-value", which refers to the utility attained from a piece of information, is used to standardize what is flowing in the system so that it can be measured. However, this utility does not remain fixed over time even for the same organization as the organizational objective function evolves over time with changing emphasis on different types of information at different time periods, not to mention the effects of changing skilled staff on the organizational valuation of the information. As a result, the same piece of information is highly likely to have different values for the same organization in different periods.

The second is that the flow of new information is intrinsically blocked if no intellectual property rights system exists that ensures the appropriation of the benefits by the producer of the new information, which then hinders the socially optimal production of new information. Therefore, public interventions such as subsidies and tax exemptions are necessary to promote the production and flow of the specific new information desirable by the government. This makes the government an indispensable actor in information system both a regulator of the system and the producer/user/disseminator of the new information. A principle-agent problem arises naturally, which may hamper the participation of private actors/organizations in the information system. The problem is to organize the actors of information system around a common system goal, as well as organizing groups of similar organizations around component-level goals which are in line with the common system goal. However, there must be a commitment technology to ensure that organizations do not change their goals arbitrarily.

The third is that the assessment of the strength of linkages and fluidity of information between any two organizations requires not only the use of comparable means and mechanisms in information exchange but also the presence of context and skilled human resources. The main reason is that people's skills in creating information and knowledge differ across organizations. This constraint can partially be removed if different organizations are compared with respect to the skills of their staff and resources available for information dissemination. Our methodology develops a questionnaire to measure organizational dissemination capacity, which can also be used as a proxy for the linkage capacity of the organization concerned. The problem, however, is that high level of linkage capacity does not ensure the presence of the linkage concerned unless and until the relevant

organizations get in touch with each other for actual information exchange. This brings the context generation issue to the fore in discussions about linking organizations.

The fourth weakness relates the structure-conduct-performance paradigm. Performance is relative, requiring a benchmark (reference) situation with which the information system under consideration can be compared. Setting a benchmark performance calls for the development of specific performance indicators to be organized around a system goal, which itself depends on the changing needs of information users. Therefore, it is quite demanding to develop quantitatively testable hypotheses. In addition, intertwined interactions among system structure, conduct and performance further complicate the development of valid testable hypotheses.

The current study is conceptual, but we are in the process of gathering information on the food security information systems (FSISs) in Tajikistan and Kyrgyzstan. With the application of the methodology, we will be able to examine the structure, conduct and performance of the FSISs concerned, and hence be able to give a comparative picture of the evolution of the FSISs in these countries. Given the fact that, informed decision making in food security policy is a top priority in the agenda of both donors and developing country policy makers, an addition to the tool box of information system analysts should be viewed as an important contribution to the literature.

# References

[1]     Ackoff, R.L. (1989). From data to wisdom. *Journal of Applied Systems Analysis, 16*, 3-9.

[2]     Ahsan, S., Shah, A. (2006). Data, information, knowledge, wisdom: A doubly linked chain? In the proceedings of the 2006 international conference on information knowledge engineering, 270-278.

[3]     Aldridge, K. M. (1992). A framework for analyzing alternative institutional arrangements for the cereals market information system in Mali. Michigan State University.

[4]     Antonelli, C. (2003). Knowledge complementarity and fungeability: Implications for regional strategy. *Regional Studies, 37,* 595–606.

[5]     Arrow, J.K. (1986). The value of and demand for information. In McGuire, C.B., and Radner, R. (Eds.), *Decision and organization* (2nd ed.). Minnesota, Mpls: University of Minnesota Press.

[6]     Aqil, A., Lippeveld, T., Hozumi, D. (2009). PRISM framework: A paradigm shift for designing, strengthening and evaluating routine health information systems. *Health Policy Plan, 24(3)*, 217-228.

[7]     Awad, M.A., Ghaziri. H.M. (2004). *Knowledge management*. Upper Saddle River, USA: Pearson Education International.

[8]     Bellinger, G., Casstro, D., Mills, A. (2012). Date, information, knowledge, and wisdom. http://www.outsights.com/systems/dikw/dikw.htm accessed 06 October 2012.

[9]     Berg, v.d. R., Sleegers, P. (1996). Building innovative capacity and leadership. In K. Leithwood, J. Chapman, D. Corson, P. Hallinger & A. Hart (Eds.), *International Handbook of Educational Leadership and Administration. Vol. 1, Part 2,* 653-699. Netherlands: Kluwer Academic Publishers.

[10]   Bosch, v.d. F.A.J., Volberda, H.W., de Boer, M. (1999). Co-evolution of firm absorptive capacity and knowledge environment: Organizational forms and combinative capabilities. *Organization Science, 10(5)*, 551-568.

[11]   Braman, S. (2011). Defining information policy. *Journal of Information Policy*, 1-5. http://jip.vmhost.psu.edu/ojs/index.php/jip/article/view/19/14 accessed 06 October 2012.

[12]   Caves, E. R. (1992). *American industry; Structure, conduct and performance*: Harvard University, Prentice Hall.

[13]   Cohen, W.M., Levinthal, D.A. (1990). Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly, 35(1)*, 128-152.

[14]   Connor, S. J., Thomson, M. C., Flasse, S. P., Perryman, A. H. (1998). Environmental information systems in malaria risk mapping and epidemic forecasting. *Disasters*, *22(1)*, 39-56.

[15] Cowan, R., David, P. A., Foray, D. (2000). The explicit economics of knowledge codification and tacitness. *Industrial and Corporate Change*, *9*, 211–253.

[16] Cowan, R., Foray, D. (1997). The economics of codification and the diffusion of knowledge. *Industrial and Corporate Change*, *6*, 595–622.

[17] Development Coordination Council (DCC). (2011). Food security stakeholders in Tajikistan. (unpublished)

[18] Diarra, S., Traoré, A., Staatz, J. M. (2004). Developing sustainable agricultural information services: Lessons from Mali. East Lansing. Michigan State University.

[19] Dibbon, D.C. (1999). Assessing the organizational learning capacity of schools. (Unpublished Ph.D. dissertation). Toronto, Canada: Department of theory and policy studies in education, Ontario Institute for Studies in Education of the University of Toronto.

[20] Dodgson, M. (1993). Organizational learning: A review of some literature. *Organizational Studies*, *14(3),* 375-394.

[21] FAO. (2000). *Handbook for defining and setting up a food security information and early warning system*. Rome, Italy.

[22] FAO. (2011). Enhancing market transparency: Agricultural market information system. AMIS inception meeting, September 2011. Rome, Italy.

[23] FAO. (2012). An FAO e-mail conference on agricultural innovation systems and family farming. Rome, Italy

[24] Fiol, C.M., Lyles, M.A. (1985). Organizational learning. *Academy of Management Review*, 10, 803-813.

[25] Gallup, S.D., Dattero, R., Hicks, R.C. (2002). Knowledge management systems: an architecture for active and passive knowledge. *Information Resource Management Journal*, *15(1),* 22-7.

[26] Gupta, A.K., Govindarajan, V. (2000). Knowledge flows within multinational corporations. *Strategic Management Journal, 21*, 473-496.

[27] Joshi, K.D., Sarker, S. (2007). Knowledge transfer within information systems development teams: Examining the role of knowledge source attributes. *Decision Support Systems, 43*, 322-335.

[28] Kimberly, J.R. (1979). Issues in the creation of organizations: Initiation, innovation and institutionalization. *Academy of Management Journal, 22*, 437-457.

[29] King, J.L. (1993). Editorial notes. *Information Systems Research, 4(4),* 291-298.

[30] King, J.L., Gurbaxani, V., Kraemer, K.L., McFarlan, F.W., Raman, K.S., Yap, C.S. (1994). Institutional factors in information technology. *Information Systems Research*, 5(2).

[31] Kizito, A. (2008). Structure-conduct-performance and food security. FEWS NET Markets Guidance, No. 2. Washinton D.C., USA: USAID.

[32] Kizito, A. M. (2011). The structure, conduct and performance of agricultural market information systems in Sub-Saharan Africa (Unpublished Ph.D. thesis). Michigan State University, Agricultural, Food, and Resource Economics. Michigan, USA.

[33] Kuiken, J., van der Sijde, P. (2011). Knowledge transfer and disseminative capacity: A review and propositions for further research on academic knowledge transfer. (Unpublished manuscript). Amsterdam, The Netherlands: Faculty of social sciences, department of organization science, VU University Amsterdam.

[34] Lafond, A., Field, R. (2003). *The PRISM. Introducing an analytical framework for understanding performance of routine health information system* (draft). RHINO Second International Workshop, September 20–October 4, Eastern Cape, South Africa

[35] Lane, P.J., Lubatkin, M. (1998). Relative absorptive capacity and inter-organizational learning. *Strategic Management Journal*, *19(5)*, 461-477.

[36] Lenox, M., King, A. (2004). Prospects for developing absorptive capacity through internal information provision. *Strategic Management Journal*, *25(4)*, 331-345.

[37] Lippeveld, T., Sauerborn, R., Bodart, C. (2000). *Design and implementation of health information systems*. Geneva: World Health Organization.

[38] Martin, X.Y.F., Salomon, R. (2003). Knowledge transfer capacity its implications for the theory of multi-national corporation. *Journal of International Business Studies*, *34(4)*, 356-373.

[39] Marquardt, M. (1996). *Building the learning organization.* New York: McGraw-Hill.

[40] Nonaka, I., Takuchi, H. (1995). *The knowledge-creating company: How Japanese companies create the dynamics of innovation*. New York, USA: Oxford University Press.

[41] North, D.C. (1990). *Institutional structure and institutional change*. New York, USA: Cambridge University Press.

[42] OECD. (1997). *National innovation systems*. Paris, France: OECD

[43] OECD. (1999). *Managing national innovation systems*. Paris, France: OECD.

[44] OECD. (2011). Conference on Agricultural Knowledge Systems (AKS): Responding to Global Food Security and Climate Change Challenges. June 15-17, OECD Conference Centre, Paris, France

[45] Orna, E. (2008). Information policies: Yesterday, today, tomorrow. *Journal of Information Science*, *34(4),* 547–565.

[46] Pan American Health Organization. (1998). *Information systems and information technology in health – challenges and solutions for Latin America and the Caribbean*. Washington, DC, Pan American Health Organization.

[47] Parent, R., Roy, M., St. Jacques, D. (2007). A systems-based dynamic knowledge transfer capacity model. *Journal of Knowledge Management*, *11(6)*, 81-93.

[48] Rowlands, I. (1996). Understanding information policy: Concepts, Frameworks, and Research Tools. *Journal of Information Science*, *22(1)*, 13-25.

[49] Senge, P. (1990). The leader's new work: Building a learning organization. *Sloan Management Review*, *32(1),* 7-23.

[50] Shepherd, A. W. (1997). Market information services - theory and practices. Rome, Food and Agriculture Organization of the United Nations.

[51] Spulber, Daniel F. (1999). *Market Microstructure: Intermediaries and the Theory of the Firm*. Cambridge: Cambridge University Press.

[52] Staatz, J. M., et al. (2010). Pathways from improved market information to better market performance: Implications for the evaluation of investments in agricultural market information systems.

[53] Stigler, G. J. (1961). The Economics of Information. *Journal of Political Economy 69(30),* 213-225.

[54] Stiglitz, J.E. (2000). The contributions of the economics of information to twentieth century economics. *Quarterly Journal of Economics*, 1441-1478.

[55] Szulanski, G. (1996). Exploring internal stickiness: impediments to the transfer of best practice within the firm. *Strategic Management Journal, 17*, 27-43.

[56] Temel, T. (2006). Systems information management: Graph-theoretical approach. *International Journal of Computer Applications in Technology, 25(1)*, 15-21.

[57] Temel, T. (2004a). A method for cross-sector priority setting: Gaps and hypotheses in malaria research -Tanzania. *European Journal of Health Economics, 5(4),* 317-323.

[58] Temel, T. (2004b). Mapping organizational linkages in the agricultural innovation system of Azerbaijan. *International Journal of Agricultural Resources, Governance, and Ecology*, *3(1/2)*, 134-153.

[59] Williamson, O.E. (1975). *Markets and hierarchies*. New York, USA: The Free Press.

[60] Williamson, O.E. (1985). *The economic institutions of capitalism*. New York, USA: The Free Press.

[61] Wolf, S., Zilberman, D., Wu, S., Just, D. (2001). Institutional relations in agricultural information systems. In Wolf, S., and Zilberman, D. (eds.). *Knowledge generation and technical change: Institutional innovation in agriculture*. Boston, USA: Kluwer Academic Publishers.

[62] WB. (2012). *Agricultural innovation systems: An investment sourcebook*. Washington D.C., USA: World Bank

[63] WHO. (2008). Framework and standards for country health information systems - Health Metrics Network, WHO (accessed October 16, 2012) http://www.who.int/healthmetrics/documents/hmn_framework200803.pdf accessed 25 September 2012.

[64] WHO. (2006). *Strengthening country health information systems: Assessment and monitoring tool*. Geneva: Health Metrics Network.

[65] Zahra, S. A., George, G. (2002). Absorptive capacity: A review, re-conceptualization, and extension. *Academy of Management Review*, *27(2),* 185-203.

| | | **Policy Environment** | | |
|---|---|---|---|---|
| | | Information Policy encompasses laws, regulations, and doctrinal positions – and other decision making and practices with society-wide constitutive effects – involving information creation, processing, flows, access, and use. Policy Governance (achieve what the policy should and avoid unacceptable situations): solve conflicts between information agents (producers, intermediaries and users) and adopt decisions (legality); facilitate proper functioning of information-related institutions and their acceptance by the public (legitimacy); and exercise authority based on the information-related traditions and institutions (enforcement) | | |
| | | **Information System (S)** | | |
| | | Information Generation (Supply) – ($I_1$) | Information Dissemination (Flow) – ($I_2$) | Information Use (Demand) – ($I_3$) |
| **Institutional Interventions to** | Regulate | <u>Market Developments</u><br>• Introduce intellectual private property rights<br>• Establish enforcement rules for contractual agreements<br>• Set rules to support pluralistic and transparent information generation<br><br><u>Resource Mobilization</u><br>• Establish requirements for funding and subsidizing<br>• Arrange immigration laws to attract skilled labor to ICT sector<br>• Set standards for liability reduction in ICT investment<br><br><u>Public-Private Collaboration</u><br>• Ensure compliance with jointly-developed quality control methods and mechanisms<br>• Set requirements for partnerships in investment and national-international collaboration<br><br>**I** | <u>Market Developments</u><br>• Introduce intellectual private property rights<br>• Establish rules and ensure quality standards for the dissemination of reliable information<br>• Enforce compliance with info dissemination contracts<br>• Set rules for pluralistic and transparent information flow<br><br><u>Resource Mobilization</u><br>• Establish requirements for access to public resources (human/financial/IT) to improve information flow<br><br><u>Public-Private Communication</u><br>• Establish standards in database access/data transfer formats<br>• Set formal mechanisms and standards for joint exchange/ dissemination of timely, efficient and effective information<br>• Introduce rules for pluralistic information dissemination/ exchange such as free media and the press<br><br>**II** | <u>Market Developments</u><br>• Introduce ethical and quality standards for information use<br>• Introduce enforcement rules to ensure quality standards, resolve conflicts and promote transparent use of information<br>• Introduce standards/mechanisms for the use of public/semi-public databases and information sources (i.e. use of libraries or specialized information banks)<br><br><u>Resource Mobilization</u><br>• Establish requirements for funding advocacy for use of information in decision making<br><br><u>Public-Private Collaboration</u><br>• Require standards/mechanisms for joint use information<br>• Require compliance with jointly-developed mechanisms to reach out information users<br><br>**III** |
| | Influence | **IV**<br><u>Market Developments</u><br>• Promote pluralistic and transparent information generation and strengthen trust among organizations<br><br><u>Resource Mobilization</u><br>• Provide subsidy, tax benefits and loans for investment<br>• Provide resources (human/financial/IT) for standardization<br>• Provide education/training to improve capacity for learning-by-generating information<br>• Subsidize direct/indirect provision of complementary information<br><br><u>Public-Private Collaboration</u><br>• Support formal and informal networks for scaling up information provision via resource sharing, partnerships and joint activities<br>• Support funding for joint programs for info generation | **V**<br><u>Market Developments</u><br>• Promote pluralism to improve access to and flow of information<br><br><u>Resource Mobilization</u><br>• Provide subsidy, tax breaks and loans for investment<br>• Provide resources (human/financial/IT) to promote information flow<br>• Provide education/training to improve capacity for learning-by-exchanging/disseminating information<br><br><u>Public-Private Collaboration</u><br>• Promote formal and informal networking (communities of practice) for scaling up information exchange through resource sharing, partnerships, question and answer forums<br>• Provide funding for joint programs aimed to improve access to and exchange of information | **VI**<br><u>Market Developments</u><br>• Promote transparency in information use<br>• Support context generation activities<br><br><u>Resource Mobilization</u><br>• Promote investment in human resources and ICT in innovative services/products via tax breaks and loans<br>• Provide education/training to improve capacity for learning-by-using information<br><br><u>Public-Private Collaboration</u><br>• Support formal and networking for scaling up information use through resource sharing, partnerships, joint activities and virtual collaborations<br>• Support partnerships for advocacy for information use (staging of events, establishing social traditions via higher education, seminars, expositions, professional networks) |

Source: Authors

**Table 2**

The (C-E) Structures of **S[v]** and **Ω**

| Component | S[v] | | Ω | |
| --- | --- | --- | --- | --- |
| | **(C, E)** | **Characteristics** | **(C, E)** | **Characteristics** |
| $S_1$ | (24, 18) | dominant | (51, 56) | strongly interactive |
| $S_2$ | (9, 33) | strongly subordinate | (59, 59) | strongly interactive |
| $S_3$ | (15, 3) | dominant | (10, 28) | subordinate |
| $S_4$ | (0, 24) | strongly subordinate | (34, 14) | strongly dominant |
| . | . | | . | |
| . | . | | . | |
| . | . | | . | |
| $S_{n-1}$ | (12, 12) | interactive | (33, 43) | subordinate |
| $S_n$ | (30, 0) | strongly dominant | (37, 24) | dominant |

**Table 3**

Description of Some Elements in $\Omega$

| | In Terms of Utility<br>Elements in the 1st row of $\Omega$ | In Terms of Learning from Information<br>Elements in the 1st row of $\Omega$ | Path |
|---|---|---|---|
| $S_{11}C_{11} + S_{21}C_{21} + ... + S_{n1}C_{n1} =$ | Com[1]'s net total utility obtained from others | Com[1]'s learning from its own info plus info from others | $\Omega_{11}$ |
| $+ S_{11}C_{11}$ | Com[1]'s net utility from using its own information | Com[1]'s learning from its existing info | 11 |
| $+ S_{21}C_{21}$ | Com[1]'s net utility obtained from info disseminated by Com[2] | Com[1]'s learning from info Com[2] sends to Com[1] | 21 |
| $+ S_{n1}C_{n1}$ | Com[1]'s net utility obtained from info disseminated by Com[n] | Com[1]'s learning from info Com[n] sends to Com[1] | n1 |
| $S_{11}C_{12} + S_{21}C_{22} + ... + S_{n1}C_{n2} =$ | Com[2]'s net total utility obtained from others via Com[1] | Com[2]'s learning from info obtained via Com[1] | $\Omega_{12}$ |
| $+ S_{11}C_{12}$ | Com[2]'s net utility from external effects of Com[1]'s learning | Com[2]'s learning from external effects of Com[1]'s info stock | 12 |
| $+ S_{21}C_{22}$ | Com[2]'s net utility from external effects of info it sends to Com[1] | Com[2]'s learning from info it sends to Com[1] | 212 |
| $+ S_{n1}C_{n2}$ | Com[2]'s net utility from external effects of info Com[n] sends to Com[1] | Com[2]'s learning from info Com[n] sends to Com[1] | n12 |
| $S_{11}C_{1n} + S_{21}C_{2n} + ... + S_{n1}C_{nn} =$ | Com[n]'s net total utility from others via Com[1] | Com[n]'s learning from info obtained via Com[1] | $\Omega_{1n}$ |
| $+ S_{11}C_{1n}$ | Com[n]'s net utility from external effects of Com[1]'s learning | Com[n]'s learning from external effects of Com[1]'s info stock | 1n |
| $+ S_{21}C_{2n}$ | Com[n]'s net utility from external effects of info Com[2] sends to Com[1] | Com[n]'s learning from info Com[2] sends to Com[1] | 21n |
| $+ S_{n1}C_{nn}$ | Com[n]'s net utility from external effects of info it sends to Com[1] | Com[n]'s learning from info it sends to Com[1] | n1n |
| | **Elements in the 2nd row of $\Omega$** | **Elements in the 2nd row of $\Omega$** | |
| $S_{12}C_{11} + S_{22}C_{21} + ... + S_{n2}C_{n1} =$ | Com[1]'s net total utility from others via Com[2] | Com[1]'s learning from info obtained via Com[2] | $\Omega_{21}$ |
| $+ S_{12}C_{11}$ | Com[1]'s net utility from external effects of info it sends to Com[2] | Com[1]'s learning from info it sends to Com[2] | 121 |
| $+ S_{22}C_{21}$ | Com[1]'s net utility from external effects of Com[2]'s learning | Com[1]'s learning from external effects of Com[2]'s info stock | 21 |
| $+ S_{n2}C_{n1}$ | Com[1]'s net utility from external effects of info Com[n] sends to Com[2] | Com[1]'s learning from info Com[n] sends to Com[2] | n21 |
| $S_{12}C_{12} + S_{22}C_{22} + ... + S_{n2}C_{n2} =$ | Com[2]'s net total utility from others | Com[2]'s learning from its own info plus info from others | $\Omega_{22}$ |
| $+ S_{12}C_{12}$ | Com[2]'s net utility from info disseminated by Com[1] | Com[2]'s learning from info Com[1] sends to Com[2] | 12 |
| $+ S_{22}C_{22}$ | Com[2]'s net utility from using its own information | Com[2]'s learning from its existing info | 22 |
| $+ S_{n2}C_{n2}$ | Com[2]'s net utility from info disseminated by Com[n] | Com[2]'s learning from info Com[n] sends to Com[2] | n2 |
| $S_{12}C_{1n} + S_{22}C_{2n} + ... + S_{n2}C_{nn} =$ | Com[n]'s net total utility from others via Com[2] | Com[n]'s learning from info obtained via Com[2] | $\Omega_{2n}$ |
| $+ S_{12}C_{1n}$ | Com[n]'s net utility from external effects of info Com[1] sends to Com[2] | Com[n]'s learning from info Com[2] sends to Com[2] | 12n |
| $+ S_{22}C_{2n}$ | Com[n]'s net utility from external effects of Com[2]'s learning | Com[n]'s learning from external effects of Com[2]'s info stock | 2n |
| $+ S_{n2}C_{nn}$ | Com[n]'s net utility from external effects of info it sends to Com[2] | Com[n]'s learning from info it sends to Com[2] | n2n |

**Table 4**

A Roadmap for Information System Assessment Based on Structure, Conduct and Performance

| | **Information System Assessment Dimensions and Issues** |
|---|---|
| **Institutional analysis (Section 2.2)** | Structure and Conduct<br>• Policy environment in which information system operates – key macro- and socio-economic characteristics influencing information policy, governance & resource allocation in such areas as employment, ICT infrastructure, funding, literacy, education, user voice, transparency, pluralism, centralized versus decentralized adm of information activities<br>• Developing standards for pluralistic and transparent information activities – legal requirements, informal ethical standards (trust) for quality control<br>• Supporting system context generation and infrastructure development (technical, knowledge, human & financial resources, ICT infrastructure)<br>• Promoting information chains – contractual arrangements, enforcement rules, intellectual property rights, tax exemptions & subsidies, information quality standards (reliability, credibility, accuracy), availability of & access to information, stability of information flow, incentives for transparent information activities<br>• Employment policy – immigration laws, incentives for skill development and ICT investment, mobility of skilled labor & information workers to ICT sector<br>• Education policy – incentives to improve capacity for learning-by-generating, by-exchanging & by using information; incentives for education/training of citizens<br>• Incentives for public-private partnerships in – information quality control; developing protocols for access to public resources (human, financial, IT, libraries, specialized information banks) & to information transfer means, formats and mechanisms; developing protocols for joint production & dissemination of timely, efficient and effective information; for advocacy for information use (staging of events, establishing social traditions via higher education, seminars, expositions, professional networks)<br>• Funding – tax breaks, loans, credits, subsidies for promoting info activities, ICT development (investment, resource allocation), advocacy for informed decision making<br>• Networking (formal, informal) – for scaling up information activities (via resource sharing and joint activities) and improved access to complementary information |
| **Linkage & information flow analysis (Section 2.3)** | Structure<br>• System information scope & density – growth of context (national, regional), user demand and elasticity of demand for information, ICT and resource use; information standards; entry conditions (barriers to entry and exit); system forms (centralized versus decentralized, flexible versus rigid, formal versus informal)<br>• System characteristics – system goal, component-level objectives, organizational objectives and strategies, system and component-level coordination<br>• Stakeholder characteristics – number and distribution of organizations in the system (proportions: information producers, users and intermediaries; both producers and users; both producers-users and distributors; identification of dominant, subordinate & interactive components); concentration of information stakeholders (public, private, national NGOs, international NGOs, donors); stable versus temporary features of stakeholders;<br>• Stakeholder linkages – means & mechanisms used in linkage building, strength of linkages, sensitivity of linkages to economic, political & social situation, institutions supporting linkage development<br>• Information and information flow characteristics – nature of information (e.g., food security information, product innovation information, etc.), locality (geographic and administrative coverage); identification and characteristics of information flow pathways, system and component level constraints (environmental, institutional & organizational) on information flow<br>Conduct<br>• Organization information strategies & activities – mandate, objectives, actions, level of operation (national, regional, district); information valuing, buying & disseminating behavior; R&D investment, decisions on information product dimensions; information acquisition, merging & collusion both explicit and tacit; legal tactics; motivation of users & producers; information differentiation (vertical coordination mechanisms)<br>• Use of information acquisition & dissemination means and mechanisms – traditional ICT (radio, TV, fax), modern ICT (email, internet, SMS)<br>• Use & level of information collection methods – structured questionnaire, interviews, surveys, enumerators, web, secondary information sources; national, regional, district level; public, private use;  frequency of information products (monthly, quarterly, annual);<br>• Use of information quality control protocols, standards, routines & feedback mechanisms (ICT & web-based, network-based, research-based, community-based focus groups)<br>• Strategies for – investment, financing, staff capacity building, organizational learning for improved information activities (increased fluidity & accumulation of useful info) |
| **Capacity analysis (Section 2.4)** | Conduct<br>• Characteristics of staff & management – capacity for planning, decision making, linking analysis to action & using info means & mechanisms; proactive or responsive to incentives; leadership features, accountability of management body; interpersonal interactions; team making, collaborative, individualistic; sensitivity to ethical, cultural & traditional issues;<br>• Characteristics of information and information products – reliability, credibility, accessibility by different users, timeliness, cost efficient, effectiveness; frequency (monthly, quarterly, annual); state (raw, processed or both);<br>• Dimensions of system/organization performance – effectiveness, efficiency, quality & equity: degree of achieving desirable outcomes (given the nature & quality of information, incentives & culture of the organization); system's and organization's optimal use of available resources (sustainability or affordability) to yield maximum benefits or good results (technical, productive , allocative efficiency: system's or organization's productivity given inputs); quality of information - degree to which information services for decision makers increase the likelihood of informed decision/policy making; equity – equal access of different users and producers to information & resources |

Source: Authors

**Table 5**

Stakeholders in the Food Security Information System

| | Availability | Access | Utilization | Stability |
|---|---|---|---|---|
| **Government** | Ministry of Agriculture<br>State Food Reserve<br>State Food Grain Fund<br>Ministry of Finance<br>National Bank<br>Ministry of Education<br><br>Agricultural Universities/Research Centers<br>State Adm. for Meteorology<br>Ministry of Melioration-Water Resources<br>State Agency for Env. Protection & Forestry<br>State Committee for Land Reform<br>Statistics Agency (Agricultural Survey) | Ministry of Agriculture<br>Ministry of Economic Development-Trade<br>Ministry of Labor & Social Protection<br>Ministry of Education<br><br>Universities/Marketing Research Centers<br>Ministry of Transport & Communications<br>Ministry of Finance<br>Private Banks & Credit Agencies<br>Statistics Agency (Living Standards Survey, Household Budget Survey) | Food Safety Agency<br>Ministry of Health<br>Ministry of Education<br><br>Universities/Nutrition-Health Research Centers<br>Statistics Agency (Demographic and Health Survey) | State Food Reserve<br>State Food Grain Fund<br>National Commission of Emergency Situation and Civil Defense<br>Food Security Council<br>Rapid Emergency Assessment Coordination Team |
| **National NGOs** | Agricultural Information Service<br>Association of Extension Organizations<br>Advisory Information Network<br>Private Sector (carriers, importers & exporters of foodstuffs)<br>National Association of Farms | Private Sector (Chamber of Commerce, managers of wholesale/retail markets, managers of food processing companies);<br>Associations (farmers, producers, small traders and carriers, consumers);<br>Private Consulting Firms;<br>Agricultural Information Service | NGOs | |
| **Int'l Orgs, Donors** | WFP, FAO, GIZ, IFAD, JICA,WB, DFID,UNICEF | WFP, GIZ, WB, USAID, DFID, UNICEF, UNDP-DRMP, Development Alternatives | WFP, WB, USAID, DFID,UNICEF, WHO, USDA Family Planning Program | FAO, EU |
| **Int'l NGOs** | Mission East, Mercy Corps, Oxfam GB, Save the Children Federation, CESVI-Development and Cooperation, ACTED, CARITAS Switzerland, AKF/MSDSP | Mercy Corps | Mercy Corps, Save the Children Federation, Operation Mercy | Mercy Corps, Food Security Cluster |

Source: DCC report (2011) and authors' compilation

**Table 6**

Food Security Information Flow in **S**

| | | | | | |
|---|---|---|---|---|---|
| **P**<br><br>Food Security Policy<br><br>**PP** | Development policies priorities, strategies; food security & agr. programs, institutions, interventions; poverty reduction strategies<br>**PR** | Development policies priorities, strategies; food security & agr. programs, institutions, interventions; poverty reduction strategies<br>**PM** | Development policies priorities, strategies; food security & agr. programs, institutions, interventions; poverty reduction strategies<br>**PA** | Development policies priorities, strategies; food security & agr. programs, institutions, interventions; poverty reduction strategies<br>**PE** | Development policies priorities, strategies; food security & agr. programs, institutions, interventions; poverty reduction strategies<br>**PX** |
| Assessment of developments/critical gaps in agricultural sector, food markets & their implications for food security policy<br>**RP** | **R**<br><br>Food Security Research<br><br>**RR** | Assessment of developments/critical gaps in agricultural/ food markets<br><br>**RM** | Assessment of developments/critical gaps in agricultural/ food production system<br><br>**RA** | Assessment of developments/critical gaps in agricultural extension/information services<br><br>**RE** | Assessment of developments/critical gaps in agricultural sector, food markets & food security situation<br><br>**RX** |
| Prospects, bottlenecks, critical gaps in food & agricultural markets and their implications for food security policy<br>**MP** | Prospects, bottlenecks, critical gaps in food & agricultural markets and their implications for food security research<br>**MR** | **M**<br><br>Agricultural and Food Markets<br><br>**MM** | Prospects, bottlenecks, critical gaps in food/ agricultural markets and their implications for agricultural/food production<br>**MA** | Prospects, bottlenecks, critical gaps in food/ agricultural markets and their implications for agricultural extension/information<br>**ME** | Prospects, bottlenecks, critical gaps in food/ agricultural markets and their implications for food security<br>**MX** |
| Prospects, bottlenecks, critical gaps in food/ agricultural production and their implications for food security policy<br>**AP** | Prospects, bottlenecks, critical gaps in food/ agricultural production and their implications for food security research<br>**AR** | Prospects, bottlenecks, critical gaps in food/ agricultural production and their implications for agricultural/food markets<br>**AM** | **A**<br><br>Agricultural and Food Production System<br><br>**AA** | Prospects, bottlenecks, critical gaps in food/ agricultural production and their implications for agricultural extension/information<br>**AE** | Prospects, bottlenecks, critical gaps in food/ agricultural production and their implications for food security<br>4.1.1<br>**AX** |
| Prospects, bottlenecks, critical gaps in agr extension/information and their implications for food security policy<br>**EP** | Prospects, bottlenecks, critical gaps in agr extension/information and their implications for food security research<br>**ER** | Prospects, bottlenecks, critical gaps in agr extension/information and their implications for food/ agricultural markets<br>**EM** | Prospects, bottlenecks, critical gaps in agr extension/information and their implications for food/ agricultural production<br>**EA** | **E**<br><br>Agricultural Extension/Information Services<br><br>**EE** | Prospects, bottlenecks, critical gaps in agr extension/information and their implications for food security<br>**EX** |
| Critical gaps in food security policy<br><br>**XP** | Critical gaps in food security research<br><br>**XR** | Critical gaps in the development of efficient agricultural and food markets<br>**XM** | Critical gaps in the development of efficient agricultural/ food production system<br>**XA** | Critical gaps in the development of agricultural extension and information services<br>**XE** | **X**<br><br>External Sector<br><br>**XX** |

Source: Authors

36

## Annex A: Workshop Design for Measuring Value of Information and Organizational Capacities

A workshop design is proposed to gather expert knowledge on the use value or utility of context-specific information generated, disseminated and used by stakeholders in an information system. For purposes of clarity, we explain the design in the context of food security. Using **Tables 5 and 6**, the desired workshop can be organized as follows.

<u>**Step 1:**</u> **Documents to be prepared for the workshop**

*(a) Define food security and identify food security stakeholders*

Food security is defined as the state in which all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (1996 World Food Summit). **Table 5** presents a list of food security stakeholders across four dimensions of food security: (1) *Availability* of food by considering agricultural production, imports, exports and losses of staple foods and animal products, (2) *Access* to food by considering mainly social indicators and market information such as poverty, food prices, incomes, unemployment etc, (3) *Stability* of availability and access by considering market developments, the status of infrastructure and stocks, external factors including extreme events and (4) *Utilization* of food by considering health and nutrition status of the population.

*(b) Define a food security information system S and classify the food security stakeholders in **Table 5** as individual components of S (**Table 6**)*

A food security information system **S** is defined as a set of food security stakeholders – evolving around a common system goal of eradicating hunger and malnutrition – that jointly and/or individually generate, collect, analyze and distribute food security data and information to help achieve the system goal.

**Table 6** defines **S** as six components: {**P**, **R**, **M**, **A**, **E**, **X**}. A component is composed of those stakeholders with comparable objectives. For example, component **P** would be composed of those stakeholders that are directly/indirectly contribute to the formation or implementation of food security policy. Naturally, it will include ministries, collaborating international organizations, public and private agricultural banks, etc. Similarly, component **R** would consist of those organizations that conduct food security research, including universities, private and public research centres, international research centres, etc. Component **M** would include those stakeholders concerning agricultural commodity and food markets, and so on.

*(c) Identify the critical gaps in food security information that warrant better understanding*

Each off-diagonal cell of **Table 6** describes the type of information that is expected to flow from one component to another. For example, the cell **PR** assumes that stakeholders in component **P** generate and make the desired information available to those stakeholders in component **R**. The desired information may include development policy, priority and strategy documents, food security and agricultural reform programs,

institutions and interventions, poverty reduction papers, etc. Likewise, **ME** would represent the type of information concerning prospects, bottlenecks, critical gaps in food and agricultural markets and their implications for agricultural extension and information. By construction of **S**, this information would be produced by stakeholders in component **M**, while demanded by stakeholders in component **E**. **Table 6** characterizes the type of data and information necessary to analyze the system **S**. This mapping of available information allows us to identify the critical gaps in food security information that warrant better understanding.

<u>Step 2:</u> **Design working groups and voting scheme**

*(d) Given **S** with six components, invite at least six representatives from each component and form a working group of six representatives, each of which comes from a different component*

A working group (WG) of 6 members is formed by randomly choosing one representative from each component. This way each component is fully and equally represented in each WG. Each representative is assigned 5 types of votes: a "high-value" vote which is worth of 5 points; an "above mediocre-value" vote, worth of 4 points; a "mediocre-value" vote, worth of 3 points; a "below mediocre-value" vote, worth of 2 points; and a "low-value" vote worth of 1 point. This multi-voting scheme allows the representatives to rank their preferences over the binary causal information flow in **S**. One can also see the flip side of the coin that voting is over the "use-value" or "importance" of the information flow for the receiver. The concept of "use value" refers to the utility of using or the want-satisfying power of the information. In this sense, a "high-value" vote of 5 points for the binary relation **PR** in **Table 6** implies that data and information flowing from stakeholders in component **P** to those in **R** occupy an important place in the utility function of stakeholders in **R**. It should be noted from the outset that voting is neither about the actual flow of information from **P** to **R** nor availability of such information. Voting is about the expected utility that can be attained from the use of such hypothetical information.

Using **Table 6**, each WG prepares a map of the causal relations that the WG thought to be critical. The resulting 6 maps are in turn consolidated. The representatives vote over the causal relations in the consolidated map by following the "expected utility principle" described in the previous paragraph.

<u>Step 3:</u> **Carry out the questionnaire in Annex B to measure organizational capacities**

Each stakeholder in the workshop individually answers the questions to reflect upon the current status of capacities in his/her organization.

# Annex B: Questionnaire for Measuring Organizational Capacities

## Part 1
## Measuring Learning Capacity

1. **In this organization,...**

   a) there is little focus on <u>professional learning</u>.
   b) most learning focuses on reacting to and trying to solve day-to-day operational problems.
   c) staff members and the management body look internally and question themselves about why errors or successes occurred in the first place.
   d) staff members and the management body try to avoid negative results and experiences by identifying the best future opportunities and then finding ways to achieve that future.
   e) in addition to (b), (c) and (d), we contemplate our own learning behaviors, in other words we engage in activities that help us learn about our own learning.

2. **In this organization...**

   a) there is little <u>sharing among colleagues</u>.
   b) staff members are inclined to share with their departmental colleagues. However, there is a limited ability to transfer information and knowledge beyond the departmental level.
   c) people are inclined to share with each other but there is no formal distribution plan. Basically, if I want to know something I know who to see.
   d) peer-to-peer sharing and the existence of cross-department teams ensures that information and knowledge diffuse throughout the organization, however, it occurs slowly.
   e) we are skilled at moving information and knowledge efficiently and quickly throughout the entire organization.

3. **As an organization…**

   a) we never take time to <u>reflect on what our organization is</u> all about.
   b) we take time to reflect on what our organization is about, once or twice a year on professional development days.
   c) we take time to reflect on what our organization is all about when we meet as teams or committees and at regularly scheduled staff meetings.
   d) challenging the status quo and experimenting with new ways of doing things is a way of life.
   e) In addition to (d), we collaborate with each other on action learning projects.

4. **In this organization…**

   a) <u>new ideas</u> are resisted.
   b) it takes forever to implement a new idea.
   c) there are groups of staff members who will take a new idea and run with it but there are others who resist anything that even resembles change.

d) we strongly support innovation and we have become skilled at moving information and knowledge efficiently and quickly throughout the entire organization, therefore new ideas get implemented quickly.

e) as a result of (d), we are able to successfully implement multiple innovations, simultaneously.

5. **In this organization...**

a) things are pretty routine; there is not much change.

b) <u>new ideas</u> are usually imposed upon us and we have no choice but to comply.

c) new and innovative ideas are acknowledged but most people pay lip service to them therefore implementation is difficult.

d) staff members and the management body get excited about innovative ideas but they often become frustrated because of a lack of resources to implement the ideas.

e) innovative ideas usually result in new ways of thinking as well as new ways of doing things.

6. **This organization acquires high <u>quality and highly relevant information</u> by...**

a) accident. Staff members and the management body don't pay much attention to what happens outside the organization nor are there any internal efforts to be innovative.

b) accident, as well as through the management body and the relevant ministries.

c) accident, as well as intentionally scanning the local environment and importing new information from other organizations. For example, attending conferences, hiring external consultants, using benchmarks from other organizations.

d) in addition to (c), partnering with other organizations and businesses for the purpose of developing new ways of doing things.

e) (b), (c) and (d).

7. **In this organization...**

a) there is very little <u>investment in learning resources</u>.

b) the management body recognizes the need for qualified workforce and improved ICT but often becomes frustrated because of a lack of financial resources to acquire them.

c) staff members and the management body regularly discuss the current and expected organizational resource issues and draw an innovative investment plan.

d) in addition to (c), the management body allocates funds for the procurement of the priority resources (physical, human, technical, etc) and effectively acquires what is needed.

e) in addition to (d), staff members and the management body are able to internalize the implications of efficient resource use for the organizational sustainability.

8. **In this organization...**

a) Attention is not paid at all <u>to policies/formal and informal institutions that may affect organizational learning</u>.

b) the management body recognize the need for better understanding of the implications on organizational learning of policy and institutional issues, but often become frustrated because of a lack of specialized experts.
c) staff members and the management body regularly review policies and formal institutions (legal rules and requirements) that may affect learning through their effects on market developments resource mobilization and public-private collaboration and the management adjusts the organizational strategy accordingly.
d) in addition to (c), the management body mobilizes resources to effectively implement the strategy.
e) in addition to (d), staff members and the management body proactively initiate the formation of a community of organizations to respond to/influence policy/ institutional changes concerning organizational learning.

*Directions: Please circle the letter corresponding to your answer. Then add the number of circled items in each column. Multiply by the number provided at the bottom of the column. Then add the tallies at the bottom of each column to provide a total category score.*

**Part 1: Learning Capacity**

|     |   |   |   |   |   |
|-----|---|---|---|---|---|
| 1.  | a | b | c | d | e |
| 2.  | a | b | c | d | e |
| 3.  | a | b | c | d | e |
| 4.  | a | b | c | d | e |
| 5.  | a | b | c | d | e |
| 6.  | a | b | c | d | e |
| 7.  | a | b | c | d | e |
| 8.  | a | b | c | d | e |

| _____ x1 | _____ x2 | _____ x3 | _____ x4 | _____ x5 | Score |
|-----|-----|-----|-----|-----|-----|
| _____ + | _____ + | _____ + | _____ + | _____ | = _____ |

# Part 2

## Measuring Dissemination Capacity

1. **In this organization the work culture...**

   a) there is very little <u>professional and cross-organizational sharing</u> or collaboration.
   b) professional and cross-organization sharing or collaboration is focused on resisting change and defending the status quo.
   c) staff members and the management body work together on information sharing or dissemination problems.
   d) in an attempt to improve the dissemination process, staff members and the management body frequently collaborate with other organizations to develop new dissemination means and mechanisms.
   e) in addition to (d), staff members and the management body take responsibility for and contribute to one another's information sharing or dissemination as they go about their daily activities. As well, staff members are provided with time to meet, share ideas and plan collaboratively.

2. **In this organization the linkages with its environment…**

   a) virtually no one recognizes the <u>interrelationships between the organization and its environment</u>.
   b) the management body appears to understand the complex relationship between the organization and its environment but it experiences difficulty explaining these relationships to staff members.
   c) staff members and the management body understand the complex relationships that exist between the organization and the environment.
   d) in addition to (c), staff members and the management body are able to think and act with a comprehensive understanding of the entire system.
   e) in addition to (d), staff members and the management body understand the concept of leverage and how a small well-focused change in one organization can produce significant, long lasting improvements in another.

3. **In this organization, <u>strategies for information dissemination</u> (e.g. dissemination plans, innovative dissemination means and mechanisms, professional networking)...**

   a) are virtually non-existent.
   b) have been developed but they are not widely accepted by staff members.
   c) focus on improving individual staff learning.
   d) focus on individual staff learning, team learning and organizational goals.
   e) in addition to (d), they are carefully designed and implemented in such a way to promote the organization by reflecting upon the needs of other organizations in its environment.

4. **In this organization, when people come together to discuss <u>information dissemination strategies...</u>**

   a) we do not discuss dissemination strategies.
   b) the discussion is usually dominated by the opinions of a few and the result is poor quality decisions.

c) the discussion operates like a democracy and results in decisions that are based on the opinions of the majority.
d) staff members recognize the diversity and expertise of the group and work towards a consensus.
e) in addition to (d), there is a free flow of ideas and creativity that generate new ideas about the dissemination of the information across other organizations.

5. **In this organization the <u>dissemination of information</u>...**

a) does not occur on a large-scale basis. When it does occur it is by chance, on an informal basis.
b) does not occur on a large-scale basis. The few new ideas are usually protected by the owners and are not willingly shared or disseminated
c) is common. It happens as a result of informal networks and between organizations and through peer-to-peer communication. It is often a response to a demand or crisis.
d) is common. It happens as a result of carefully planned events and processes (e.g. reports, bulletin boards, staff meetings, briefings, cross-organizational work teams, and electronic communication networks).
e) both (c) and (d).

6. **This organization disseminates high quality & highly relevant information by...**

a) there is little evidence that <u>this organization disseminates any new information</u>.
b) experimenting with new ideas to see what works.
c) staff members and the management body working closely together on organizational dissemination issues.
d) staff members and the management body taking some piece of existing information and adding theirs to it, in order to create and disseminate something new.
e) staff members and the management body creating new information, adopting it to the needs of other organizations in its environment and making it available to those in its environment.

7. **In this organization...**

a) there are few <u>resources to facilitate new dissemination initiatives</u>.
b) there are plenty of skilled people and non-human resources (e.g. time, money, technology) but there is little information dissemination.
c) there are plenty of non-human resources but no skilled people to facilitate information dissemination.
d) there are plenty of skilled people who are anxious to engage in new dissemination initiatives but they are handcuffed by a lack of non-human resources.
e) we are fortunate. There are many skilled people who are engaging in new dissemination initiatives and we have the non-human resources to make the experience worthwhile.

8. **In this organization, <u>computer and communications technologies</u> have...**

a) had no real effect on professional/organizational information dissemination.

b) been introduced and accepted by a small minority of staff members and/or the management body.

c) been adopted by a large percentage of staff members and/or the management body who use the new technologies (e.g. World Wide Web, E-mail, presentation software) in their day-to-day information exchange with other organizations.

d) been adopted by everyone in the organization. Everyone has access to the information highway and all staff members use the new technologies (e.g. World Wide Web, e-mail, presentation software) in their day-to-day information exchange, and all staff members communicate via email.

e) in addition to (d), have stimulated new dissemination methods. Staff members are constantly looking for new ways to apply the technologies to their information exchange.

9. **In this organization...**

a) when leaders and other knowledgeable staff members leave we usually find ourselves in a state of crisis, because <u>information is not retained.</u>

b) there is no formal plan for storing and disseminating information but undeclared information is stored with department members and is available to other members if they know where to look and who to ask.

c) in addition to (b), staff members and the management body are aware of the need to retain and disseminate the undeclared information to other organizations.

d) staff members and the management body are aware of the need to disseminate organizational information. They have systems and structures in place (e.g. teams, documents, and/or electronic files) to ensure that important information is not lost and shared with other organizations.

e) in addition to (d), the stored information is organized in such a way that it is easily accessible to other organizations when it is needed.

10. **In this organization...**

a) Attention is not paid at all <u>to policies/formal and informal institutions that may affect information dissemination</u>.

b) the management body recognize the need for better understanding of the implications on information dissemination of policy and institutional issues, but often become frustrated because of a lack of specialized experts.

c) staff members and the management body regularly review policies and formal institutions (legal rules and requirements) that may affect information dissemination through their effects on market developments resource mobilization and public-private collaboration and the management adjusts the organizational strategy accordingly.

d) in addition to (c), the management body mobilizes resources to effectively implement the strategy.

e) in addition to (d), staff members and the management body proactively initiate the formation of a community of organizations to respond to/influence policy/institutional changes concerning information dissemination.

**Directions:** *Please circle the letter corresponding to your answer. Then add the number of circled items in each column. Multiply by the number provided at the bottom of the column. Then add the tallies at the bottom of each column to provide a total category score.*

| **Part 2: Dissemination Capacity** | | | | |
|---|---|---|---|---|
| 1. a | b | c | d | e |
| 2. a | b | c | d | e |
| 3. a | b | c | d | e |
| 4. a | b | c | d | e |
| 5. a | b | c | d | e |
| 6. a | b | c | d | e |
| 7. a | b | c | d | e |
| 8. a | b | c | d | e |
| 9. a | b | c | d | e |
| 10. a | b | c | d | e |
| ____x1 | ____x2 | ____x3 | ____x4 | ____x5  **Score** |
| ____ + | ____ + | ____ + | ____ + | ____ = ____ |

Source: The questionnaire is adopted from Dibbon (1999).