Establishing Government Chief Information Officer Systems – Readiness Assessment

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ABSTRACT

Effective Information Technology (IT) leadership is critical for achieving a good alignment between business needs and IT means of an organization. In the public sector, IT leadership is increasingly realized through the Government Chief Information Officer (GCIO) function, typically established by governments based on local circumstances and emerging needs. This makes peer-learning about the working of such systems and their transfer between different government contexts challenging. To address this concern, the authors introduced earlier a GCIO System - a set of inter-related activities to guide governments in gradually establishing, operating and sustaining the GCIO function. Based on a common conceptual model of the GCIO function, this paper defines a methodology for conducting the readiness assessment part of the GCIO System. The methodology comprises a set of assessment areas and a step-wise process to conduct assessment in these areas. The paper also shares the experience in applying this methodology in practice, and proposes how the assessment could inform the execution of other activities of the GCIO System.

Categories and Subject Descriptors

K.4.0 [Computers and Society]: Public Policy Issues – Regulation. K.6.0 [Management of Computing and Information Systems]: Project and People Management – Strategic information systems planning.

General Terms

Management, Human Factors

Keywords

IT Leadership, Chief Information Officer, Government Chief Information Officer, Readiness Assessment, Institutionalization

1. INTRODUCTION

Originated in the private sector, the Chief Information Officer (CIO) function aims at successfully planning, coordinating, managing, executing, and controlling IT operations and initiatives within an organization. Recently, the CIO function is increasingly adopted by governments to support the planning, execution and monitoring of Information and Communication Technology (ICT)

and Electronic Government (EGOV) initiatives, and to help utilize the benefits created by such initiatives for both governments and the public. Similar expectations are expressed in the GCIO models used by various benchmarking surveys. For instance, the World e-Government Ranking by Waseda University [1] considers GCIO capabilities in government as one of the determinants of maturity of EGOV development and usage. A clear emerging trend is that more governments will adopt the GCIO function in coming years.

To guide the systematic adoption of the GCIO function, a GCIO System was proposed in [2], comprising seven interrelated activities: Readiness Assessment, Regulatory Framework, Capacity-Building, Institutional Development, International Collaboration, Cross-Agency Coordination, and Collaboration and Engagement. All such activities require localization to address specific needs and circumstances of a given public administration.

A key activity in the localization process is determining a gap between existing and required government capabilities, resources, functions and environment to make possible the implementation of the GCIO function. For example, determining a gap between the skills and knowledge possessed by current government workforce and the skills and knowledge required from the GCIO roles, or between the current level of coordination in government and the coordination required for executing whole-of-government initiatives. In addition, the enabling institutional environment for establishing the GCIO functions must be assessed as well.

While many e-readiness assessment surveys have been carried by applying methodologies available in the public domain, these surveys mostly evaluate country-level institutional capacities for benchmarking purposes. However, it is recognized that to fulfill its purpose, e-readiness assessments should be focused and action-oriented [3]. In view of this and based on our literature review, concrete guidelines on how to assess and carry out gap analysis towards the establishment of a GCIO function are missing.

This paper presents a methodology for assessing the readiness of a government organization for establishing the GCIO function, implementing the first activity of the GCIO system [2]. The methodology is based on a common conceptual model of the GCIO function, and comprises a set of assessment areas and a step-wise process to conduct readiness assessment in these areas. The process covers the whole lifecycle, from assessment planning, through construction and testing of assessment instruments, to the application of instruments and analysis and presentation of results. The paper also shares experience in applying this methodology, presented as guidelines for developing assessment instruments.

The main contribution of this paper is offering a methodology, with validation experience, for assessing the readiness of a given government organization for establishing a GCIO function.

The rest of this paper is structured as follows. Section 2 explains the adopted research methodology, followed by background and related work in Section 3. Section 4 presents the conceptual model for the GCIO function, underpinning the assessment methodology in Section 5 (scope) and 6 (process). The experience and lessons learnt from applying the methodology are discussed in Section 7, while Section 8 examines how assessment can inform other parts of the GCIO system. Finally, Section 9 draws some conclusions.

2. RESEARCH METHODOLOGY

The work presented here is part of research on technology leadership in government, and particularly on the GCIO function. The research methodology comprises the following six steps:

S1. *Literature Review* – carried out to better understand the GCIO function, its authority and responsibilities;

S2. *State-of-Practice Review* – carried out to compare GCIO implementation experiences in various countries like USA, UK, Thailand, Singapore, Hong Kong and Canada, covering capacity-building programs, partnership development, governance structures and institutionalization mechanisms;

S3. *e-Readiness Assessment Review* – carried out to identify various elements used in assessment methodologies for assessing the capacity of IT workforce;

S4. *Assessment Techniques Review* – carried out through literature review to determine methods and techniques that could be applied for conducting an assessment exercise;

S5. *Analysis and Synthesis* – carried out to synthesize the GCIO assessment methodology based on the analysis of the results of previous steps S1 to S4; and

S6. *Validation* – carried out to apply the methodology in a concrete government context, and validate it in the process.

The results of the steps S1 and S2 are partly presented in [2], providing the background for this work. The results of the step S3 are summarized in Section 3, while the results of S4 are applied throughout Sections 5 and 6 where the bulk of the GCIO assessment methodology is introduced. The research methodology is depicted in the Figure 1 below.
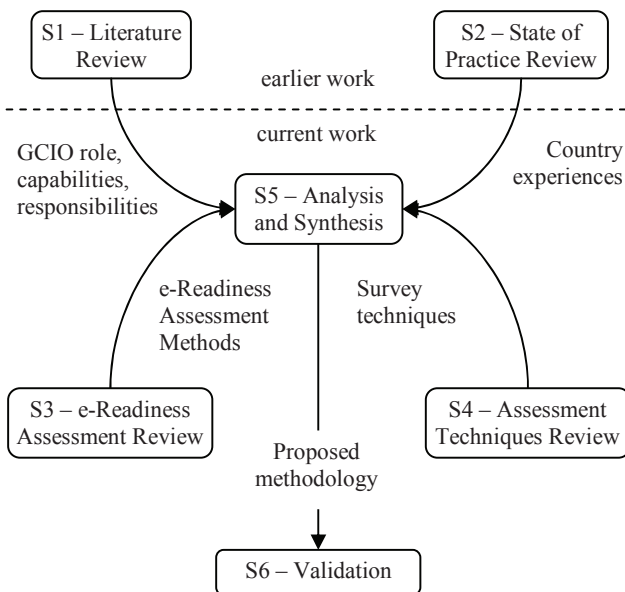

Figure 1. Research Methodology

3. BACKGROUND AND RELATED WORK

Measuring the readiness of government for introducing the GCIO function involves assessing human capacity as well as aspects of organizational and institutional capacity [2]; both ICT-related and relevant non-ICT-related capacities are of interest. Usually, the presence of such capacities is established through an e-readiness assessment exercise. While several definitions of e-readiness exist, most respond to specific assessment objectives [4] and thus choosing the most appropriate one is challenging. For the purpose of this work, e-readiness assessment is a process of measuring the degree to which a country, society or economy is prepared to benefit from the use of ICT. Specifically, e-readiness assessment focused on the GCIO function entails measuring the degree to which a given government is prepared for establishing a GCIO function as part of its (and its agencies') organizational structures. Thus, GCIO e-readiness assessment covers human and organizational capacity of individual government agencies as well as the institutional environment in which these agencies operate.

Several organizations conduct regular e-readiness assessment exercises around the world. These include inter-governmental bodies like the United Nations Department of Economic and Social Affairs which publishes the UN e-Government Survey series [5], international organizations like the World Economic Forum which publishes the Global Information Technology Report 2009-2010 [6], and academic institutions like the Waseda University which publishes the World e-Government Ranking series [1]. Given the variety of existing e-readiness assessment models and tools, a number of comparisons have been conducted [4][7] and two categories were identified: e-Economy – ICT infrastructure preparedness for business or economy growth, and e-Society – the ability of the society to benefit from IT [4].

In this work, our interests center on those e-readiness assessment methodologies which include processes and indicators relevant to the GCIO function. These include the methodologies for assessing human capacity, organizational capacity for developing ICT-related skills, and the legal and policy environment as follows:

o *Assessing Human Capacity* - Most assessment methodologies include the indicators for measuring human capacity. For instance, the UN e-Government Survey [5] measures human capacity as a weighted mean of the adult literacy index and the gross enrolment index, while the ITU e-Government Readiness Assessment Framework [8] includes the newly defined ICT Development Index (IDI) [9] to measure levels of education. However, none of them considers ICT-related literacy. Such literacy, which is part of the Digital Prosperity Checklist [10] tool provided by Asia-Pacific Economic Cooperation (APEC) to assist economies in promoting the development and use of ICT. Another assessment area of the APEC tool is to measure intellectual capital - efforts to increase computer literacy and ICT development skills of the ICT workforce, including policies and programs for the private sector to enhance ICT professional development, opportunities and international exchange programs.

o *Assessing Organizational Capacity* - A number of methodologies assess organizational capacity for developing ICT skills in the public workforce. For example, the Readiness Assessment for the Networked World conducted by the Center for International Development at Harvard University [11]. The methodology applies 19 categories of indicators and four steps for each of them. One of the indicators measures the efforts in developing the ICT

workforce: technical schools with specialized curricula on ICT, ICT-related training opportunities, and online resources and courses to help build the technical skills. Another methodology is the e-readiness assessment conducted by the World Economic Forum which aims at identifying the enabling factors for countries to fully benefit from ICT, while highlighting the co-responsibility of the main social actors - individuals, governments and businesses [6]. The methodology is based on the Networked Readiness Index which assesses the availability of scientists and engineers, quality of research institutions, and tertiary enrolment. For individual readiness the indicators include quality of math and science education and quality of the educational system, while for business readiness, quality of management schools. Interestingly, while readiness assessment for businesses considers the extent of staff training, university-industry collaboration, and capacity for innovation, such indicators are not part of readiness assessment for governments.

o *Assessing Institutional Capacity* - Some methodologies focus on assessing the legal and policy frameworks that enable ICT-driven innovations. For example, the ITU e-Government Readiness Assessment Framework [8] includes policy as one of its six assessment areas. The assessment covers policies related to: import and export of ICT goods; protection of local ICT industries, including tariff barriers; cyber-security, privacy and data protection; digital identification and digital signatures; and e-payment, among others. The e-readiness methodology proposed by the Economist and the IBM Institute for Business Value [12] also includes an assessment area for the legal environment, measuring the effectiveness of the traditional legal system, laws related to Internet, complexity of new business registration, and electronic IDs.

As mentioned earlier, there is a general paucity of scholarly work in the area of GCIO readiness assessment. The closest to the goal of this research is the Waseda University World e-Government Ranking [1] which dedicates one of its areas to assessing the human and institutional capacity for the GCIO function, covering: 1) the presence and mandate of the GCIO function, 2) supporting GCIO organizations, and 3) GCIO development programs.

While the general EGOV benchmarking surveys may not directly contribute to the GCIO assessment, parts of such surveys could be adapted to this purpose covering: 1) Human Capacity – e-literacy, 2) Organizational Capacity – educational institutions, training programs and resources to support the development of ICT skills, 3) Institutional Capacity – policies and laws regulating the ICT sector. Concerning human and organizational capacity assessment areas most surveys consider e-literacy indicators and some include the indicators to assess ICT training and educational programs, and the quality of educational and research institutions. However, such indicators are considered at the country and societal levels, and do not address specific requirements for assessing the government IT workforce. Concerning the institutional capacity and particularly the legal and policy environment, many of the indicators are suitable for inclusion in the GCIO assessment.

With respect to the state-of-the-art on GCIO readiness assessment, this work provides an in-depth methodology for assessing the readiness of a given public administration to establishing and sustaining a GCIO function. In contrast to earlier methodologies, this work is not intended for the benchmarking purposes, but for enabling concrete actions by governments and their agencies in establishing and sustaining an effective GCIO function.

4. GCIO CONCEPTUAL MODEL

In order to introduce the GCIO assessment methodology, and particularly the scope of an assessment exercise, we first present the conceptual model for the GCIO function, a revised version of the model in [2]. Depicted in Figure 2, the model partly specifies the elements which are required for or are affecting successful fulfillment of the responsibilities assigned to GCIO. The model also clarifies the meaning of the GCIO function, and enables making assertions about its nature.
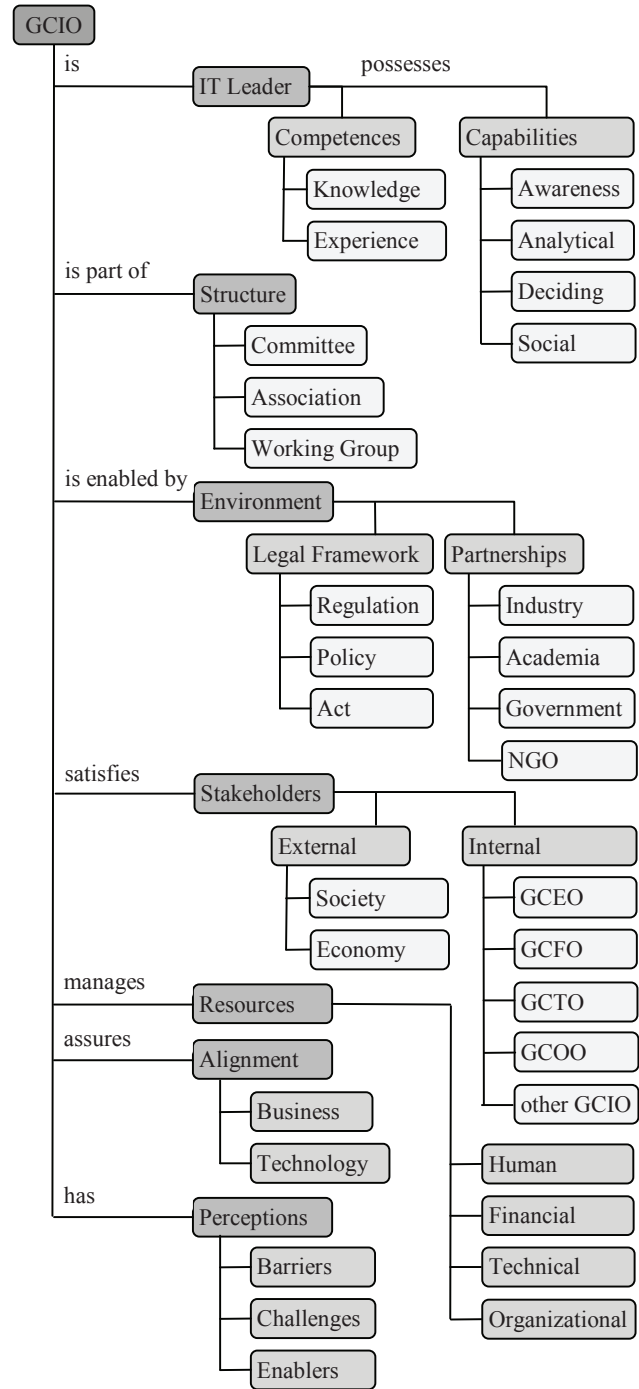

Figure 2. GCIO Conceptual Model

The key concept in Figure 2 is GCIO – Government Chief Information Officer. GCIO is related to seven high-level concepts - IT Leader, Structure, Environment, Stakeholders, Resources, Alignment and Perceptions. These concepts are as follows:

1. *IT Leader* – GCIO is an IT Leader who should possess certain competences, both knowledge and experience, and capabilities. In general IT Leader should be knowledgeable in technology, management and public administration issues, as well as possess the knowledge of the specific function and level of government where his or her organization is located. Experience is required, for instance, in the development and implementation of ICT project portfolios, and in the larger organizational and societal context in which ICT is used. However, while knowledge can be obtained through formal (e.g. executive degree) or continuous (e.g. courses, seminars) training, experience can be obtained over time through practice. Also participation in communities of practice, study visits and international collaboration can be successful in enriching knowledge and experience required by IT leaders. Specific capabilities include: 1) awareness – awareness of the new trends and innovations in ICT and its usage; 2) analytical skills – being able to analyze different ICT solutions and their impact on the organizational environment; 3) decision-making skills – ability to make and justify IT-related decisions in view of their impact on the organization, and 4) leadership, communication and negation skills.

2. *Structure* – The GCIO should be placed at the highest levels in the organizational hierarchy to ensure that he or she has a voice in defining organizational strategies and that ICT initiatives are well aligned with and can contribute to the realization of such strategies. In addition, institutions and governance structures specifically established to strengthen the GCIO function are becoming increasingly important. Such structures could be established formally e.g. a committee of agency heads, or informally e.g. a community of IT procurement practitioners. They could be located within government e.g. through a working group structure, or outside government e.g. through a professional association.

3. *Environment* – The GCIO functions within an environment that enables and supports its operation. Two key elements in this environment are the legal framework and partnerships. A legal framework is required to locate the function within the larger government structure, to define the responsibilities and competences expected from these who hold GCIO positions, and to provide a GCIO with the authority and resources to be able to fulfill such responsibilities. In order to sustain the function, the legal framework should also facilitate the introduction of ICT and ICT-enabled innovations to the working of government, for example by legalizing electronic documents and digital signatures. Depending on the country, the legal framework can comprise regulations, policies, acts and other legal instruments. The second part of the GCIO enabling environment is the establishment and maintenance of partnerships in both national and international contexts. Collaboration with academic institutions, private sector, international bodies and other governments brings different perspectives to problems, highlights alternative solutions and approaches, and makes available new knowledge and expertise to enhance government ICT products and services, and strengthen the performance of the GCIO function.

4. *Stakeholders* – A GCIO must negotiate the expectations and satisfy the needs of various stakeholders. External stakeholders comprise various societal and economic actors like citizens, businesses, politicians, journalists, professional associations and NGO, etc. Internal Stakeholders comprise government leaders, managers and civil servants, including a family of government executives - Chief Executive Officer (GCEO), Chief Financial Officer (GCFO), Chief Technology Officer (GCTO), Chief Operations Officer (GCOO) as well as other Chief Information Officers (GCIO).

5. *Resources* – These comprise various ICT-related resources that can be used or can contribute to the GCIO-led initiatives including: 1) Human Resources – ICT and non-ICT staff that contribute to GCIO operations and projects, 2) Financial Resources – the budget allocated to cover the cost of GCIO operations and projects, 3) Technical – hardware and software used as part of GCIO operations and projects, and 4) Organizational – documented procedures, processes and management practices, covering budgeting, procurement, maintenance, hiring, retention, and other processes.

6. *Alignment* – As the main objective of a GCIO is to make sure that technology contributes to the formulation and fulfillment of the organizational objectives, he or she should have a clear understanding of such objectives and should be involved in their formulation and assessment. With such knowledge and access, a GCIO can make sure that ICT projects contribute to organizational objectives and, at the same time, that such objectives fully utilize the opportunities created by ICT.

7. *Perceptions* – In order to anticipate and address various obstacles that a GCIO may encounter in fulfilling his or her responsibilities, it is important to be aware about perceptions and attitudes of the organization's leadership and staff on existing barriers and challenges, as well as opportunities and enablers. Corrective actions and initiatives can then be undertaken to overcome the barriers and challenges, while strengthening the enablers and utilizing opportunities.

5. GCIO ASSESSMENT AREAS

Based on the GCIO conceptual model presented in Section 4, Sections 5 and 6 present the bulk of the GCIO assessment methodology: what should be assessed - a set of assessment areas to establish the readiness of a government organization for establishing a GCIO system, and how the assessment should be carried out - a methodology for carrying out readiness assessment.

While no one-size-fits-all solution exists for establishing a GCIO function, four assessment areas are identified in accordance with the GCIO practice and the conceptual model in Section 4, which governments should adapt to their own needs and circumstances:

o *Competences* – the presence in the organization of the competences required to carry out GCIO responsibilities,
o *Perceptions* – perceptions of the organization's technology leaders on the role of the GCIO function and the barriers and opportunities for its establishment and operation,
o *Environment* – whether the existing organizational and institutional environment enables the acquisition and utilization of GCIO competences in the organization, and
o *Utilization* – the utilization of GCIO-related competences in the management of IT and EGOV in the organization.

These assessment areas and their components are depicted in Figure 3 which also includes a one-to-many mapping between the areas and the top-level concepts in the GCIO conceptual model. The assessment areas are elaborated in the following sections.
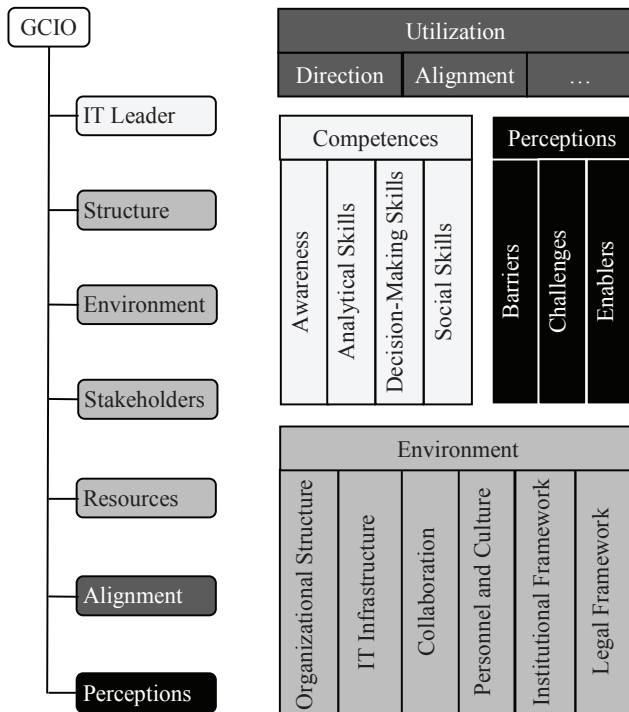

Figure 3. GCIO Assessment Areas versus Conceptual Model

5.1. Competences

This area focuses on assessing the presence and the level of the required GCIO competences among technology leadership of an organization, including knowledge, experience and capabilities.

A technology leader is expected to possess knowledge in four core domains: 1) technology – methods and tools used for software development and application; 2) management – managing projects and programs, aligning them with organizational objectives, and controlling their organizational impact; 3) public administration – norms, procedures and values of government; and 4) domain-specific – the knowledge of the function and level of government where his or her organization is located. The knowledge areas to be assessed are depicted in Figure 4.
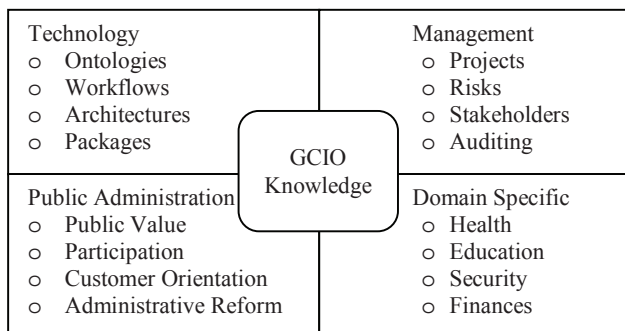

Figure 4. GCIO Knowledge Areas

Experience refers, for instance, to the record of strategic IT initiatives of different type, scope, budget and impact on the organization, developed and managed by the technology leader. Experience could be evaluated through data collected in other assessment areas like for example IT Strategy – management of projects, and Resources – management of resources and budget.

Specific capabilities include:

1. *Awareness* – Is a technology leader able to keep up-to-date with new technologies? This capability can be evaluated through the record of schools, workshops, courses attended, participation in communities of practice and online courses, contribution to online forums and newsletters, and subscription to newsletters and journals, among others.
2. *Analytical Skills* – Is a technology leader able to analyze different ICT approaches and solutions and their impact on the organization? Such skills are required to be able to determine and evaluate alternative implementation paths, and choose the one that is most optimal to the organization.
3. *Decision-Making Skills* – Is a technology leader able to make and justify IT-related decisions and their impact on the organization? Both analytical and decision-making skills can be obtained through formal or continuous education and through in-job learning, and assessed by enquiring about the academic degrees and educational certificates received.
4. *Social Skills* – Social capabilities like communication, leadership, negotiation and consensus-building, are required for technology leaders to be able to introduce innovations to the organization and manage the resulting changes. Such skills could be evaluated through the data collected in the stakeholders and collaborations areas.

As an example, the CIO Wheel proposed by the US Federal CIO Council [13] and revised every two years defines 12 competency areas required from a GCIO working for the US government.

5.2. Perceptions

This area aims at assessing the perceptions of technology leaders on the establishment of the GCIO function in their organization and, indirectly, their attitudes on making this function successful:

1. *Role* – perception of technology leaders on the role of the GCIO function in their organizations to anticipate and address any obstacles that may arise while attempting to develop, implement and sustain the GCIO function; and
2. *Challenges and Opportunities* – Knowing the challenges and opportunities facing the establishment of a GCIO function, makes possible to plan initiatives aimed at utilizing the opportunities and overcoming the challenges. A possible approach to gathering such data is to list the challenges and opportunities using a literature review and local knowledge, and asking technology leaders to rank them.

The outcome will inform the design of any GCIO human capacity building programs for the organization. Table 1 lists a number of common challenges facing a GCIO.

5.3. Utilization

While the presence of specific competences and generally positive attitudes from technology leaders are necessary for establishing a GCIO function, they are insufficient. Many factors could prevent technology leaders from making proper use of such competences and attitudes. In view of this, assessing the actual operation of technology leadership in an organization is very important.

Table 1. Typical GCIO Challenges

1	Insufficient financial resources
2	Insufficient IT resources
3	Insufficient human resources
4	Lack of qualified staff
5	Lack of training programs
6	Lack of communication
7	Lack of awareness about expectations
8	Inappropriate prioritization
9	Lack of time for strategic thinking
10	Lack of political support
11	Lack of collaboration culture
12	Integration of legacy systems

Considering two core functions of GCIO – setting a direction for technological development within an organization and aligning such development with the broader business objectives of the organization, two assessment areas are put forward:

1. *Direction* – To what extent does technology leadership engage in the development of IT and business strategies within their organization and in the monitoring and control of how such strategies are being implemented, including the coordination of the resulting initiatives? This area assesses the work of technology leaders in developing and leading the implementation of IT strategies, programs and projects. Data to be collected in this area includes a portfolio of IT strategies and projects of different types, scope, duration, schedule, budget, staffing and impact on the organization, developed and managed by the technology leader.

2. *Alignment* – In order to ensure that technology contributes to the accomplishment of organizational goals and strategies, a GCIO should have a clear understanding of organizational objectives. Therefore, the assessment must also cover the level of awareness by technology leaders of: 1) the corporate direction of the organization – its mission, vision, goals, objectives and initiatives, and 2) impact of technology and technology-enabled innovation on the structure and working of the organization, and how various projects contribute to achieving desirable impact and fulfillment of organizational goals. This assessment area contributes to determining the understanding and commitment of technology leaders to aligning IT initiatives to broader organizational goals.

5.4. Environment

The last area focuses on assessing the enabling organizational and institutional environment to facilitate the sustained development of GCIO competences and ensure their effective utilization in the organization. The organizational environment is assessed in four areas while the institutional environment in two areas, as follows:

1. *Organizational Structure* – A GCIO should be placed at the highest level in the organization to ensure a voice in defining organizational strategies and in utilizing ICT initiatives to fulfill them. In addition, the institutions and governance structures established to strengthen the GCIO function, such as the CIO Council in the UK [14] are becoming important. Therefore assessment should include: 1) the position of IT leadership function in the authority hierarchy, and 2) organizational structures that support the GCIO function. If GCIO institutions do not exist, the type of governance structures to be created, and the most appropriate regulatory mechanisms for their establishment should be assessed.

2. *IT Infrastructure* – A foundation for building the planned IT capability [14], the IT infrastructure is assessed with respect to the level of proficiency and authority possessed by technology leaders in managing various types of resources [16]: 1) human – numbers and profiles of IT and non-IT staff, 2) software – operating systems, in-house and off-the-shelf applications, tools; 3) hardware – workstations, servers, printers; 4) networks – phone lines, Internet access, intranet services and remote access; and 5) financial – total budget allocated to ICT and its break down into different areas.

3. *Partnerships and Collaboration* – Managing stakeholders represents a major leadership challenge for a GCIO [17]. The aim of this area is to identify the technology leaders' network of stakeholders and to understand their approach for managing the relationships with them. Data to be collected include: 1) internal and external stakeholders; 2) stakeholder segmentation criteria – influence, supporters and opponents; 3) measures for managing the stakeholders' satisfaction; 4) types of formal or informal collaboration and partnership agreements; and 5) activities carried out with stakeholders including events and projects. The stakeholders identified by IT leaders should be categorized according to their leverage.

4. *Personnel and Culture* – The personnel and organizational culture can greatly contribute to strengthening or hindering the IT leadership function within an organization. Data to be collected in this area includes: 1) capacity-building efforts including the type, content, delivery, assessment of training; 2) communication styles – the means of communicating with staff – formal memos, newsletters or e-mails, or informal meetings or whiteboard-supported discussions; and 3) staff appraisals and performance indicators for IT staff.

5. *Institutional Framework* – Institutionalization plays a key role in providing a GCIO with the adequate resources and authority for fulfilling his or her responsibilities. This area evaluates the most suitable mechanisms for establishing the GCIO function, covering: 1) the position of the technology leadership function within the organizational structure including reporting lines, 2) the assigned responsibilities and expected competences, 3) supporting governance structures, and 4) adopted mechanisms for introducing the GCIO function in government through law, strategy, acts or others.

6. *Regulatory and Legal Framework* – The legal and regulatory framework refers to existing laws, regulations, acts, statutes, policies and other enforcement artifacts that promote and facilitate the usage of ICT products and services. This area is to assess whether the existing regulatory framework enables or hinders introducing ICT innovations in government and society. Assessment in this area should cover, for instance, the effectiveness of the traditional legal system, Internet-related laws, cyber-security, digital identification and digital signatures, privacy and data protection, and others.

While the organizational factors (1 to 4) should be assessed periodically to ensure the sustainability of the GCIO function, the institutional factors (5 and 6) are typically assessed only once, when introducing the GCIO function.

6. GCIO ASSESSMENT PROCESS

After defining the GCIO conceptual model in Section 4 and identifying a range of GCIO assessment areas in Section 5, we propose in this section a concrete process to guide the assessment exercise, extending the process presented in [15]. The process comprises nine sequential steps depicted in Figure 5.
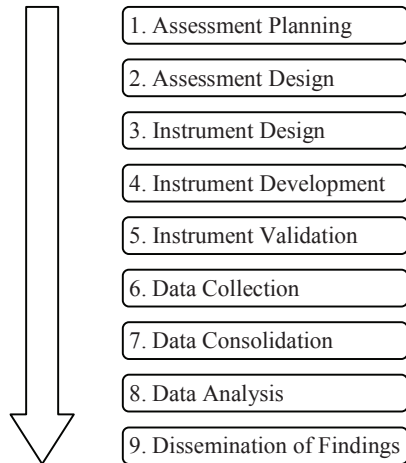

1. Assessment Planning
2. Assessment Design
3. Instrument Design
4. Instrument Development
5. Instrument Validation
6. Data Collection
7. Data Consolidation
8. Data Analysis
9. Dissemination of Findings

Figure 5. GCIO Assessment Process

The process steps are explained below, including aim, required inputs, expected outputs, an approach for performing the activity.

1. *Assessment Planning* – The aim of this step is to define the objectives, target audience, and possible risks facing the assessment exercise. The required input is an agreement between the project manager and the project owner – senior government official responsible for the exercise, specifying the assessment areas and the institutions participating in the exercise. Expected outputs are: the objectives pursued by the exercise, possible sources of information including the list of stakeholders; and the risk factors together with the measures adopted to address them. An approach for conducting the activity is for each assessment area to specify the objectives to determine assessment targets, for each objective to identify information sources, and for each objective and information source pair as well as for the whole process to determine possible risks and mitigation plans.

2. *Assessment Design* – The aim of this step is to define a strategy for conducting the readiness assessment exercise based on assessment objectives and information sources. The required inputs are: the list of objectives and information sources produced in step 1, the list of data collection methods obtained from literature, and the candidates for the assessment team. The expected outputs are: the data collection method adopted for each objective and information source pair, and the assessment team to carry out the exercise. An approach for conducting the activity is to identify the most effective data collection method for each objective and information source pair, and to identify the assessment team based on the list of candidates. Typically, primary data collection relies on questionnaires, observations and interviews [16]. Data collection methods are selected depending on the type of data, source of information and the skills possessed by the assessment team; the team should be assembled at this step.

3. *Instrument Design* – Based on the assessment design, the expected output from this step is a set of guidelines to support the development of assessment instruments. The required input is a list of data collection methods produced in step 2 together with application procedures for each method. For example, questionnaire guidelines should prescribe the maximum number and types of questions [16]: closed – respondents select answers from sets of options, or open – respondents provide answers by themselves. Observation guidelines should specify: the type of activities to be observed, whether the activities should be recorded, a person to act as an observer, and the observer´s role - if he or she participates in the activities. Finally, interview guidelines should determine: the type of interview, for instance an in-depth interview with an individual or an interview with a group of people who share a common experience; the style of interview, for instance structured or non-structured; and whether the interview will be recorded.

4. *Instrument Development* – This step aims at producing the instruments to be used in collecting data, constrained by the instrument design. The inputs comprise: objectives produced in step 1, data collection methods obtained in step 2, and the guidelines prepared in step 3. The output comprises the assessment instruments. Independent of the data collection method adopted, the following top-down approach is proposed for developing assessment instruments [16]:

    a. Define a list of objectives (high-level questions) to be asked, where at least one high-level question should be asked for each assessment area;
    b. For each objective, formulate all associated questions to which answers are sought;
    c. For each associated question, identify all information items required to answer it; and
    d. Formulate the questions to obtain the information (c).

    The questions obtained in (d) are expected outputs of this step, to be directly used as instruments in questionnaires or structured interviews or indirectly in understanding the data collected during observations or non-structured interviews. Supporting tools should be deployed and configured at this step, for instance to conduct online questionnaires.

5. *Instrument Validation* – The aim of this step is to test the instruments before they are officially deployed. The inputs include the instruments developed in step 4, any instrument supporting tools, and representative types of information sources – stakeholders, documents, etc. The output of this step is the feedback used in correcting and improving the instruments. An approach is to run a pilot exercise with reduced number of participants, selected to maximize the opportunity for feedback, and to analyze the data collected through the pilot to determine whether the instruments are suitable for collecting all required information.

6. *Data Collection* – The aim of this step is to gather data from the target respondent group. The inputs are: information sources, instruments, supporting tools, and a data collection schedule. The output is a repository of data. Depending on the method and instruments, the data can be collected using traditional channels - face-to-face, phone, paper forms, etc. or electronically - online forms, e-mails, blogs, etc.

7. *Data Consolidation* – The aim of this step is to assemble and prepare the data collected in step 6 for further processing. The input is the data collected in step 6. The output is a database of clean and normalized data. Spurious registers should be identified, corrected or eliminated; inconsistent data should be normalized e.g. through date formatting or scale standardization, and procedures for processing incomplete data should be followed.

8. *Data Analysis* – This step is to classify, synthesize, compare and summarize collected data to produce expected insights. The required inputs include the database produced in step 7 and selected tools for analyzing data. The output is a list of findings. Many tools can support data analysis - spreadsheets, analytical tools, statistical tools, social network analysis tools, etc. Depending on the volume, data warehousing and data mining might be utilized as well.

9. *Dissemination of Findings* – The aim of this step is to share the findings of the readiness assessment exercise with major stakeholders. Required inputs include the findings produced in step 8, and the list of stakeholders to whom the findings should be disseminated. The output is the dissemination of results. Dissemination methods include distribution of policy reports and white papers to government officials; workshops to present findings, discuss future action and raise awareness; etc. The main usage of the findings is to localize the remaining activities of the GCIO System.

7. CASE STUDY

The assessment methodology proposed in Sections 5 and 6 was applied to assess the IT leadership and coordination needs of Macao SAR Government. This sections aims at describing this experience, including the localization of the methodology, considering separately the nine steps of the assessment process:

1. *Assessment Planning* – Competences and Perceptions were two agreed assessment areas. One objective was defined for each area: 1) to assess the knowledge and capabilities of technology leaders, and 2) to determine the barriers, enablers and challenges for performing the IT leadership function in government. For both objectives, the sources of information comprised IT heads and senior IT staff from 57 agencies and educational institutions. Two risks were identified for the whole assessment process: language barrier and low response rate. To address the language barrier, a bilingual help desk was set up, attended in collaboration with government staff. To address the low response rate, a key agency undertook sponsoring and promoting the activity within government. No specific risks were identified for individual objectives.

2. *Assessment Design* – Based on both objectives, the data was collected from the stakeholders through questionnaires, aimed at collecting the same information from all respondents. The assessment team included two staff responsible for the help desk. A software tool - Lime Survey [17] was applied to administer the questionnaire online.

3. *Instrument Design* – Following guidelines from [16], four design decisions were adopted to guide the development of questionnaires: 1) using closed questions, whenever possible, and including the complementing "Other, please explain" field; 2) setting limits on the size of the questionnaire – the maximum number of questions per section, the maximum number of items per question, and the maximum amount of time to answer the questionnaire; 3) including hints for all

questions to explain valid replies; and 4) restricting the use of technical language and including explanations of concepts.

4. *Instrument Development* – Based on the objectives defined in step 1, the selected data collection method (questionnaire) and the guidelines in step 3, the resulting questionnaire comprised 3 sections, 8 questions and 87 assessment items. The sections were: 1) Knowledge – assessing the training needs in technology and management areas; 2) Awareness Capabilities – assessing the continuous learning practice by the agencies' senior IT staff; and 3) Perceptions – assessing the perceptions of senior IT staff on barriers and challenges. Figure 6 below illustrates the application of the instrument development process from Section 6 to the first objective from step 1 – to assess the knowledge and capabilities possessed by technology leaders. The objective gives rise to four associated questions on the knowledge of technology and management, and on the capabilities and awareness. All four create certain information requirements, which are addressed through detailed questions.

Objective	To assess the knowledge and capabilities possessed by technology leaders
Associated Questions	How much do they know about technology?
	How much do they know about management?
	What are their capabilities?
	What is their awareness?
Information Requirements	Knowledge of technology issues
	Knowledge of management issues
	Formal education
	Continuous learning culture
Detailed Questions	Classify from low to high your knowledge of the following technology topics
	Classify from low to high your knowledge of the following management topics
	Do you have a university degree? If so, indicate the degree and graduation year
	Do you regularly attend professional seminars? If yes, How many times per year?

Figure 6. Instrument Development Example

For assessing technological and management knowledge, a non-exhaustive list of topics representing the state-of-the art was prepared, as shown below. The topics require regular updates based on existing trends and specific public administration objectives e.g. adoption of open source technologies or a specific project management methodology.

Here is a list of topics for assessing technological knowledge:

o networks and communications,
o IT security,
o open source technologies,
o open standards,
o web services,
o workflow engines,
o business process models,
o groupware office tools,
o semantic web and web 2.0 applications,
o cloud and grip computing,

o software as a service,
o customer relationship management,
o enterprise resource planning,
o interoperability frameworks,
o enterprise architectures,
o software development methodologies,
o maturity models and certification, and
o business intelligence tools.

Here is a list of topics for assessing management knowledge:

o project management,
o program management,
o scope management,
o time management,
o cost management,
o performance management,
o quality management,
o risk management,
o human resource management,
o communication management,
o procurement management,
o auditing and controls,
o strategic planning,
o stakeholders management,
o benefits management,
o business case management,
o integration management,
o balance scorecards,
o change management, and
o business process reengineering.

5. *Instrument Validation* – After the online questionnaire was deployed, two activities were conducted to test and validate it. First, the questionnaire was demonstrated to a small number of senior officials and access was provided to selected group of practitioners. The feedback received was incorporated in the new version of the questionnaire. Second, three agencies were selected to conduct pilot exercises with face-to-face interviews carried out to collect opinions. Based on the feedback received from such interviews, the final version of the questionnaire was prepared and disseminated.

6. *Data Collection* – In order to collect data, the questionnaire was published for six weeks online and a printed version was distributed to the target group (IT heads and IT senior staff of 57 agencies and educational institution). During that period, a help desk was open to support respondents. The output was a MySQL database with collected data.

7. *Data Consolidation* – Since the questionnaire was carefully designed and the online version validated the data entry in real-time, the collected data was automatically consistent. The consolidation comprised exporting data to a spreadsheet, converting alphabetic to numeric values, and converting the questions depending on the values of previous questions into standalone questions. From 57 agencies invited to participate, 34 successfully completed the survey (60% response rate).

8. *Data Analysis* – The collected data was analyzed through statistical analysis and graphs. For example, Figure 7 shows the result of assessing the training needs in open source technologies, part of the technology knowledge assessment area. According to the figure, 53% of the respondents consider the importance of training in this area as medium,

38% as high and 3% as very high. Thus 94% consider the importance of training in this area as medium or higher.
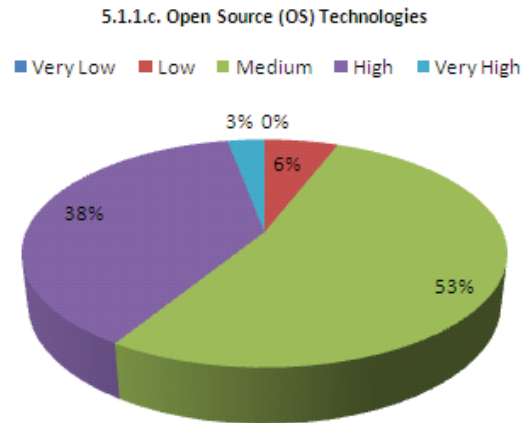

Figure 7. Training Needs in Open Source Technologies

9. *Findings Dissemination* – The findings of the assessment exercise were documented in a policy report delivered to the government, and presented during a workshop for senior officials. In addition, such findings were used to localize other activities of the GCIO system, such as defining the curriculum for building human capacity in government.

8. EXPLOITATION

As readiness assessment is the first activity carried out as part of the GCIO System [2], it has a major influence on the way other activities are carried out. Using numbered arrows, Figure 8 depicts possible exploitation scenarios of the results of readiness assessment upon other activities of the GCIO system:

1. When assessing the enabling environment, the data collected on existing regulations, policies, and laws informs the Legal and Regulatory Framework activity.

2. GCIO authority and responsibilities, governance structures supporting the GCIO function, and the GCIO position candidates all serve as inputs to Institutional Development. The information can be collected through Institutional Framework, except the candidates which could be identified through IT Leaders, IT Strategies, IT Alignment, Resources and Collaborations areas: which competences do IT leaders possess; what portfolio of IT strategies and projects do they manage; what kind of impact and contribution to organizational goals did they produce, what financial, human and other resources do they manage, and which stakeholders do they cater for.

3. Collected as part of the IT Leaders area, the information about existing competences helps identify possible skill gaps and therefore inform future capacity building efforts.

4. The information on collaborative projects, collected as part of the Stakeholders and Collaboration area, helps document ad-hoc collaborative efforts in government, which in turn can contribute to defining more formal approaches to cross-agency coordination, part of the GCIO System.

5. The information on professional associations, forums and training institutions, collected as part of the Stakeholders and

Collaborations, and IT Leaders areas, could be used to establish formal collaborations to sustain the GCIO function.

6. The information on institutions, practitioners and researchers collaborating with IT leaders, collected as part of the Stakeholders and Collaborations areas, should be identified to strengthen international collaboration.
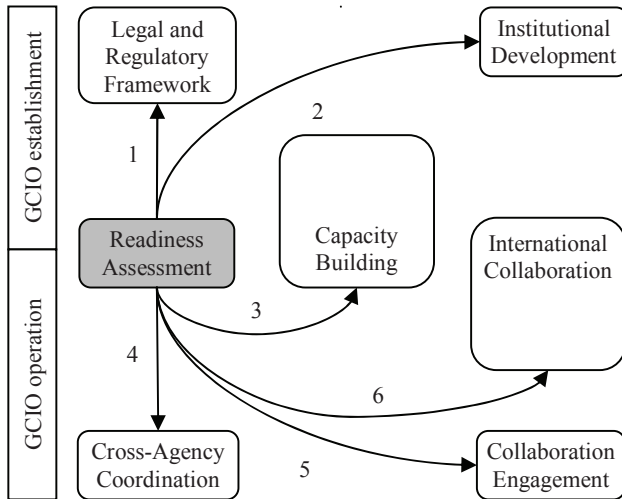

Figure 8. GCIO System Usage Scenarios of Readiness Data

9. CONCLUSIONS

Technology leadership has been recognized as one of the key success factors for the development of Electronic Governance. Increasingly, this type of leadership is delivered through the Government Chief Information Officer (GCIO) function. However, the implementation and sustenance of an effective GCIO function is highly dependent upon proper planning. This, however, should be based on the accurate knowledge of the local conditions, determined through a readiness assessment exercise.

This paper presented a conceptual model for the GCIO function and a methodology, based on this model, to assess the readiness of a government organization for establishing such a function. The methodology comprises a set of assessment areas and a step-wise process to carry out the assessment exercise. The set of areas takes into account the presence of the required competences among the government workforce, how the competences are used to perform the technology leadership role, and how the environment supports the continuous development of competences and the GCIO function as a whole. The process covers the full life cycle of an assessment exercise, from planning, through construction and testing, to dissemination. The methodology was validated through a readiness assessment exercise conducted in a city-state government in Asia. The paper presents this experience, and also shows how the collected assessment information can be used to localize the whole GCIO development effort.

The main contribution of this work is a GCIO conceptual model and a holistic, action-oriented methodology to assess the readiness of a government organization for establishing a GCIO function.

Our future work includes developing detailed guidelines for localizing the GCIO development activities, including curriculum development, based on the findings of the assessment exercise.

ACKNOWLEDGMENTS

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