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Building an Open Lab on Information Quality for Future Computer Education

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***Abstract*—The first Open Lab on Information Quality (OLIQ) is planned and being offered to prepare trainees for careers in industry and government as well as advanced graduate studies. The Lab is built according to the vision, mission, strategies and objectives, which can be achieved by two types of roadmaps, one is the roadmap of research and development (R&D), and the other is strategy roadmap. Research areas, current projects and training courses in the OLIQ are provided in the detail. The training integrates two key educational innovations: (1) an interdisciplinary approach to curriculum design, and (2) a balance between theoretical rigor and practical relevance.**

***Index Terms*—Information Quality, Data Quality, Open Lab, Roadmap, Computer Education**

I. INTRODUCTION

We are experiencing a transition from an industrial economy to an information economy. The current era is associated with widespread and successive waves of innovations in information technology (IT). Technologies such as Internet, electronic commerce, World Wide Web (www) and mobile commerce bring with them ubiquitous connectivity, real-time access and overwhelming volumes of data and information. Vast databases holding terabytes of data and information are becoming commonplace[1]. Data and information have become as much a strategic necessity for an organizations' well being and future success as oxygen is to human life [2]. In 1999, Bill Gates [3], the founder of Microsoft, stated:

"*The most meaningful way to differentiate your company from your competitors, the best way to put distance between you and the crowd, is to do an outstanding job with information. How you can gather, manage and use information will determine whether you win or lose*".

Gates' statement implies that there are some issues that traditional information management systems have not addressed. One critical issue in particular is the quality of data and information an organization should gather, manage and use [4]. Almost every activity in which an enterprise engages requires data and information and without adequate quality, the activity may not provide a quality outcome. In addition, quality of data and information is not an option because of various mandatory types of legislation. Organizations are coming to realize that they must provide the quality information expected by their customers "or run the risk of legislation that forces them to provide such quality"[5, 6].

The remaining paper is as follows. Section 2 reviews related work on data and information problem. Section 3 describes the strategies of OLIQ. Section 4 describes details of the two roadmaps and provides details about specific implementations and how they relate to relevant ISTIC goals. Finally, in Section 5 we conclude the research areas, current projects and training courses in the OLIQ

II. LITERATURE REVIEW

The literature emphasizes that national and individual enterprises, including those organizations responsible for providing statistics at national level, have far more data than they can possibly use. Yet, at the same time, they do not have the data they or the society actually need [1, 2]. Furthermore, the stored data and information may be obsolete, ambiguous, inaccurate or incomplete. In other words, enterprises have achieved 'quantity' of data and information but not necessarily the 'quality' of either [7, 8].

The relevance of information quality to strategic decisions and public debates has recognized by several governments, institutions and organizations. For instance, the mission of the European Statistical System is defined as follows: "We provide the European Union and the world with high quality information on the economy and society at the European, national, and regional levels and makes the information available to everyone for decision-making purposes, research, and debate"[9].

Poor information quality is not only prevalent in government departments and manufacturing and service organizations; it can also be at the root of many disasters of national and international importance which dominate the news [10]. For example, the explosion of the American space shuttle Challenger is related to a information quality perspective; the analysis reports present more than ten different categories of information quality problems having a role in the disaster [11]. Considerable part of the damage resulted from the earthquake disaster in China in 2008 is due to information quality problems, among them the unavailability of adequate flow of information, lack of accessibility to information, and incomplete, inaccurate or out-of-date information[12]. The case is more obvious with the latest disaster in Australia resulted

from bushfire during February 2009. The importance of information quality has been emphasized by Al-Hakim [4].

While the costs of poor information quality are recognized but not yet estimated at national level in China, It is estimated that the information quality problems costs U.S. businesses more than 600 billion dollars a year (Data Warehousing Institute, 2002). The total cost of the work done in preparation for Y2K (Year 2000 Problem) is estimated at over 300 billion [13]. The Y2K problem is a good example of poor information quality practice of using only two digits to representing a year. Problem in healthcare services makes problems associated with information quality the eighth leading cause of death in the United States, with a total cost of injuries related to medical errors exceeding U$17 billion a year [14]. In a survey of NHS trusts in England, the National Audit Office found that almost one million medical mistakes were reported in 2004-05, costing around 2bn Sterling. It is estimated that 200,000 mistakes went unreported. In regard to the number of deaths resulting from these mistakes, the survey concludes that "NHS simply does not know" [15].

Such problems, errors, costs are motivations at the basis of the several initiatives that are being launched in the public and private sectors, with information quality having a leading role; the initiates include, for instance, the Data Quality Act effected by the United States government in 2002 [16].

III. STRATEGIES OF OPEN LAB ON IQ

A. Vision

The vision of Open Lab on IQ (OLIQ) is to be recognized as a world leader in delivering information quality services focused on facilitating decision-making processes and on improving customer satisfaction.

B. Mission

The OLIQ works as part of ISTIC and with its stakeholders to develop standards, concepts, methodology and frameworks to help executives, decision-makers, researchers and other scholars address the information related challenges. The validity of our works is ensured by the active collaboration and participation of various key government, R&D, production and service industry, institutions and organizations at national and global levels.

This mission can be achieved through maintaining OLIQ as a viable laboratory that:

- Develop standard for quality collecting, processing and dismantling data and information. This includes also national statistical data and information related to economy, finance, healthcare and population topology.
- Develop tools, techniques and methodology for information
- Pursues world-class research, research and practices on information quality.
- Collaborating with other academic and research institution in providing internal and distance-education on information quality.
- Engages with communities, business and government through ongoing and mutually beneficial partnerships.

C. Strategies and Objectives

The broad strategies of OLIQ include:

- Facilitate team-based multi-disciplinary collaborative research within ISTIC and with external partners including R&D institutions and Universities, both nationally.
- Establish collaborative links with other related labs and centers, both nationally and internationally.
- Establish collaborative links and projects with manufacturing and service industry and Government organizations

The OLIQ uses the above strategies to achieve the following aims and objective:

- Establish a research incubator for identifying industry focused information quality research needs.
- Develop strategy, policies and procedure for information quality assurance both for government and private industry and organizations.
- Develop computer software, techniques and methodologies for assessing and improving information quality for various industrial and government sectors.
- Provide distance education programs and courses on information quality for postgraduate research students.
- Provide continuing education for the profession in the form of short courses and training programs.
- Asses and review information quality projects and proposal for information quality submitting for funding from Government organizations.
- Provide specialist consulting and strategic advice to industry and Government organizations in the field of information quality.
- Disseminate research outcomes through reports, policy guidelines, seminars, journals and conference publications.

IV. ROADMAPS OF OLIQ

There are two types of roadmaps, one is the roadmap of research and development (R&D), and the other is strategy roadmap. All of them are brought into practice from 2009 to 2014.

A. R&D Roadmap

The R & D roadmap we propose in Figure 1 consists of four major elements: The first element is the roadmap's vertical structure. It consists of four contents or outputs on information quality lab that categorize crucial achievements according to their relation to the target community, the basic theory, technical methodology, detecting tools, , and to its architecture.

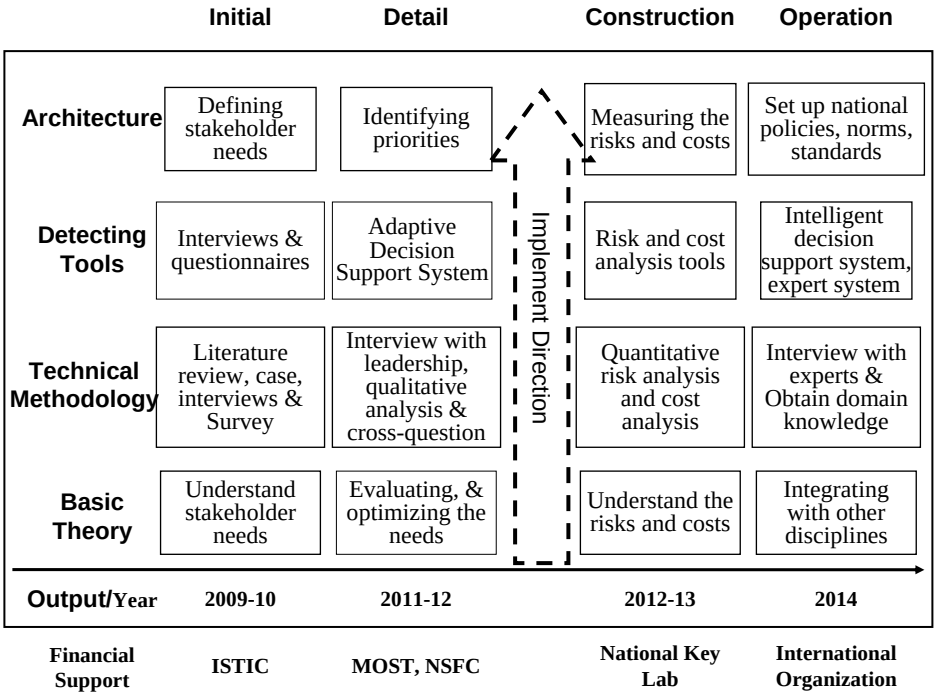

Figure 1. R & D Roadmap

The next element of the roadmap is the horizontal structure, which is divided into four phases. The four phases represent the life cycle of lab from our point of view: it is searched and found, evaluated, adapted to a new context (allocated in our terminology), and applied. The information quality studies– the third component of the roadmap – are placed along these phases according to their importance for the different phases. How these studies can be improved is answered by the last element of the roadmap, the management stages. The stages help to plot out the key areas of research in every phase. In the following sections we describe these elements in detail.

1) Initial Phase

a) Understand stakeholder needs: Consumers rate the quality of products and services they buy based on how well they satisfy their needs or purposes. Knowledge workers will also characterize information quality based on how well it meets their needs for the information, whether to perform a process, support a decision, or answer a question.

b) Literature review, case, interviews & Survey: The choice of evaluation criteria can either be based on intuitive understanding, industrial experience, literature review, or consumer interviews.

c) Interviews & questionnaires: As far as tools are concerned, we convert the criteria into questionnaires that specify various aspects of the criteria.

d) Defining stakeholder needs: This process defines the essential and critical characteristics of information definition and information architecture.

2) Detail Phase

a) Evaluating, & optimizing the needs: All of these process stress the identification or selection, evaluation or assessment, transformation or allocation, and application or use of information.

b) Interview with leadership, qualitative analysis & cross-question: This methodology is qualitative and user oriented because it generates linguistic recommendations on the information quality of the content-based Web sites based on users' perceptions.

c) Adaptive Decision Support System: This study proposes a new technique, namely the Adaptive *Decision Support System* (ADSS), for simplifying existing quality detection and removal methods. This technique is developed based on a modified backpropagation algorithm using a fuzzy membership function on the error term. It is able to make use of noisy info in a single step, with an automatic adjustment of information contribution to network training.

d) Identifying priorities: We use a cost/benefit evaluation model to ferret out the poor-quality information and set priorities for improvement given limited resources. Our approach allows system developers to document relevant quality info as metadata, which may be associated with the whole life cycle of information systems.

3) Construction Phase

a) Understand the risks and costs: The risks associated with making decisions based on poor-quality information are quite high. Consequently, the management of information quality and the quality of associated information management processes has become critical for organizations. An important first step in managing information quality is the ability to

TABLE I. STRATEGY ROADMAP

Year	Roadmap of Open Lab			
	Strategy	***Activity***	***Element***	***Function***
2009	committee	Set up advisory committee	International experts	Recommendations Development Practice New research direction OLIQ assessment study Participate in collaborative research
		Set up steering committee	National experts	To discuss strategy Provide direction Facilitate research Facilitate cooperation
2009-2014	Cooperation	Set up contact with international	Link with international universities, research institutions	Set up collaborative research Sharing information
		Set up contact with national	Link with domestic universities, research institutions, industry	Set up mutil-discipline research group Set up education and training institutions Development of computer software Set up cooperation projects Accreditation assessment
2010-2014	Education	Set up the postgraduate education of IQ	Link with the University set up information quality of master's and doctoral programs.	Set up program On-campus education Distance education Online education
			Link with R/D and industry to establish educations training.	Short programs On-campus education Distance education Online education
2010	Consultation	Set up domestic consultants group	Establish national multi-disciplinary Advisory Group	Provide consulting to Government organizations Sevice industry Manufacture enterprise
2011		Set up international consultants group	Establish international multi-disciplinary Advisory Group	Provide consulting to Government organizations Sevice industry Manufacture enterprise

measure the risk of information products (derived data) based on the quality of the source data and associated processes used to produce the information outputs.

b) Quantitative risk analysis and cost analysis: For purpose of quantitative analysis, we examined the relationship between actual stakeholder participation and organizational benefits and between desired user and costs.

c) Risk and cost analysis tools: Above approach provides a way to directly attack the areas of greatest current cost to the company by supplying common data collection and analysis tools in the production, inspection, and repair areas.

d) Measuring the risks and costs: we provide measurement of the trade-off between risk and detection costs and provides an example of calculation of costs of incompleteness.

4) Operation Phase

a) Integrating with other disciplines: Staff at The Open Lab for Information Quality (OPLQ) have worked with an extensive list of partner organizations from a range of disciplines. These stakeholders express a desire to see improvement in the standards of information quality, and display a willingness to embrace new approaches in order to achieve change.

b) Interview with experts & Obtain domain knowledge: We are going to choose based on existing literature (e.g., articles on scholarly writing and academic journal review policies), common sense and interviews with experts.

c) Intelligent decision support system, expert system: An Intelligent decision support system (DSS) with multi-alternative implementation scenarios is proposed to enhance the quality assurance process.

d) Set up national policies, norms, standards: We will set up national policies, norms, standards on information quality both for government and private industry and organizations.

B. Strategy Roadmap

In the strategy roadmap in Table I., we define the strategies which can achieve the functions demanded. These functions are consistent with our aims and objectives of OLIQ required. In order to achieve these functions, we define the elements and activities within the scope of three broad strategies mentioned above.

As part of the ISTIC, OLIQ is mainly engaged in research work. However, because of IQ study a very wide-ranging and many required resources. Strategic roadmap above provides a good solution, that is, to engage in employment of its graduate student research. These graduate students possibly come from other universities which are contacted with ISTIC. This can make other universities can also participate in the study of OLIQ. Training courses can be taught by outside professor and experts who can also hold the position of project director. They can cooperate with the OLIQ through the contract, in this way OLIQ will become a leader in the information quality of .China.

V. RESEARCH AREAS

Information Quality is an interdisciplinary research, so it is necessary to make decision at any time. In accordance with the current research projects undertaken by the Center of Resource Sharing and Promotion, we will give priority to some areas of the following: 1, Information sharing 2, Medical and health 3, Emergency disaster 4, Education (human resources, project) 5, Financial Accounting 6, Logistics 7, Environment and Energy Conservation 8, Infrastructure 9, Information security

A. Current Projects

1) "Reducing disruptions affecting surgical flow inside operating rooms" research.

This research considers actions conducted inside operating rooms with the aim of reducing disruptions in surgical flow using information quality concepts.

The research tackles the following main research questions; how can disruptions affecting surgical flow inside operating rooms be identified and eliminated prior to start of surgical session?

To achieve this research question, two sub-research questions should also be answered;

What information is needed from actions conducted outside operating rooms before starting and completing the surgical sessions?

How can the interdependencies between information govern actions inside and outside operating rooms be identified and mapped?

2) Assessing the Extend of honesty in the Not for Profit Sector in China: Information Quality Perspective

The not-for-profit sector is funded mainly by government funds and fund raising. Honesty in this sector can significantly enhance its reputation and its ability to attract funds to support the services that it provides

The motivation for this project is to gauge the perceptions about the importance of truthfulness, the incidence dishonesty in this sector, methods used to conduct dishonesty events, and characteristics of dishonest perpetrators. The project uses information quality concepts to identify the main factors contributing to fraud in not-for-profit organisations and the effectiveness of existing prevention methods, and the proposed required actions. The project aims to determine the best preventing methods to deal with fraud.

3) Reducing information Quality Risk for Disaster management

Disaster management depends on large volumes of comprehensive, accurate, relevant, on-time information that various organizations systematically create and maintain. One cannot assure information quality (IQ) without first being able to measure it meaningfully and establishing a causal connection between the source of IQ change, the IQ risk types, the types of activities affected, and their implications. This research hopes to propose a general IQ risk reduction framework. In contrast to context-specific IQ risk models, which usually focus on a few variables determined by local needs, presented framework consists of comprehensive typologies of IQ risks, related activities, and a taxonomy of IQ dimensions organized in a systematic way based on semiotic theories and practices. The framework can be used as a knowledge resource and as a guide for developing IQ risk measurement models for many information technologies which can offer a variety of opportunities to aid management and recovery in the aftermath of disasters.

B. Training Courses

Following the Master Degrees for Computer Science (MDCS) 2008 guidance, the training courses also has five building blocks. A comparison of two courses is summarized in Table II.

VI. CONCLUSIONS

Institute of Scientific and Technical Information of China (ISTIC) began building IQ training courses in Fall 2009. The first Open Lab on Information Quality (OLIQ) is planned and being offered to prepare trainees for careers in industry and government as well as advanced graduate studies. The Lab is built according to the vision, mission, strategies and objectives, which can be achieved by two types of roadmaps, one is the roadmap of research and development (R&D), and the other is strategy roadmap. Research area, current projects and training courses in the OLIQ are provided in the detail. The training integrates two key educational innovations: (1) an interdisciplinary approach to curriculum design, and (2) a balance between theoretical rigor and practical relevance.

As is true for any pioneering programs such as the first computer science, the first information science, or the first healthcare program, the creation of the OLIQ program at ISTIC encountered several difficulties, the primary of which was to justify the need for creating such a program. We resolved this difficulty via several means. We conducted surveys to estimate demand in the industry and to project the enrollment in the next few years. We also established strong relationships with the industry and other academic institutions to gain their support ranging from student scholarships, internship opportunities, software, and instructional materials.

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TABLE II. COMPARISON OF MDCS 2000 AND OLIQ PROGRAM

MDCS 2008 Curriculum	Training Courses in Information Quality
IS Foundation: Prescribes a minimum level of prerequisite IS knowledge. • Fundamentals of IS • Hardware and Software • Programming, Data and Object Structures	Trainees will meet this criterion through the admission requirements for the OLIQ Program. It is anticipated that the majority of trainees entering this OLIQ Program will possess either a degree related to information technology or have work experience in this area.
Business Foundation: Prescribes a minimum level of basic business knowledge. • Financial Accounting • Marketing • Organizational Behavior	Trainees will meet this criterion either through other academic work or through work experience. It is anticipated that the majority of trainees entering this OLIQ Program will be working professionals familiar with a variety of business functional areas and processes.
IS Core: Defines the minimal knowledge required of all MDCS students. • Data Management • Analysis, modeling, and design • Data Communications and networking • Project and change management • IS Policy and Strategy	OLIQ trainees will complete the following information science/quality coursework. • Database Systems • Information Systems Analysis • One course from the following list: Data Mining Concepts and Techniques, Database Security, Advanced Data Mining, or Data Protection and Privacy. • One course from the following list: Project and Change Management, Case Studies for IQ Professionals, or IQ Policy and Strategy. • Information Visualization.
Integration: A course that allows students to synthesize what they have learned from either the perspective of integrating the Enterprise, the IS function or IS technologies.	OLIQ trainees must complete either Graduate Project or Thesis. Both of these courses are designed to help trainees synthesize, integrate, and apply what they have learned.
Career Tracks: A set of courses organized around a particular IS career.	OLIQ trainees will complete the following courses designed to prepare individuals for a career in Information Quality. • Introduction to Information Quality • Total Quality Management and Statistical Quality Control • Information Quality Theory • Information Quality Tools and Industry Landscape

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