Coordinating Higher Education as an e-Government Initiative

Olga Cherednichenko[1], Dmytro Kuklenko[1], Sergiy Zlatkin[2]

[1)] Computed-Aided Management Systems Department,
National Technical University "Kharkiv Polytechnic Institute",
Kharkiv, Ukraine
marxx@kpi.kharkov.ua, dmytro.kuklenko@gmail.com

[2)] Department of Information Systems,
Massey University, New Zealand
s.zlatkin@massey.ac.nz

Abstract: Government plays a key role in providing higher education. It supplies policies and regulations, information to the society, administers funds and licensing, develops standards, etc. In the context of total e-Governing Ministries of Education of many countries initiated the creation of supporting information systems. These systems in most cases are limited to providing information resources of different kinds to the society by web-portals. Administering and coordinating functions are left out for some reasons. In this paper we discover the typical structure of higher education, different stakeholders involved in the process of providing higher education services, information and data flows. We discuss the key functions that information systems must support. And finally we propose the e-Government higher education reference model to be addressed when developing such information systems.

1 Introduction

One of the main government operations is the formation and execution of the highly-effective policy in many areas of human activity, such as trade, education, medicine, social welfare, law, entertainment, etc. [Wi06]. The policy must ensure the political means for stable and straightforward development of a country.

The system of state regulation has a complex hierarchical structure. This structure consists of the following three decision making levels:

- legislative and executive power, i.e. such superior bodies as President, Premier, Parliament, Cabinet of Ministers, etc.;
- ministries and others public authorities;
- business sector, i.e. companies of all forms of ownership as well as non-profit organizations.

Regulation involves a variety of diverse tasks. Decision making as well as coordination of made decisions take place at all levels of a government hierarchy. That is a complicated state-run process, and therefore requires formalization and ICT support.

The effectiveness of the decisions the top managers made depends to some extent on the quality of the information provided. Large volumes of information accumulated during government operations, large number of parameters have to be considered, their multidimensional and complex nature – they all require advanced technology available. The concepts of e-Government seem to be the suitable contemporary technology [Pa02].

As mentioned above, education – and particularly higher education – is an important and one of the most prior activities of the state. The quality and effectiveness of higher education define to a significant extent the success of the nation. That is why wealthy countries pay much attention to education.

Volumes of information that need to be collected, stored, processed and circulated are enormous. In general we can classify them as follows:

1. Information about institutions of higher education (IHE) that perform undergraduate and postgraduates trainings. Examples of IHE are Universities, institutes of technology, polytechnics, academies, etc. The types of IHE financing (i.e. public, private, or mixed) should be also considered.
2. Specialties/programs run by IHE, their codes, prerequisites, etc.
3. Statistical information related to the number of graduates for all existing specialties.
4. Statistical information about the students for all IHE, including the number of students for each specialty, year of studying, financial support, residential status, etc.
5. Forecasting information, i.e. figures on predicted numbers of students, potential applicants, labour market demands, etc. for a particular time period.
6. The data related to the IHE size. That includes the number of academic, general and casual staff, available lecture halls and laboratories, libraries, original learning resources, etc.
7. Other secondary information.

E-Government is not just about moving on-line or other sort of computerization. It is also the way to analyze and rethink the existing structure of the system of higher education, its functions, processes, etc. It is the way to modernize, optimize and reengineer it. Therefore, the primary goal of this research is to have a deep look into different education systems, investigate commonalities and similar requirements. When those are identified, we propose the e-government higher education reference model. We list its main components, specify information flows and define protocols supporting those flows.

The rest of the paper is structured as follows. In the next section we briefly recall existing e-Government standards and solutions. In section 3 we discover the typical structure of higher education, stakeholders involved in the respective processes, data and material flows, and provide the respective models. Section 4 proposes the e-Government higher education reference model that we advise to follow when developing education

supportive information systems. We conclude the paper and discuss our future and ongoing works in section 5. And finally we provide the list of our references.

2 Concepts and approaches of e-Government

Recently e-Government turned into a vivid research area. We believe the following were the main factors for its quick evolution:

- rapid growth of life speed that supposes intensive information exchange between people, organizations, and official government agencies; and
- fast development of information technologies, especially in the Internet sector.

Many definitions exist for the term 'e-Government' (see e.g. [As05, Pa02, Ri03, Sa02]). We prefer the definition given in [As05], i.e.: *"Electronic government refers to a situation in which administrative, legislative and judicial agencies (including both central and local governments) digitize their internal and external operations and utilize networked systems efficiently to realize better quality in the provision of public services."*

The main goals of creating and deploying e-Government systems are the following:

- transparency of governmental institutions functioning;
- simplification of the bureaucracy routine;
- making the official documents and acts available for all citizens and organizations by means of web publishing;
- support for on-line document exchange, etc.

The same resource classifies existing e-Government models and systems as:

- **G2G**, i.e. Government to Government. This class of e-Government systems suggests information exchange between different official institutions or agencies;
- **G2B**, i.e. Government to Business. G2B systems usually aim to ensure transparent tendering or registering business trades;
- **G2C**, i.e. Government to Citizens. These systems can provide different functions to citizens, including tax payment, voting, etc., but mostly they just provide on-line access to documents, forms, and services.

Many solutions exist for government agencies (departments) of various types such as internal affairs, immigration services, police, embassies of foreign representatives, etc. However, if we pay our attention to e-Government solutions that support different aspects of higher education, the whole picture would not be so spectacular. The most popular type of e-Government solutions in this sector are web-sites of respective Ministries and agencies that usually provide only factual information. One can see examples of these resources in [Fe06, Mi05, Ne06].

However, the problems and tasks that exist in the national education sector are more complex than just “going on-line” and therefore require more sophisticated models and solutions.

3 Higher Education System Discovered

The quality of higher education is one of the main factors that ensure the nation success. The problems of higher education effectiveness and quality are very typical for all fields of educational policy. Such aspects as government role, financing and subsiding principles, responsibilities of IHE’s administration, and many others have to be considered in this context.

The primary goal of the educational policy is to satisfy the nation needs in highly educated citizens. The successful development of educational system requires a tradeoff between public (state), local (region) management and IHE autonomy. Special requirements are made to higher education because it is the basis for developing a modern society.

In analogy to the state regulation we can distinguish the following decision making levels in the higher education (see Figure 1 for graphical representation):

1. Government.
2. Higher Education Coordinating Unit (HECU).
3. Level of IHE.

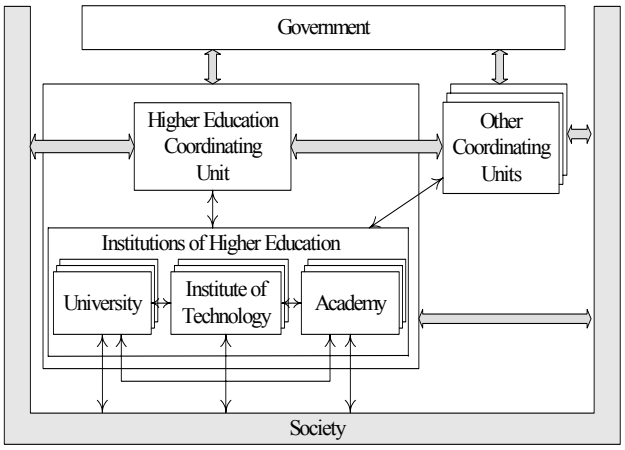

Figure 1 – Decision making level in the system of higher education

We have discovered that the structure of the system of higher education (SHE) is typical for many countries. The governmental level is represented by the Cabinet of Ministers. The Ministry of Economy and Ministry of Finances implement the direct management of economy based on the national budget. The role of HECU is “played” by the Ministry of

Education (e.g. in New Zealand [Ne03]) or the Ministry of Education and Science (e.g. in Ukraine [Mi05]). Qualification Authorities, Teachers Councils, Career Services are other important coordinating units. On the level of IHE universities, institutes of technologies, polytechnics, academies, etc. exist. These institutions run under-graduate and post-graduate programs.

As Figure 1 illustrates, SHE contains several internal and external relationships. Below we emphasize the types of these relationships:

1. **Government – HECU**. This relationship type defines the interaction between the government and the agency that coordinates higher education. Government determines the public policy in the higher education sector as well as its strategy and development priorities. The amounts and destinations of the budget allocations are also defined on the governmental level. HECU elaborates strategic and tactical plans how educational policy should be implemented, how budget should be accumulated, etc.

2. **HECU – IHE**. In this type of relationships HECU forms common standards of higher education quality, allocates grants and awards, manages licensing and accreditation (see [GC03] for details). IHE in turn provides to HECU reports of any kind, development plans, etc.

3. **SHE – Society**. The system of higher education exists and develops according to the society needs in qualified specialists. Society defines the goals of SHE, uses the results of its functioning, estimates those results and performs a control over SHE. Interaction between SHE and the society is performed in different ways: applicant-to-IHE, applicant-to-SHE, student-to-IHE, business-to-SHE, business-to-IHE, citizens-to-government. Different interaction relationship types between the society and SHE define different types and parameters of data flows.

4. **SHE – Other Coordinating Units**. The higher education sector is closely related to other sector of the national economy. It is necessary to take into account the communication of SHE with other coordinating units. For example, the central coordinating unit in the health sector influences forming the policy for doctor training. On another hand, information about number of graduates in different specialties has to be taken into account when forming the state policy in the economical and social sectors.

Various tasks of coordination and control in SHE can be named. Considering the three-level structure of SHE we can define the main tasks typical for each of the decision making level (see Figure 2). The following points define the structure and parameters of data flows that exist in the public administration and coordination system of higher education:

- National specifics of SHE;
- Coordination and administration methods in use;
- Specifics of solving tasks.

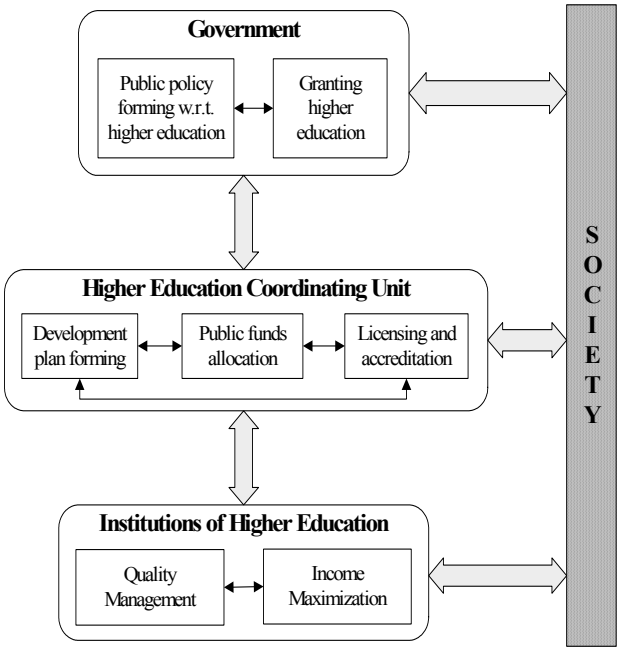

Figure 2 – Main tasks of SHE parties

We consider the main types of tasks that are solved during the administration and coordination processes in SHE and define their most important data flows.

On the governmental level the following tasks can be distinguished:

- Forming the public policy in the higher education sector (see Figure 3-A);
- Defining the public funds volumes aimed to support the development of higher education (see Figure 3-B);
- Forming the plan of SHE development (see Figure 3-C);
- Granting IHE (see Figure 3, D);
- Licensing and accreditation.

On the level of HEEs usually the following main tasks are solved:

- Managing the quality of education;
- Managing the research quality and intensity;
- Income maximization.

Large volumes of data flows in SHE, their complexity and interrelationship require ICT support. Taking into account the different nature of SHE in different countries we first target at common e-Government higher education reference model. In this model we try to embrace all required components that are common for every SHE.

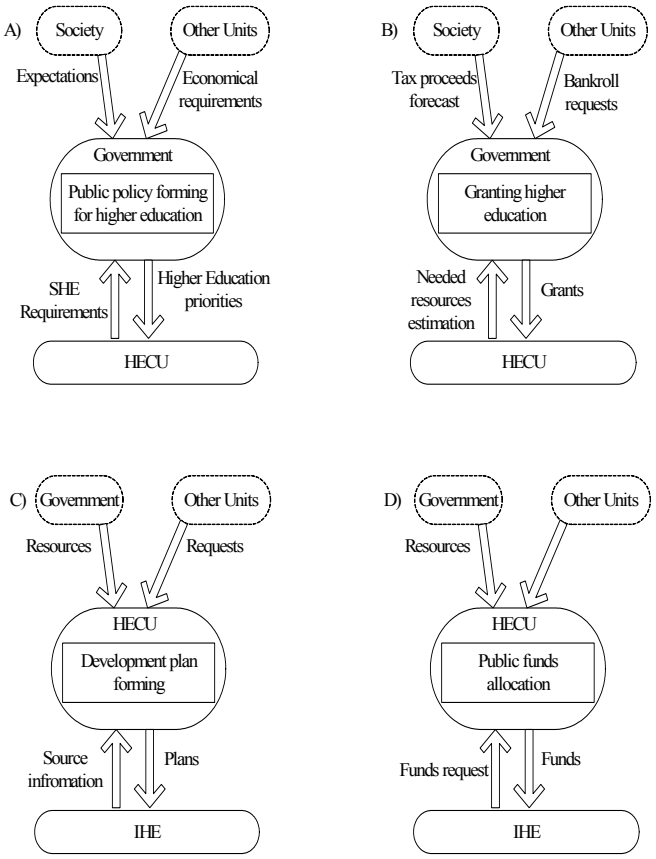

Figure 3 – Data flows between SHE parties

4 E-Government Higher Education Reference Model

In this section we propose a common reference model for e-Government higher education systems. In analogy to [Ho95] we identify characteristics, terminology and components of those systems, enabling the individual specifications to be developed within the context of an overall model.

Figure 4 illustrates the major stakeholders, components and protocols of the system architecture. These are discussed in turns below in this section.

4.1 Higher Education Coordination Unit

The key node of the model is HECU. It coordinates the functioning of various IHE, performs the HES-related data integration and federalization. It also provides data access and presentation services to all stakeholders of SHE.

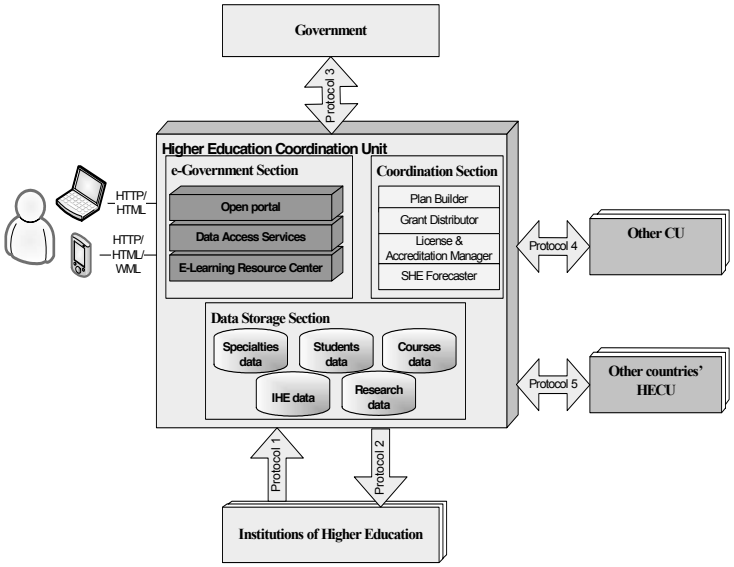

Figure 4 – E-Government Higher Education Reference Model

Although many common systems may be in use in different HECU (e.g. database management systems, content-management systems, workflow management systems, BIS, etc.), below we discuss components related to education purposes only. We believe some components are required and recommend every HECU to deploy them. We classify these components by the services they provide:

1. Coordination services.

- Plan Builder, assigned to build SHE development plan. Various mathematical and computational methods can be used to obtain such plan. We discussed some of these methods in [GC02];
- Grant Distributor, allocating the budget between different scientific branches, IHE, specialties, etc.
- License and Accreditation Manager, coordinating the licensing policy in SHE, i.e. licenses validity control, correction of license supporting documents, etc., as well as accreditation of IHE.
- SHE Forecaster, elaborating the forecast of SHE development. Various statistical data, including fertility and death rates, IHE functioning indices, public budget parameters etc. should be taken into account during the forecast development.

2. **Data Integration services.** Components of coordinating services process statistical data to generate correct and fair outcomes. To be deployable in any SHE node those components must operate the data with a predefined structure. We are currently working upon education ontology reflecting common data terms and structures. Obviously, data collected for different SHE and IHE are diverse. But the major data categories are common. We classify those data categories as follows:

   - IHE data, i.e. the name, type, location, internal structure, number of staff, etc.
   - Research data, i.e. information about research directions and projects, leading researchers, etc.
   - Specialties data, i.e. information about programs/curriculum each IHE runs on both under-graduate and post-graduate levels.
   - Courses data, i.e. information about what courses each program/IHE provides, which courses available for e-learning, etc..
   - Students data, i.e. statistical information about the number of current students (their social status, gender, age, etc.), graduates per program/IHE, etc.

3. **e-Government services**. These services play the principal role in the whole model since they allow distribution of the SHE-related data among authorized stakeholders and citizens. By providing such functionality we achieve the goals of e-Government system that were described in section 2. These services include the following:

   - Open portal. This provides on-line access to the information and services of SHE and to be used by various user categories (IHE entrants, scientists, businessmen, journalists, etc.) that need to obtain official data related to higher education.
   - Data Access Services. By implementing these services we provide an authorized access to stakeholders that can (or should) serve as HECU data providers and/or data receivers. So, universities should upload their reports and statistical indices as well as they should obtain revived curriculum standards or can get information about available options for granting.
   - E-Learning Resource Center. This component serves as an official catalogue for existing e-Learning systems and courses. Visitors can quickly find necessary e-Courses or get familiar with the e-Learning options available in the nation HES.

4.2 Institutions of higher education

In the IHE node their own information systems exist. These systems can have different destinations that are traditional to universities and other similar institutions, including students and staff accounting, library, e-Learning system, on-line enrollments, research output databases, etc. We do not pretend to construct any kind of internal reference model for any IHE node. But we intend that an interaction between IHE and HECU nodes (as well as between HECU and other stakeholders) has to be organized according to the defined *data exchange protocols* and transfer data of a defined structure as we claimed in the previous subsection. In this paper we do not provide the explicit specifications of these protocols, rather we give their informal definitions.

Protocol 1. This protocol is intended to transport into HECU the data specified in the previous subsection. Because those data are semi-structured the optimal transportation format is XML [GP04]. After having been received, those data are parsed and saved in the internal HECU database. As mentioned above, an ontology and XML-based specification for the protocol 1 are under development.

Protocol 2. This is a ”reverse” protocol. Data generated by respective Coordinating Services of HECU are supplied to IHE.

4.3 Government and other reference model stakeholders

In this section we consider the data flow between government and HECU. We leave out of the scope of this paper the internal structure of the government IS. The same way we distinguish the data flow with other public agencies that participate in higher education management. These agencies include the foreign HECU, which coordinate e.g. exchange of students, lecturers, etc., and other national agencies related to another economical or social fields. Analogous to protocols defined in the previous subsection we will briefly introduce other data exchange protocols related to HECU.

Protocol 3. This protocol is used for data exchange between government and HECU and allows transferring the priorities in higher education sector from the governmental level to HECU. It should be developed according to principles of G2G systems.

Protocol 4. It allows the data communication between HECU and other coordination units that can take part in higher education management. Example of a coordination unit is the Ministry of Health that coordinates the nation standards used for physician trainings.

Protocol 5. The protocol is aimed for data communication between different countries' HECU.

Protocols 4 and 5 have to support both G2B and G2G type of systems.

We assume that government, HECU of partner countries, other CU have their own e-Government solutions implemented and deployed. Because e-Government is a relatively new area, we also assume those systems are similar in a way they collect and provide data. We therefore believe using web-services, specifying the order of their communication (e.g. in BPEL [An03]) and orchestrating them by means of available technologies should be the core of Protocols 3-5. Though, additional research is required.

Besides these protocols that are aimed to provide a connection between different organizations, a set of protocols that realize G2C communication is needed. These protocols must allow citizens to access HECU Open Portal resources using different devices, such as PC, PDA, mobile phones etc. online.

5 Conclusions and Future Works

In this paper we have investigated the common structure of the system of higher education. We discovered the major stakeholders, their expectations and responsibilities. We then proposed e-Government higher education reference model. That model considers the typical tasks of higher education management on the national level. We advise this model to be taken into consideration when designing and developing any information system for the higher education sector.

We are currently developing domain ontology that will provide a glossary of terms related to the higher education. It then to be used as a base for XML-like language supporting data exchange protocols 1 and 2. Some parts of it may be used for other protocols as well.

We also plan to use all cumulative experience on forecasting models and algorithms to develop a prototype for the SHE Forecaster component of the proposed reference model. Narrowing ourselves to using ontology of educational terms common for any SHE and IHE, makes this task feasible.

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