Perceptions of Stakeholders in Evaluating Enterprise Application Integration: A Case Study of East African Banks

IRENE NAKIYIMBA‡‡
College of Computing and Information Sciences
Makerere University, Uganda

DDEMBE WILLEESE WILLIAMS
KCA University, Kenya

ABSTRACT

Research has identified a number of approaches for evaluating Enterprise Application Integration (EAI). The majority of these approaches focus primarily on the technical functional and non-functional capabilities of an EAI solution. Although, where the technical dimensions have received considerable attention from researchers, other dimensions needed for EAI evaluation, such as stakeholder feedback, have not received explicit consideration. As a result, attaining a consummate EAI solution is still a major challenge for many enterprises. The current EAI evaluation models simply provide piecemeal insights towards the evaluation criteria variables from limited stakeholder perceptions and do not help to understand EAI evaluation as a dynamic, feedback, time based and non-linear problem. Different stakeholders view the outcome of an EAI project from different perspectives and therefore will more likely than not arrive at different conclusions. To achieve a consensus among stakeholder perceptions, we represent EAI evaluation as a feedback analysis problem from multi-stakeholder perceptions for proper alignment with business goals, vision and mission. This paper proposes the application of System Dynamics (SD) model towards guiding policy analysis for evaluating criteria factors from multi-stakeholders perceptions for EAI adoption; this will provide for holistic evaluation where emphasis is the importance of evaluation as whole (not piece meal perceptions) and the interdependence of evaluation criteria factors from the diverse stakeholder perceptions is analyzed. In this paper we present a case-study performed at a large portion of the East African banking system. A total of 800 responses to questionnaires are analyzed to formulate a systems thinking model, which in turn allows us to analyze feedback loops between different stakeholders with distinct evaluation criteria. Findings result in a structured and holistic systems thinking model which identifies six groups of stakeholders with distinct evaluation criteria. The model is validated against literature and expert views. The case study findings contribute towards the general understanding of EAI evaluation dynamics. It provides EAI evaluation with a way to analyze feedback between different EAI evaluation criteria from diverse stakeholders.

Keywords: Enterprise Application Integration Evaluation, System Dynamics Modeling, Banking

IJCIR Reference Format:
Irene Nakiyimba and Ddembe Willeese Williams. Perceptions of Stakeholders in Evaluating Enterprise Application Integration: A Case Study of East African Banks**.** International Journal of Computing and ICT Research, Vol. 7 Issue 2, pp 92-115. http://www.ijcir.org/volume7-issue 2/article 7.pdf

‡‡ Author's Address: Irene Nakiyimba, College of Computing and Information Sciences, Makerere University. P.O. Box 7062,Kampala
Ddembe Willeese Williams - KCA University,Thika Road, Ruaraka, P.O Box 56808-00200, Nairobi, Kenya

International Journal of Computing and ICT Research, ISSN 1818-1139 (Print), ISSN 1996-1065 (Online), Vol. 7, Issue 2, pp 92-115, December 2013.

1.0 INTRODUCTION

These days, the most pressing technology investment needed in the business sector is Enterprise Application Integration (EAI) (Li, 2009; Kamal et al., 2009; Themistocleous, 2004). EAI provides intra-and inter-business connectivity while aiming to lower costs while providing the same, or better, business value to clients (Li, 2009, Sharif et al., 2005; Chen and Dai, 2005; Themistocleous and Irani, 2001). EAI technologies facilitate the sharing of information and business processes of interrelated information systems in order to achieve integrated systems such as those used by the commercial banking system (Li, 2009). The necessity to join information systems can be traced to the fact that most components are designed and deployed to meet business strategic changes. As the majority of larger organizations are consolidations of multiple smaller businesses or departments with disparate legacy systems, this presents an important integration problem. With the introduction of various business and information technologies such as Service Oriented Architectures (SOA), EAI Tools, and Web Services, organizations are able to realize effective reusability and extensibility of their systems, and are thus able to provide better services to end users (Li, 2009; Sharif et al., 2005; Chen and Dai, 2005; Themistocleous and Irani, 2001; Moradi and Bahreininejad, 2010; Lam, 2007; Kamal et al., 2009). However, the integration of information systems still requires great expertise. Any possible disruption or even temporary unavailability of key business services is a basis for high business risk and losses (Sandeep Purao and Smith, 2007).

As a result, maintaining and upgrading legacy systems is one of the most difficult challenges that any decision maker faces. The lack of EAI knowledge combined with a diverse EAI market make it difficult evaluate and implement suitable EAI solutions. EAI evaluation techniques are essential for mitigating these issues (Silveira and Pastor, 2006).

Various models for analyzing factors EAI adoption in both private and public domains have been proposed (Chen and Dai, 2005; Kamal, 2006; Kamal et al., 2008c; Kamal and Weerakkody, 2009; Themistocleous, 2004, Khoumbati and Themistocleous, 2006; Lam, 2007; Mantzana et al., 2007; Sharif et al., 2005; Themistocleous and Irani, 2001; Themistocleous and Love, 2004). However, none of these models capture feedback relationships between different evaluation criteria, and therefore can only provide short-term insights towards different stakeholder perceptions. In addition, the models provide EAI evaluation from piece meal stakeholder perceptions. Yet in reality, the perceived value of any technology adoption versus its relative advantage differs with each stakeholder perception which, in turn, is inter-dependent on one another (Ribeiro et al., 2011). Current research has disregarded this interdependence, and as such they do not help to understand EAI evaluation as a dynamic feedback problem (Khoumbati and Themistocleous, 2006). Assessing the efficiency and effectiveness of an EAI solution requires valid metrics for input, processing, and output. EAI Evaluation is characterized by variables that undergo significant changes over time, such as the evolution of the EAI system, evaluation criteria factors, and diverse stakeholder perceptions. The inputs of EAI evaluation, which are the actual view points, tend to change over time, which in turn affects the conclusions reached by different stakeholders. In this paper, we illustrate EAI evaluation as a causal relationship model that provides systemic feedback to enhance policy analysis based on dynamic input-output methods. .

To provide a comprehensive understanding of the dynamics of EAI evaluation we propose the use of Systems Dynamics (SD). SD is a methodology for the modeling and simulation of complex systems over time (Harris and Williams, 2005). A system is defined as complex if its behavior exhibits feedback loops, non-linearity and time delays characteristics (Williams, 2000). SD has been acknowledged for its ability to facilitate the understanding of the behavior of complex dynamic systems (Williams, 2003). When applying SD to EAI evaluation it provides a strategic understanding of the EAI system. When employing SD in the field of EAI evaluation, we are able to generate predictive analytics which provide insights to facilitate informed decision making before EAI implementation (Saurabh, 2010; Sterman, 2000). SD deals with internal feedback analysis and time delays which affect EAI evaluation (Check land, 2000). Employing SD for EAI evaluation provides improvements towards attaining a comprehensive analysis of EAI evaluation by visualizing feedback between different stakeholder perceptions. Envisioning these feedback loops is required to achieve concession between EAI stakeholders. Diverse system modeling approaches have been used to model complexity. Their main drawback, however, is that their analysis becomes complex with large models (Clempner, 2010). SD is advantageous over other models because of its ability to incorporate soft variables and explain dynamic feedback problems (Robinson, 2003; Sice and French, 2006). SD can also explain and predict policy and its consequences on EAI evaluation. Most EAI Evaluation models are policy resistant since it is very difficult to evaluate whether the proposed EAI solution can fail, succeed or even lead to worse situations.

In this paper, we build a case for the application of SD to enhance the understanding of the benefits and risks of EAI evaluation over time. We extend existing research by presenting a large case-study at the East African banking system and a systems thinking model for EAI evaluation. We first discuss related work in Section 2, after which in Section 3 we present the findings of a large scale case study performed in Uganda by I. Nakiyimba at the East African commercial banking system. Next, in Section 4, we discuss the application of SD in the field of EAI evaluation.

2. 0 STATE OF PRACTICE IN EAI EVALUATION

In (Moradi and Bahreininejad, 2010; Losavio et al., 2005), the authors propose a framework for evaluating the functional capabilities of EAI technologies, which simplifies the process of evaluating the functional capabilities of intra-enterprise integration technologies and solutions and cannot be used for inter-integration evaluation. This framework offers a new schema for which various EAI technologies are categorized in different classes and are evaluated based on their supporting level for functional integration capabilities by offering two lists containing integration technologies, their associated classifications and functional capabilities of integration technologies. The framework developed by (Moradi and Bahreininejad, 2010) is extended in (Moradi and Bahreininejad, 2013)'s research by specifying the evaluation criteria features for both intra and inter enterprise integration core enabling technologies which simplify the process of evaluating the requirements met by enterprise integration middleware technologies. The framework by (Moradi and Bahreininejad, 2013) proposes a new schema for which various enterprise integration middleware technologies are categorized in different classifications and are evaluated based on their supporting level for the core integration features criteria which include the functional and supporting features. In (Themistocleous et al., 2004b), the authors propose a framework for evaluating a portfolio of technologies for both inter-and intra-business integration considering permutations of the different integration technologies based on their functionality against the functional requirements of the proposed system and the constraints of existing IS infrastructures. In (Kamal et al., 2008c), an EAI adoption model is proposed which identifies the crucial factors that influence EAI adoption on the pre and post adoption life cycle phases. Fuzzy cognitive mapping (FCM) to demonstrate the inter-relationships between evaluation criteria to support evaluation of EAI adoption for health care organizations (Khoumbati and Themistocleous, 2006) is applied. FCM was used to enhance the quality of the evaluation process by showing the importance of each factor and its inter-relationship with other factors. However, the FCM simulation model merely demonstrates the causal inter-relationships between the EAI evaluation criteria and does not provide dynamic interpretation of the inter-relationships between stakeholder criteria. This research was utilized and extended by (Mantzana et al., 2007; Kamal and Themistocleous, 2006) by identifying the factors that influence EAI adoption and establishing the causal relationships between health care system actors respectively. Differences in the way small and medium enterprises approach integration technologies are detailed in (Chen and Dai, 2005). And in (Kamal et al., 2008c) Kamal's model (Kamal, 2006) is extended by prioritizing the importance of EAI adoption factors on the early life cycle phases. Quality assurance is key to mitigating risks of investment in unsuitable EAI tools as pointed out in (Silveira and Pastor, 2006). Different evaluation criteria influence the decision making process of EAI adoption (Themistocleous, 2004; Checkland, 2000). In (Kamal et al., 2009), the author considers factors that impact innovation and adoption (optimistically and pessimistically). A post hoc evaluation model is presented in (Sharif et al., 2005) seeking insights into failed Enterprise Resource Planning (ERP) integration. Recent literature signifies that EAI evaluation criteria are inter-dependent and dynamic and should be analyzed as a whole rather than piece meal (Kamal et al., 2009). Unlike these approaches, the System Dynamics Modeling methodology is able to identify causal effects, non-linearity and feedbacks between different evaluation criteria of different stakeholders, thus, enhancing complete EAI solution evaluation.

3.0 CASE STUDY: EAST AFRICAN BANKING SYSTEM

The East African banking system is, like any modern banking system, required to integrate their applications in order to streamline their business processes and customer services. We perform a single explanatory case study of commercial banks, set in East Africa, to provide a real world and in-depth understanding of EAI evaluation and adoption. Accordingly, case studies are pertinent when your research addresses either a descriptive and analytical research questions (Yin, 2003). The detailed steps that were adopted in the case-study are as follows:

Step 1. Determine and define the research Questions: In general, EAI evaluation has six distinct types of stakeholders who participate in evaluation of EAI for both intra-integration and inter-integration. The six classifications of stakeholders include: organization management, end-users, EAI technical staff, collaborators, vendors and EAI policy bodies. In this case, the researcher is primarily interested in determining how commercial banks approach EAI evaluation and focuses on the following research questions: *(a) What are the challenges of EAI system evaluation adoption?; (b) What are the EAI evaluation criteria for distinct diverse stakeholder groups?; (c) How do commercial* *banks approach EAI system evaluation from a multi-stakeholder point of view?; (d) Why do commercial banks consider EAI system adoption models?*

(i) *Step 2. Select the cases and determine data gathering and analysis Techniques:* Many enterprises have implemented EAI technologies such as banking among others. In the banking industry alone there are several types of banks and therefore at the outset of the design phase, the researcher determined that only commercial banks accepted to participate in the study given the fact that confidentiality to information is kept. Voluntary and purposive sampling was used because of confidentiality. The focus was to establish how commercial banks evaluated and adopted their existing EAI system architecture. The researcher considered multiple sources of data for this study and selects four commercial bank; document review, interviews and focus group discussions. *Data was analyzed using SPSS statistics 19 and causal Loop diagram (CLD) for the system thinking model.*

(ii) *Step 3. Prepare to collect the data: A* non-probability sample survey was used to collect information from banks with an existing EAI system. At each bank data was collected from key stakeholders of EAI evaluation. Self-enumeration standardized questionnaires with both open and closed ended response categories were provided to the respondents to collect measurable data that is easy to code, record and analyze. As such, the first author of the present paper requested participation of eight commercial banking institutions, three ICT standard bodies, 23 commercial bank collaborators, and five EAI vendors in order to investigate the factors associated with EAI evaluation. In the end, four banks, three ICT bodies, six commercial bank collaborators, and five EAI vendors accepted to participate in the study performed by the first author under supervision of the second author Because of non-disclosure agreements, the identity of the participating companies will not be disclosed. Only those banks with an operational EAI architectural system, collaborators who share data, information, services or bank processes, reputable EAI vendors, and standard bodies that regulate the implementation and use of EAI solutions were considered for the study

(iii) *Step 4. Collect data in the Field:* Administering a total of 1200 survey questionnaires with both open and closed-ended questions were distributed between participants, of which 200 to commercial bank back-end EAI users, 235 to EAI technical staff, 80 to strategic/middle managers, 185 to EAI vendor companies, 225 to ICT standard bodies and 275 to commercial bank collaborators. A total of 800 responses, registering a response rate of 66%, were collected. 80 from commercial bank back-end EAI users, 195 from EAI technical staff, 80 from strategic/middle managers, 128 from EAI vendors, 127 from ICT standard bodies, and 190 from commercial bank collaborators. The data collection methods used included questions about challenges of EAI evaluation, limitations to effective EAI evaluations, EAI evaluation approaches in practice, criteria for EAI evaluation, significance of and criteria for prioritization of stakeholder perceptions for EAI evaluation and adoption. The purpose of adoption of closed –ended questions was to produce results that are easy to summarize, compare, and generalize.

(iv) *Step 5. Evaluate and analyze the Data:* Data is analyzed as a single case of commercial banks in East Africa to find the relationships between the object of study and the research questions posed in step 1 by giving descriptive explanations.

The following sections present the findings of the case study. First, we discuss the different stakeholders and their relations in section 3.1, after which we discuss the perceptions of each stakeholder through causal loop diagrams we found by employing SD in section 3.2. Next, we discuss the reasons and challenges identified by different stakeholders of EAI in sections 3.3 and 3.4 respectively. And finally, in section 3.5, we discuss the steps of EAI as identified by literature versus those identified in the case-study.

3.1 EAI Stakeholders

Several stakeholders are involved in EAI at the East African banking system. Having different roles, each of these stakeholders naturally has different perceptions about EAI evaluation and adoption. For example, managers are concerned with the alignment of the EAI solution with the business goals, the technical staff is concerned about the conversion of the end-user requirements into the technical design, and the back-end user will be interested in the level of integration provided by a specific EAI solution. We identify the following six EAI stakeholders for the case of EAI at East African banks and describe their different perceptions:

(i) *Back-end Users:* Refers to the administrative views rather than front end-user facing views of the information system (Binildas, 2008; Chappell, 2004).
(ii) *ICT Policy and Standard Bodies:* The implementation of IT technologies raises new and different information management and policy challenges and increases public expectations with respect to information

access and services delivery (Ketchell, 2003). Standards are tools to help promote efficiency, interpretability, and innovation (Kamal, 2006).

(iii) *EAI Vendors:* The organizations that operate from the viewpoint of selling and supporting EAI technologies (Macharia and Nyakwende, 2010).

(iv) *Collaborators:* The organizations that operate from the viewpoint of joint service delivery (Karen S. Baker, 2005).

(v) *EAI Experts*: Experts adopt and represent the view of technological and methodological specifications for EAI adoption (Kamal et al., 2008c).

(vi) *Managers:* This refers to the strategic viewpoints of how the EAI solutions align with the business goals (Kamal et al., 2008c).

Figure 1 illustrates the relationships between these stakeholders. The arrow labeled A signifies that the goals and priorities of the organization are implemented by the technical system integration experts. The arrow labeled B illustrates the specification of requirements between the organization and EAI experts; the later then determines both the functional and non-functional requirements for the new system. Arrow C illustrates an information flow for conversion of user requirements into technical EAI system design. The technical design should match possible EAI vendor solutions as identified by the arrow labeled D. Arrow E illustrates the key business processes that collaborators share with the organization. Arrow F shows that the new enterprise system must abide by the existing ICT standards and policies as stipulated by the ICT policy bodies. Arrow F and G illustrate that the Technical EAI/IT experts identify the limiting factors of the current legacy systems and information systems within organizations. Finally, arrow G illustrates that the limiting factors of the current legacy systems and information systems of all EAI project initiatives, and are very important in choosing the right EAI solutions from EAI vendors/suppliers.

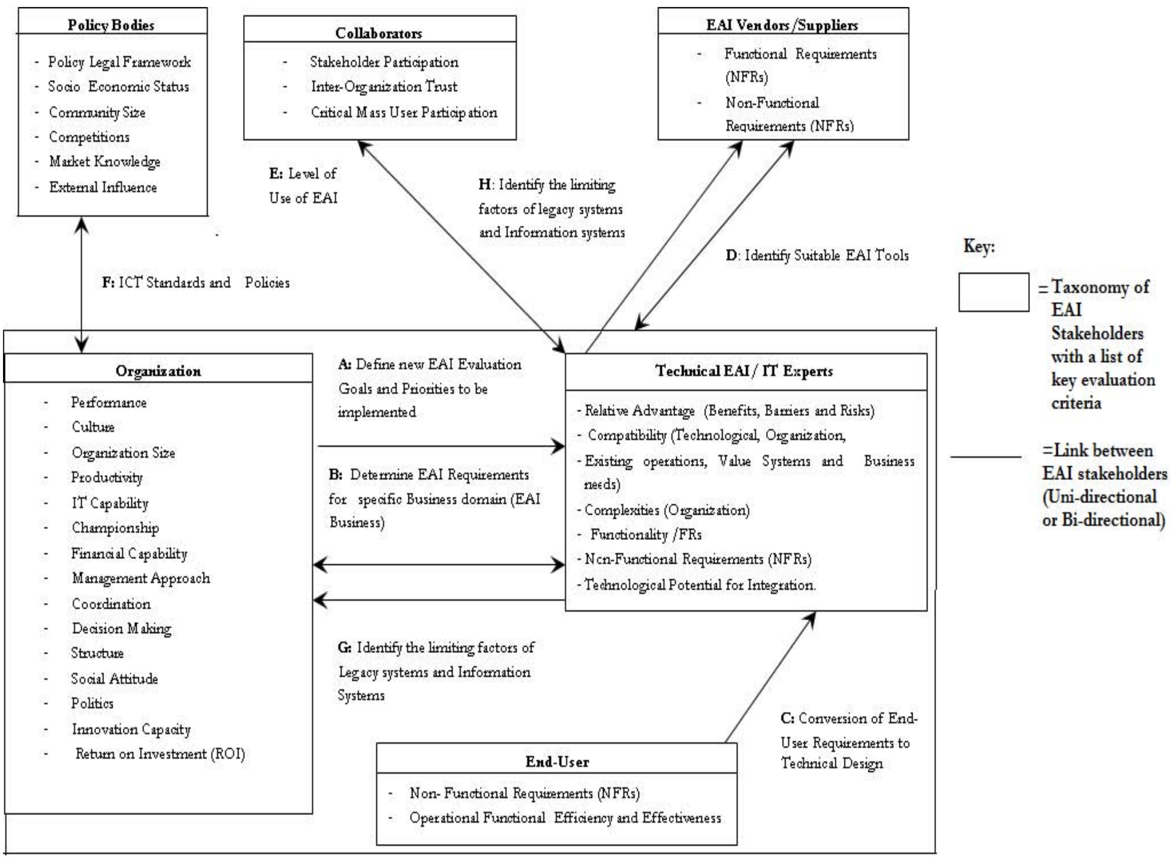

Figure 1: Stakeholder relationships

To indicate which stakeholder perceptions are considered relevant for the case-study we refer to Table 1. The table shows the outcome of interviews regarding the significance of stakeholder perceptions in the case of EAI evaluation at East African banks. A total of 131 stakeholders were interviewed and indicated that EAI Back-end users with 83%, EAI technical staff with 80%, ICT standard bodies with 80%, and bank top management with 79% were among the most important, followed by EAI tools vendors with 70% and collaborators with 43%. It is worth noting that existing EAI evaluation and adoption models (Moradi and Bahreininejad, 2010; Losavio et al., 2005; Themistocleous et al., 2004b; Kamal et al., 2008c; Kamal and Themistocleous, 2006; Kamal, 2009a; Kamal and Themistocleous, 2007; Themistocleous, 2004; Li, 2009; Khoumbati and Themistocleous, 2006; Mantzana et al., 2007; Kamal and Themistocleous, 2006; Sharif et al., 2005) lack EAI tool vendors, ICT standard bodies and collaborators as key perceptions to EAI evaluation.

Years of Experience Perceptions	**10 Years %**	**Below 10 Years %**	**Below 5 Years %**	
End-Users	0.0	0.1	17.0	82.9
IT/EAI Technical Experts	7.0	37	40	16
Strategic and Middle Managers	0	9	15	76
EAI Vendors and Suppliers	67	15	18	0.0
Collaborators	22	14	26	38
ICT standard/policy bodies	19	21	25	35

Table 1: Stakeholder Validation

Table 2 illustrates the level of experience of each stakeholder with EAI. Respondents were asked the number of years of experience with EAI systems. Each row represents a stakeholder while the columns indicate the level of experience in years ranging from 0 to 10 years. The findings reveal that 82.9% of back-end users, 76% of strategic and middle managers, 38% of collaborators, and 35% of ICT policy bodies having zero years of experience with EAI system evaluation. These results indicate that there is a large knowledge gap. 67% of external EAI vendors and suppliers have 10 years of experience and 40% of IT/EAI Technical experts have experience below 5 years.

EAI Evaluation Stakeholder	**Number of Back End Users (+)**	**Bank Top managemen t (+)**	**EAI Bank Technical Staff (+)**	**EAI Tools vendors (+)**	**Bank Collaborators (+)**	**ICT standard Bodies (+)**
Back End Users	30	34	33	10	5	25
Bank Top management	14	18	15	5	7	12
EAI Bank Technical Staff	40	40	35	18	28	38
EAI Tools vendors	13	2	15	15	4	12
Bank Collaborators	9	16	14	8	9	15
ICT standard Bodies	3	3	3	3	3	3
Total	109	103	105	59	56	105
Percentage	83%	79%	80%	70%	43%	80%

Table 2: Stakeholders Experience

3.2 Stakeholder Perceptions

Changes in EAI evaluation occur at time scales which are very difficult to predict. As such, the long run response is often different from the short run response. Therefore, in order to properly conduct policy analysis, there is need to consider time delays in feedback loops. Feedback loops occur when decisions reached by each stakeholder have an effect on other stakeholders regarding the final adoption of an EAI system.

In systems dynamics modeling, systems are represented as causal loop diagrams. Causal loop diagrams describe a system as a set of components and their interactions. Interactions in a diagram trigger other interactions, which may trigger other interactions again. By capturing these interactions, and resulting loops, we can analyze the overall system behavior. Feedback loops show the interrelationship between variables and how they link to each other. The links depict how the loop structures drive system behavior and how the variables impact on the system. Analyzing the behavior of each of these loops is key to understanding the impact of one or more variables have on the system behavior. A feedback loop is a control system that is not easily predictable because it has inputs and outputs to the system where an output is fed back into the system as part of its inputs. In other words, a feedback loop is a succession of cause-effect relations that start and end with the same variable. It constitutes a circular causality, only meaningful over time. The polarity of a loop is the algebraic product of all the polarities around the loop. If the result is "+", the loop is "positive," "compounding" or "reinforcing" and by letter R. A reinforcing loop is a positive feedback system that represents a growing or declining action. If the result is "-", the loop is "negative," "Goal seeking" or "Balancing" and marked by letter B . Reinforcing loop behavior, in which the structure reinforces itself, generally produces an exponential growth or decline. A reinforcing loop producing a desirable result is generally referred to as a virtuous cycle, and one producing an undesirable result is referred to as a viscous cycle (Williams, 2003). In case of a vicious cycle, one should find a way to break one of the feedback loops so the structure can no longer reinforce itself by introducing a balancing loop. Vicious cycles create a situation in which the apparent solution of one problem in a chain of circumstances creates a new problem and increases the difficulty of solving the original problem. Balancing processes generate the forces of resistance, which eventually limit growth. But, at the same time, provide the mechanisms, found in nature and all systems, that fix problems, maintain stability, and achieve equilibrium (Sterman, 2000). They ensure that every system never strays far from its "natural" operating range. Finally, double lines on relationship arrows indicate that there is a time delay between the variables and, as such, indicate that the effect of that relationship is obtained over time (Williams, 2003; Sterman, 2000; Rwashana and Williams, 2006).

In Section 3.1 we identified and discussed six different stakeholders, we now determine the forces between different stakeholders to confirm whether tight coupling causes feedback during EAI Evaluation.

3.2.1 Policy Bodies Perception

Figure 2 streamlines "the standards, policies, and regulations set up by policy bodies to govern quality operation of information and communication technologies sector for business organizations" (Erasala et al., 2003). R1, R2, and R3 are sub loops of B1. Causal loop B1 indicates that an increase in the social-economic status (wealth, education, income, and occupation) of any organization leads to an increase in bank community size, and the need for more banking services (Kamal, 2006). An increase in the community size leads to increased competition (Pepall et al., 2008), which in turn forces banks to use EAI systems in order to enhance their competitive advantage (Akbulut, 2002). The resulting increase of EAI market knowledge will then positively facilitate the review of current EAI Standards which again will positively impact on EAI effectiveness which, in turn, improves the social economic status of the bank (Kamal, 2006; Kamal, 2009b; Lam, 2005). Loop R1 shows us that the establishment of better EAI standards enhances the quality of EAI frameworks which, in turn, positively facilitates commercial banks to overcome confusion while selecting EAI packages. Establishment of EAI policy legal frameworks facilitate organization of policy documentation into groupings and categories that make it easier for employees to find and understand the contents of various EAI policy standards and regulations documents, as seen in Loop R2. Loop R3 shows a high social economic status in terms of total fiscal and societal position is based on high wealth, income, education, and occupation (Kamal, 2006). Loop B2 shows us that the commercial bank size, which is defined by the structure, is key to creating policies which limit the class of social network interactions (social economic status) that enforce high quality of service in and outside the organization (Themistocleous et al., 2004a).

The behavioral pattern of the major loop B1 is goal seeking, in reality the banking application integration infrastructure capacity for banking services is limited to certain goals (number of clients for specific services, bank service points, bank services) and therefore if the current levels of bank community size at time t_0 is below the bank service capacity (goal), then the loop will push its value up towards the goal. However, if at time t_0 the bank community levels are above the banking applications integration system capacity, the loop pushes its value towards the goal.

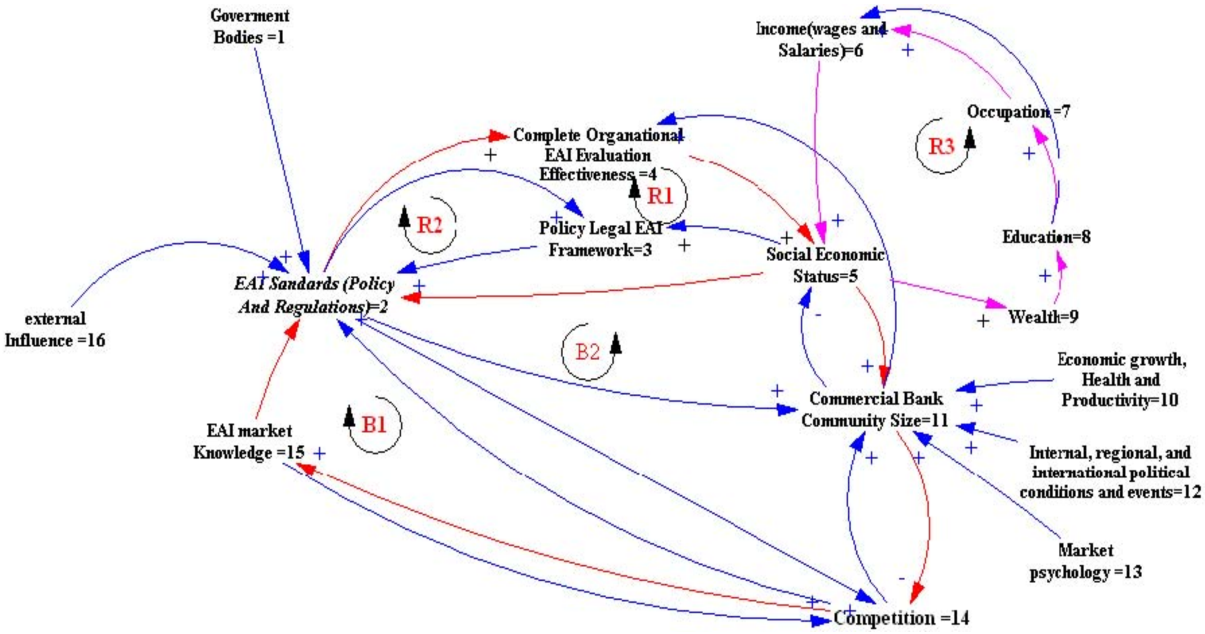

Figure 2: Causal Loop Diagram for Policy Body Perception

3.2.2 Collaborator Perception

Collaboration implies a willingness on the part of organizations to change the way services are delivered by jointly developing and agreeing to a set of common goals and directions. "This can be achieved by sharing responsibility for obtaining those goals, and working together to achieve those goals using the expertise of each collaborator" (Bullet, 1991). Initially, partners may not be ready for a collaborative relationship. Instead, they may work together cooperatively to help each other meet their respective organizational goals without making any tangible changes in the way they deliver services or in their operating procedures. "However, unless these cooperative relationships become increasingly collaborative in nature, no changes will occur in the service delivery system" (Melaville and Blank, 1993). Figure 3 illustrates the causal effect analysis for the perception of the collaborators. Figure 3 includes four causal loops, R1, B2, B3, and B4. Loops R1, B2 and B3 are sub-loops of loop B4. B4 is a negative balancing loop which describes that more collaborators implies putting into practice a number of factors contributing to collaborative linkages which increase the level EAI standards, and therefore helps to ensure that the collaboration is more collaborative than cooperative in nature. In turn, this implies an increase in partnership which requires inter-organizational trust (Gholamhosein et al., 2010; Vangen and Huxham, 2003). Yet, in reality, there is a negative effect of the actions through inter-organizational trust because of bureaucracy, increasing time of transaction processing, and therefore indirectly decreasing the critical mass of participants. This, in turn, decreases overall stakeholder participation which again decreases the level of inter-organization trust (Vangen and Huxham, 2003), and hence reduced overall collaboration within the organization. Loop R1 describes that complete collaboration is achieved through full stakeholder participation when people, groups and organizations work together to achieve the desired business goals which in turn will lead to increased effectiveness of EAI evaluation (Vangen and Huxham, 2003). However, an increase in EAI stakeholder participation will reduce the levels of inter-organization trust between stakeholders. Complete collaboration will ensure leveraging EAI standards across trusted partners which limits stakeholder participation and hence forth reduces overall collaboration, as seen in loop B3 (Vangen and Huxham, 2003).

Generally, the behaviour pattern of Figure 3 is a combination of positive (B2 and B4 sub loops of B4) and negative loops (R1) and a variety of behavioural patterns are feasible. The positive feedback loop leads to initial exponential growth (Sterman, 2000), but then, after a delay, the behaviour of the collaborator perception system structure moves towards a negative feedback loop. This permutation results in an S-shaped (Sterman, 2000) pattern since the positive feedback loop leads to initial exponential growth, and then when the negative feedback loop takes over it leads to goal seeking behavior. In reality , the level of collaboration with the banking system will initially steadily grow until a substantial level is reached, however the level of collaboration will follow S-shaped and reverse direction until the collaboration settles towards a goal (compliant number of collaborators).

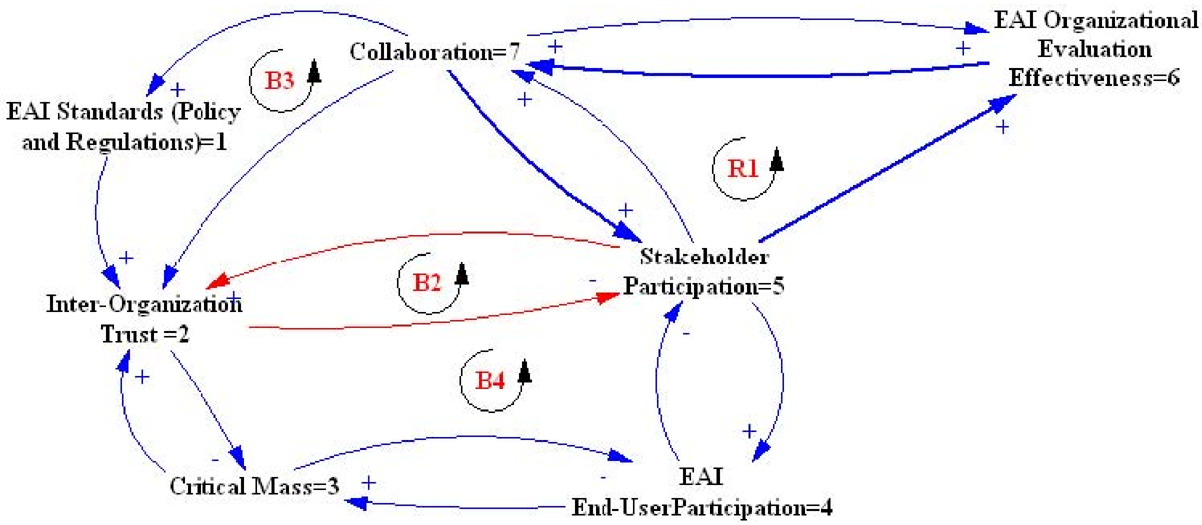

Figure 2 Causal Loop Diagram for Collaborator Perception

3.2.3 Vendor Perception

Figure 4 shows the causal effect analysis for the vendor perception. It contains five causal loops: B1, R1, R2, R3, and R4. R3 is a sub-loop of R4 and R2, and B1 is a sub loop of R1. Loop R1 is a positive reinforcing loop illustrating that the Functional Requirements (FR) elicitation for any EAI system must positively align with the values, goals, vision and mission of the target organization (Laplante, 2009; Serebrenik et al., 2010). Organizations usually compose standards, policies, and regulations that will positively guide the elicitation process of Non-Functional Requirements (NFR) to attain high system quality. These must then be implemented by EAI vendors for appropriate EAI system quality. "FR capture the intended behavior of the system, which may be expressed as services, tasks or functions the system is required to perform" (Moradi and Bahreininejad, 2010). Loop R2 confirms that the process of obtaining FR improves the organizational business functions through the EAI system, which enhance the end-user key result areas for the specific functions. At the same time, the end-user perception is properly aligned with that of the organization and their goals, vision, and mission, as illustrated by loop R3. Loop R4 illustrates that, as these processes continue, the EAI expert perception is enhanced such that he can objectively provide the most satisfying EAI solution for the organization.

In general, the behaviour pattern of the vendor perception is a combination of reinforcing and balancing loops, a variety of behavioral patterns are feasible. Initially the continual conversion of FR and NFRs into design specifications will lead to a gradual increase in available vendor solutions, but then, after a delay due to the testing of each independent EAI vendor solution against design specifications, a balancing feedback loop will dominate the behaviour of the system. The combination results in an s-shaped pattern because the reinforcing feedback loop leads to initial exponential growth, and then when the negative feedback loop takes over it leads to goal seeking behavior.

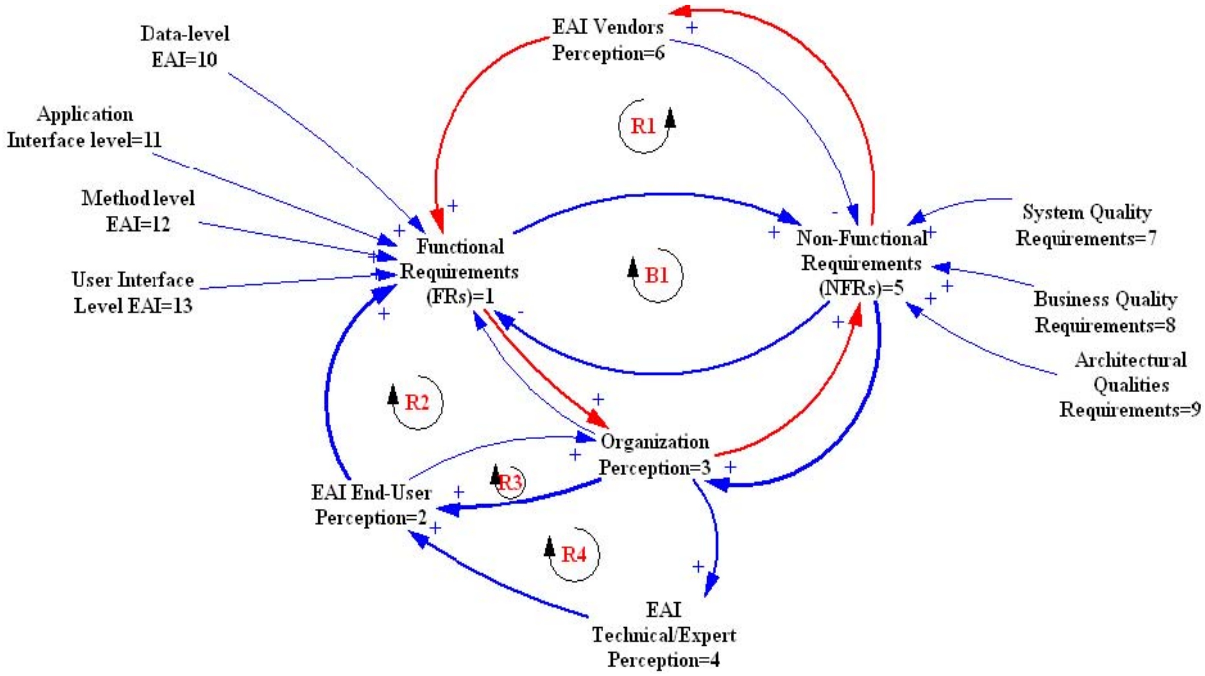

Figure 4: Causal Loop Diagram for Vendor Perception

3.2.4 Organization Perception

Figure 5 represents the causal effect analysis of the organization perception. It contains eight loops: R1, R2, R3, R4, B1, B2, B3, and B4. As seen in loop R2, an increase in financial capability leads to increased productivity, which implies high performance and strengthens organizational culture. On the other hand, loop B1 shows that negative culture norms deprive the organization from achieving excellent performance (Kamal, 2006; Khoumbati and Themistocleous, 2006). Loop B2 confirms that a positive culture will positively impact the structural units tied to the increase in performance, while a lack of organizational structure leads to negative or bad organization cultural norms (Kamal, 2009c). Loop R5 illustrates that organizational structure determines the size of an organization, and an increase in size (in terms of employees, operations, market reach or share) is associated with greater specialization and formalization, which, in turn, positively impacts the organizational structure (Khoumbati and Themistocleous, 2006). In Loop R3, the flexibility and agility of firms foster the development of knowledge (innovation capacity) through formal research based on experience, practice, and interactions between key stakeholders of the business eco-systems to (Jensen et al., 2007), which will improve on the firms IT capability in terms of IT governance which will improve growth of the organization implied by size in respective business units in the organization structure. In loop B4, a wider organization structure implies the innovation capacity is decentralized to suit individual business units. In loop R4, the organization size implied by the organization structure will clearly distinguish established ICT political links that will enhance championing or willingness for stakeholder (employees, suppliers) to participate in management of EAI system evaluation project through clear ICT governance structures which will in turn positively impact on the level of IT capability for IT service delivery and productivity to provide for value for business. The larger the structure of an organization, the more reporting lines and responsibility relationships exist between staff (Terry, 1991). Loop B3 shows that in turn, such an increase in politics positively impacts the management approach of the organization, but, in turn, negatively impacts the organizational culture since structural and behavioral culture are conditioned by politics (Terry, 1991; Amy and Hitt, 1999). A clearly established management approach enforces systematic decision making, enhancing productivity and reinforcing loop R2 (Lemon et al., 2002). Loop R1 shows that higher levels of complete EAI evaluation effectiveness will lead to high organization performance because the EAI system will perfectly align in terms of requirements specifications for organization business areas.

Generally, the behaviour pattern of Figure 5 is a positive feedback loop. Organizational performance is dependent on other evaluation criteria variables and therefore will initially follow a steady exponential growth with goal-seeking behavior resulting in the variable leveling off based on the causal effects from the dependant variables. The leveling off is as a result of the adopted EAI system having an objective towards performance of the organization and the system behavioral pattern of the organization will be S-shaped (Sterman, 2000).

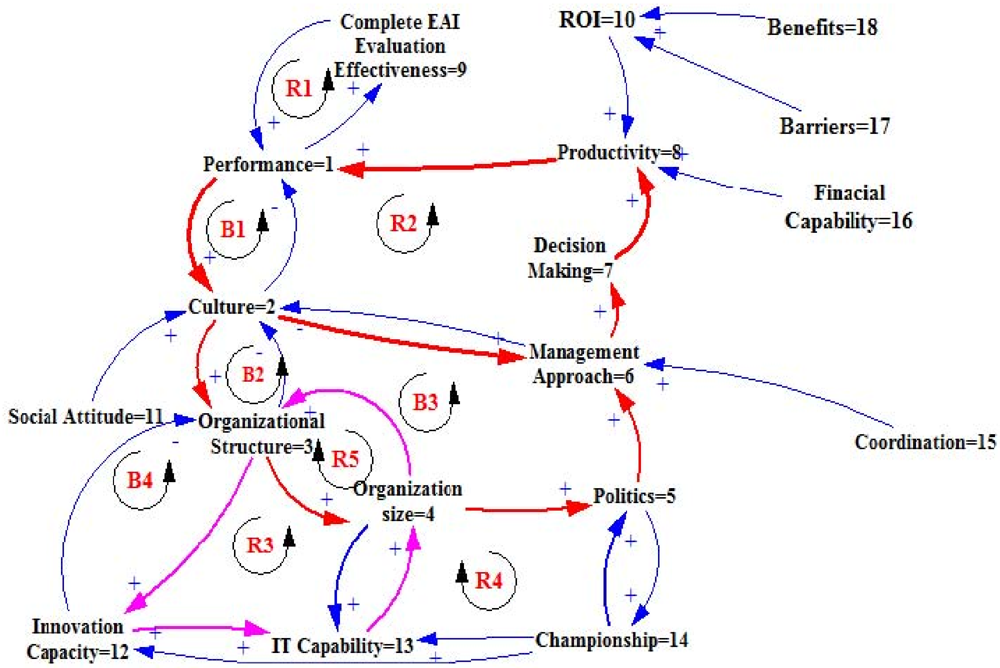

Figure 5: Causal Loop Diagram for Organization Perception

3.2.5 End-User Perception

Figure 6 shows the causal effect analysis for the end user perception. It contains three balancing loops: B1, B2, and B3. Loop B2 illustrates that an increase in EAI system reliability directly implies an increase in system availability (L. Chung, 1999; Barbacci, 2003) and therefore an increase in system usability (Wiegers, 2003; Zhefu et al., 2009). This means that there is low downtime of the system and the end users can fully utilize the system to perform their business unit functions, implying no loss of productivity due to system failure and hence an increase in performance. Loop B1 illustrates that an increase in system reliability increases throughput which results into significant increase in performance, however increased multitasking across diverse business application systems in a heterogeneous environment is bound to reduce the reliability of the system. Finally, loop B3 illustrates that an increase in system reliability increases usability (Karim, 2011), however, over time as the business realizes high levels of growth, the EAI system will not be in position to execute all end user transactions because of the limited computing resources rendering the system unreliable especially at peak hours (Lee et al., 2006). Generally, the behavioural pattern of EAI evaluation for the end-user perception is a goal seeking (negative or balancing), where the operational functional evaluation efficiency and effectiveness of EAI system dependant on other variables (reliability, usability and performance) will start above a goal level and over time moves towards the desired goal to achieve desired EAI evaluation efficiency and effectiveness level.

Figure 6 shows the causal effect analysis for the end user perception. It contains three balancing loops: B1, B2, and B3. Loop B2 illustrates that an increase in EAI system reliability directly implies an increase in system availability (L. Chung, 1999; Barbacci, 2003) and therefore an increase in system usability (Wiegers, 2003; Zhefu et al., 2009). This means that there is low downtime of the system and the end users can fully utilize the system to perform their business unit functions, implying no loss of productivity due to system failure and hence an increase in performance. Loop B1 illustrates that an increase in system reliability increases throughput which results into significant increase in performance, however increased multitasking across diverse business application systems in a heterogeneous environment is bound to reduce the reliability of the system. Finally, loop B3 illustrates that an increase in system reliability increases usability (Karim, 2011), however, over time as the business realizes high levels of growth, the EAI system will not be in position to execute all end user transactions because of the limited computing resources rendering the system unreliable especially at peak hours (Lee et al., 2006).

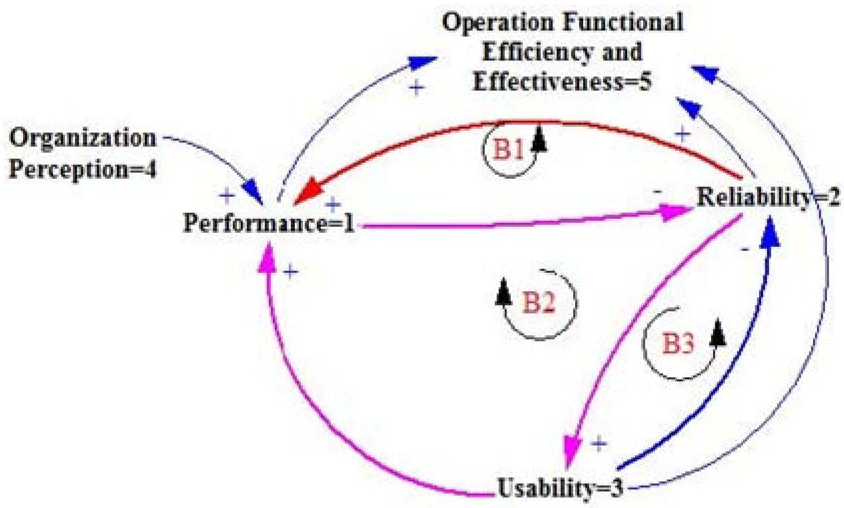

Figure 6: Causal Loop Diagram for End User Perception

Generally, the behavioural pattern of EAI evaluation for the end-user perception is a goal seeking (negative or balancing), where the operational functional evaluation efficiency and effectiveness of EAI system dependant on other variables (reliability, usability and performance) will start above a goal level and over time moves towards the desired goal for the level EAI evaluation efficiency and effectiveness level.

3.2.6 Technical EAI Staff Perception

Figure 7 illustrates the causal effect analysis of the EAI vendor perception and contains nine loops: R1, R2, R3, R4, R6, R7, B1, B2, and the main loop R5. Loop R5 describes that an increase in FR for the EAI system by the organization will lead to an increase in NFR since most NFR are related to the overall system design.

In other words, the extent to which the application possesses a desired combination of quality attributes (NFRs) such as usability, performance, reliability, and security indicates the success of the design and the overall quality of the EAI software application (Cysneiros and Leite, 2001; Cysneiros et al., 2001; Cysneiros and Leite, 2004). This implies that it is necessary to consider the "potential impact on other requirements by analyzing the trade-offs between multiple quality attributes which reduces the technological potential for integration for specific EAI solutions" (Cysneiros and Leite, 2004 and Laplante, 2009). A high level of technological complexity will make it difficult to attain system architectural compatibility for EAI solutions. This, in turn, will lead to an increase in EAI system benefits, but will increase maintenance and operational costs at the same time, as well as decrease adaptability hence creating barriers for EAI adoption (Chen and Dai, 2005, Li, 2009) and (Kamal and Themistocleous, 2007; Themistocleous et al., 2005). R2 shows us that the more costly an EAI system is, the more benefits it should provide to the organization (Themistocleous and Irani, 2001; Kamal et al., 2009).

However, R1 displays the fact that an increase in EAI system costs is in itself a barrier for EAI adoption (Khoumbati and Themistocleous, 2006; Serebrenik et al., 2010). In reality, the higher the cost of the EAI system, the higher the level of complexity at which both FR and NFR must be implemented. Since FR realize business goals, and NFR constrain the functionality of the system, this conflict may render the technological potential unfit for the organization (B2 and B1) (Cysneiros and Leite, 2004; Cysneiros and Leite, 2001; Cysneiros et al., 2001; Benslimane et al., 2007). R6 and R3 illustrate that an increase in the level of implementation of NFR assures an increase in the relative advantages of the EAI system as it generally increases productivity (Ramakrishnan and Reed, 2013), providing more benefits at an increased cost which again becomes a barrier for EAI adoption (Tatari and Skibniewski, 2011; Khoumbati and Themistocleous, 2006; Themistocleous and Irani, 2001). Loop R4 is a positive reinforcing loop that shows that a growth in the organization size will positively influence the technological potential for integration as required by the business functional units (Themistocleous, 2004; Kamal, 2006; Khoumbati and Themistocleous, 2006). In loop R7, when the new EAI system cannot be supported by existing IT system infrastructure and architecture it implies low computability of the system as a result of poor or limited infrastructure and architectural system specifications implying that the organization has a low potential for to support EAI system.

Generally, the behavioural pattern of the EAI vendor perception is a combination of reinforcing loop R5 and balancing loop B2 asserting a possibility of variety of patterns. In this specific scenario, the conversion of elicited EAI requirements (FR and NFRs) into design specifications will initially follow a gradual exponential growth, but due to a delay in the classification of these requirements into input, process, output, file/database for both logical and physical designs will result into s-shaped behaviour of the system which seeks to achieve a specific EAI system design goal as a result of the balancing loop.

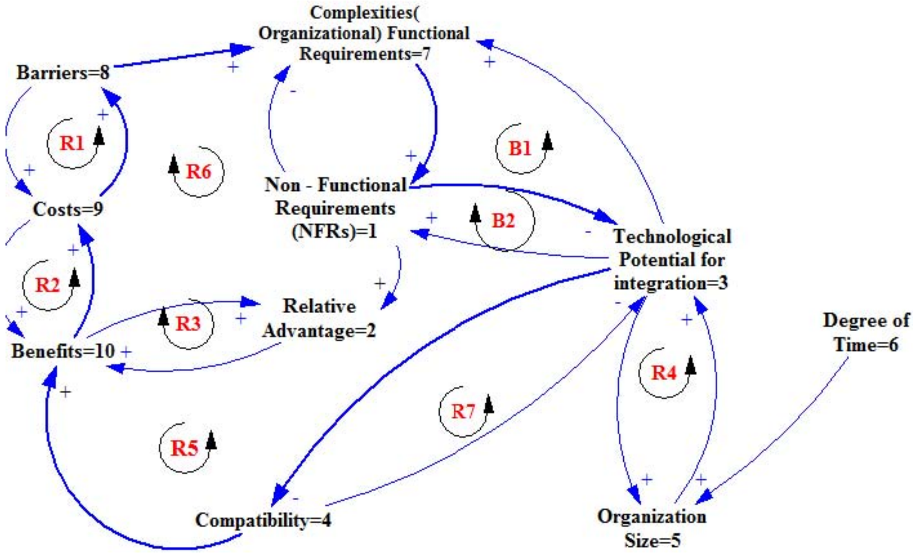

Figure 7: Causal Loop Diagram for Technical EAI Experts

3.3 Reasons for Integration

There exist a number of different reasons for integration. To establish which reasons are important, participants of the case study were asked to rate different reasons for integration on a Likert scale from zero to four, where zero was the least important and four the most. The five different reasons for integration included: data and information integration (Puschmann and Alt, 2004; Brodie, 2006; Gulledge, 2006), transactional oriented integration (Linthicum, 2003; Puschmann and Alt, 2004; Erasala et al., 2003), control integration (Brodie, 2006; Puschmann and Alt, 2004; Erasala et al., 2003; Linthicum, 2003), interface integration (Brodie, 2006, Themistocleous and Irani, 2002; Puschmann and Alt, 2004; Erasala et al., 2003; Linthicum, 2003) and create end to end business process management (Kirstan, 2004). Results, displayed in Figure 8, indicate that data and information integration, end to end business process management and transactional oriented integration rank highest and control and interface integration rank second. The percentage of importance is computed such that if all respondents rated a reason with a zero, the output would be 0%, and if all rated a four, the output would be 100%. Upon inspection of Figure 8, we notice that three of the six stakeholders, the organization, end users, and technical staff, rate all four reasons relatively the same. However, policy bodies rated transactional integration as the main reason for integration by a large margin. EAI vendors, on the other hand, rate the exact opposite. They find all reasons relatively important except for transactional integration. And finally, collaborators rated end to end business process management as the principal reason for integration followed by the three: data and information integration, transactional oriented integration and control integration rated as relatively important except interface integration, which naturally seems less important to them.

3.4 EAI Challenges

Respondents of the case study were also asked to rank EAI challenges using the same scales. The results, as shown in Figure 9, signify that that the major challenge is a wide EAI market, followed by the existence of legacy systems, lack of EAI knowledge, minimal reusability of EAI solutions, lack of mandate and ownership, high total cost of ownership, and finally a lack of monitoring and problem resolution. Upon further inspection, we immediately notice that the major challenge, a wide EAI market, was rated as such mainly by the end users, organization, technical staff, and vendors. Policy bodies, on the other hand, rate all challenges equally high, except for that of the wide EAI market. Finally, collaborators rate legacy systems, reusability, and ownership issues as their greatest challenges.

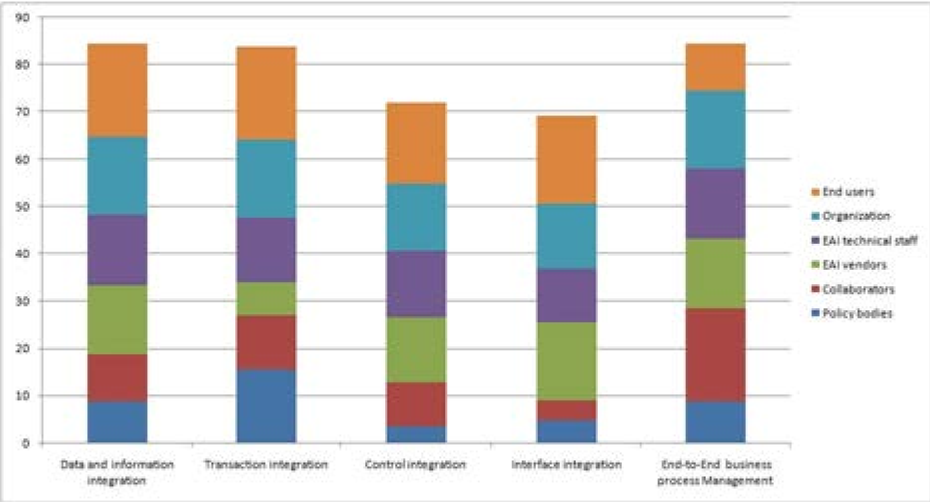

Figure 8: Reasons for Integration

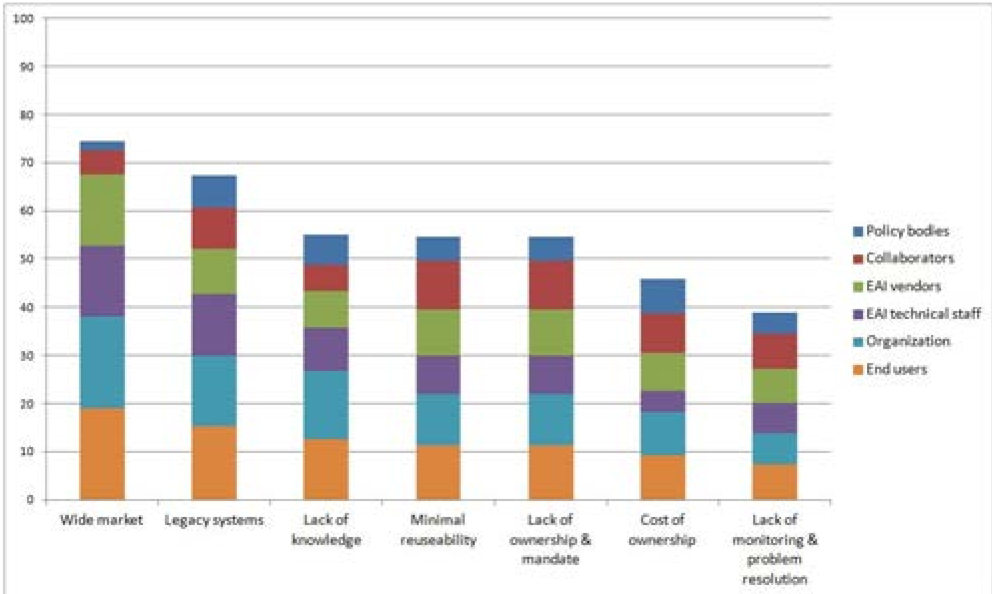

Figure 9: EAI Challenges

3.5 EAI Evaluation for Commercial Banks

In (Patricia K. Lawlis and Courtheyn, 2002; Gorton and Liu, 2002; Comella-Dorda et al., 2002; Themistocleous and Irani, 2006; Kirstan, 2004), eight steps to ease the evaluation of integration technologies are described. Included are a process for incorporating application-specific requirements, weighing individual requirements and tool support for capturing and rapidly exploring requirement trade-offs. Participants of the case study were asked to sequence these eight steps. 76% of respondents strongly agreed that EAI evaluation follow the eight steps in the correct order, 10% were not in agreement and 14% had no position about the steps of EAI evaluation process.

EAI Evaluation Steps	Case Study Strengths	Case Study Weaknesses
1. Define EAI evaluation need, scope, goals, and priorities.	EAI Evaluation based on technical and business perceptions only.	- No ranking of goals in order of significance to support complete EAI Evaluation (Kamal, 2006; Kamal et al., 2008a). -Limited EAI Stakeholder perceptions (Themistocleous, 2004) and participation (Kamal and Weerakkody, 2009).
2. Identify stakeholders.	Stakeholders considered were the organization, EAI Staff, and end-users.	- Policy bodies, collaborators, and EAI vendors were not considered (Ddembe and Kennedy, 1998; Themistocleous, 2004). - No inter-relationship evaluation criteria analysis for these three perceptions (Khoumbati and Themistocleous, 2006).
3. End to end business process analysis	Dynamic Business Process Management (BPM) and re-engineering for Banking	- Dynamic BPM is significant in Optimizing cost and improve process agility (Kirstan, 2004; Gillot, 2008; Kim and Ramkaran, 2004; Themistocleous and Irani, 2006)
4. Identify possible EAI alternatives.	Based on FR, NFR and a set of evaluation criteria. EAI evaluation models used included cost vs. benefit, weighted scoring model, balanced score card; decision making methods, and EAI evaluation criteria.	- No inter-relation evaluation analysis (Khoumbati and Themistocleous, 2006). No feedback analysis for EAI evaluation (Chen and Wong, 2004; Hasselbring, 2000). - No dynamic analysis of evaluation criteria (Khoumbati and Themistocleous, 2006; Kamal et al., 2008b).
5. Gather EAI system information.	FR and NFR based on end-user and organization perceptions. Determine feasible EAI tools.	-Considers the conflict between FR and NFR for quality EAI solutions (Moradi and Bahreininejad, 2010).
6. Iterative developed EAI evaluation.	Selection of best suitable EAI solution.	-No goal prioritization (Kamal, 2006; Kamal et al., 2008a). -No feedback on earlier iterations (Chen and Wong, 2004; Hasselbring, 2000; Kamal, 2006).
7. Risk comparative EAI evaluation.	Based on financial analysis of EAI system.	-No goal prioritization (Kamal, 2006, Kamal et al., 2008a).
8. Selection of the most suitable EAI solution.	Based on technical and business perceptions.	-Ignored other perceptions (Kamal and Weerakkody, 2009).

Table 3: An Assessment of EAI System Evaluation Process Steps for Commercial Banks

Table 3 lists these eight steps and compares them with the process used by commercial banks as they were perceived during the case study. The first column of each row describes one step of the evaluation process. The second column discusses the strengths encountered in the process used for evaluation by commercial banks during the case study. And finally, the third column describes the weaknesses encountered in the process used by commercial banks. Upon inspection of Table 3, we notice that the EAI evaluation process adopted by commercial banks that participated in the case study is limited towards an analysis of EAI solutions. Table 3 therefore confirms a feedback analysis gap in the current EAI evaluation process.

Again considering section 2, the lack feedback in EAI evaluation manifests itself in existing models and frameworks. EAI evaluation is a systemic dynamic problem where a number of stakeholders participate with different goals that show evidence of interdependences between evaluation criteria factors for the different stakeholders as shown in section 3.1. In this case study, in the next Section 4.0 we propose a systems thinking model to guide holistic EAI Evaluation with complete causal path as a system of interdependent group of items forming a unified pattern of stakeholders that cooperate in generation of EAI Evaluation system behavior over time.

4.0 EAI EVALUATION

Most EAI evaluation models simply identify and diagram the relationships between different evaluation criteria and lack the ability to learn their impact and unintended consequences for both short term and long term. EAI evaluation, however, is a dynamic problem including feedback loops. In order to develop a model which guides EAI evaluation as the dynamic process it is, we propose that understanding the relationships between the various evaluation criteria of each stakeholder will result in better EAI evaluation. As such, we propose a participant-oriented model which, identifies and prioritizes all stakeholders for EAI evaluation, establishes taxonomy of evaluation criteria of each stakeholder, establishes a cause effect analysis of the evaluation criteria of the stakeholders, and summarizes the EAI evaluation from all the stakeholder perceptions based on scenario and sensitivity analysis to guide EAI evaluation. Then, by mimicking system behavior under a wide range of alternative scenarios, the resulting system dynamics models allow managers to test alternative assumptions, decisions, propositions and policies within a simulated program environment. This dynamic analytical environment provides a method to anticipate and plan for likely future events.

We present this participant-oriented model by first defining a number of rather obvious assumptions. We then present the causal loop diagram for EAI evaluation based upon these assumptions. Next, we analyze the resulting model by deriving a set of propositions from this model, which we finally test for correctness through focus group discussions

4.1 Assumptions

In order to devise and test a participant-oriented model which captures feedback we are required to assume the following obvious statements:

a) *Multi-stakeholder:* It is assumed that the following stakeholders participate towards EAI evaluation: EAI system back-end users, organization management, EAI technical staff, policy bodies, collaborators and EAI vendors.
b) *Unique focus:* Each stakeholder has different evaluation criteria.
c) *Perception feedback: EAI evaluation stakeholder perceptions affect one another.*

The multi-stakeholder assumption can be seen to be true in the case of commercial banks which we discussed in section 3. And certainly, similar large organizations which require EAI will encounter the same or similar stakeholders. The unique focus assumption is naturally true. Every stakeholder has its own unique perception and thus other stakes during the evaluation process. And finally, the perception feedback assumption is that which we prove in this paper.

4.2 EAI Evaluation System Thinking Model

System thinking is a holistic approach to analysis that focuses on the way that a system's constituent parts interrelate and show how systems work over time and within the context of the system as a whole (Forrester, 2007). In system thinking, system behavior results from the effects of self-reinforcing (positive) and balancing (self correcting or negative) processes. A reinforcing process (positive loop) leads to the increase of some system component. If reinforcement is unchecked by a balancing process, it eventually leads to collapse. A balancing process is one that tends to maintain equilibrium in a particular system. Application of feedback loops can direct EAI evaluators and decision makers to identify other solutions rather than wasting resources on an approach that has been demonstrated to be counterproductive. System thinking uses computer simulation and a variety of diagrams and graphs to model, illustrate, and predict system behaviour. Among the system thinking tools are: The behavior over time (BOT) graph, which indicates the actions of one or more variables over a period of time; the causal loop diagram (CLD), which illustrates the relationships between system elements; the management flight simulator, which uses an interactive program to simulate the effects of management decisions; and the simulation model, which simulates the interaction of system elements over time.

Based upon our proposition, understanding the relationships between the different evaluation criteria of each stakeholder will result in better EAI evaluation and the assumptions we derive a systems thinking model for EAI evaluation using CLD. The strength of system dynamics modeling is the ability to convert qualitative data into quantitative information (Williams, 2003). System dynamics models often draw upon a wide range of data sources to quantify causal relationships. The methodology is sufficiently flexible to incorporate “soft” variables. Many static modeling methods omit soft variables because they are difficult to quantify using traditional methods. Because omitting such soft variables is tantamount to assuming the relationship is unimportant to system behavior, system dynamics models include every relationship believed to be critical to behavior, even if the model-builder must rely upon anecdotal data to quantify the variable.

Figure 10 contains one reinforcing loop which signifies the feedback between the different stakeholder perceptions during EAI evaluation. Reinforcing loops portray self-reinforcing processes wherein an action creates a result that generates more of the action, and hence more of the result leading to vicious or virtuous circle behaviour. It is a goal seeking loop through B-E-F-H-B which presents a virtuous cycle of EAI evaluation. It describes that organization goals capture the reason (system requirements) of the system to be built. Therefore an increase in organization goals (B) will cause an increase in system requirements (E). An increase in system requirements (E) will cause a decrease in the number of vendor solutions (F) that satisfy the increased number of system requirements. An increase in vendor solutions that satisfy specific system requirements causes a decrease in the potential of user evaluation tools (H) which guide the specification of system requirements. And finally, user evaluation tools (H) increase control of how EAI solutions meet organization goals (B) by comparing the actual performance to the goals. The double line marks on some of the relationship arrows in Figure 10 indicate that there is a time delay between the variables and therefore the effect is obtained over time. Because of the manner in which this structure reinforces itself, it generally produces an exponential growth or decline although they can occasionally work to stabilize them. The general behavioural pattern is s-shaped growth with oscillation whose amplitude gradually declines over time. The behaviour pattern of the system structure in Figure 10 is initially dominated by a positive feedback exhibiting exponential growth illustrating that an increase in organization goals will lead to an increase in system requirements for EAI system. However, as the EAI evaluation system approaches its requirements limit or capacity, the resultant vendor solutions that match the capacity will decrease with less ability of the user evaluation tool to suit the requirements capacity to *organization goals.*

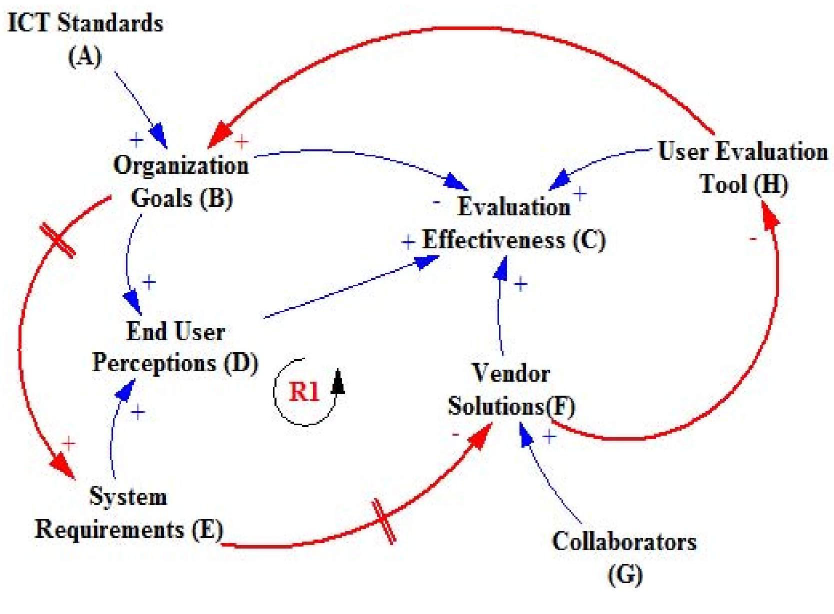

Figure 10: A Feedback Model for EAI Evaluation

4.3 Propositions

The purpose of the model is to foster EAI evaluation criteria interactions and lead to further understanding of EAI evaluation. From it we can derive a number of useful propositions:

(i) An increase in regulations increases the level of attainment of organization goals.
(ii) An increase in organization goals implies an increase in system requirements.
(iii) An increase in requirements implies a decrease in suitable vendor solutions.
(iv) The success rate of user evaluation tools decreases with a diversity of vendor solutions.
(v) User evaluation tools enforce EAI standards for the organization.

Next, validation will prove or reject these propositions and, in turn, the system thinking model.

4.4 Validation of Model Propositions

Based on the review of literature that is related to the evaluation criteria for EAI, a systems thinking model was developed as shown in Figure 10. This model is empirically tested through five focus groups composed of at least six different EAI stakeholders' experts from four Commercial Banks. The participants in each group included strategic managers, EAI back-end users, EAI experts/staff, ICT standard bodies, ESI vendor companies, collaborators and policy bodies. "Focus Group Discussion (FGD) is a rapid assessment, semi-structured, data gathering method in which a purposively selected set of the groups discussed the following questions: *(a) is there the need to consider stakeholder evaluation perception in order of significance to EAI evaluation? (b) is there an interdependence relationship between stakeholder perceptions? (c) are the polarities signs represented correctly for EAI evaluation? and (d) to prove or reject the propositions derived from the systems thinking model* in section 4.3. A Likert scale was used to illustrate the correlations between variables measured on ordinal scale for each proposition where participants in the FGDs produced paired ranks for the related variables. The participants were asked to record their responses, which were periodically posted on a white board. Upon reaching a predetermined time, the notes posted by all participants were open to inspection and debated by the group. Because the notes did not bear any names, it was possible for the participants to critically examine the results during this phase. The five FGD confirm the proposed model, demonstrated by the fact that results are equal across all groups. For qualitative case studies, data stability

is the factor corresponding to reliability in quantitative research. The goal is to identify findings that are stable throughout the groups upon which conclusions can be developed. Based on the evaluation questionnaire for the conceptual model, it was agreed by 90% of the FGD participants that the conceptual model can be used as a decision making tool to guide EAI evaluation completeness.

Table 4 shows the validation of polarity (+, -) of each variable in relation to other variables. Each row represents a causal link from Figure 10. The columns represent the source, or point of origin, of the causal link, its target, polarity, and the result of validation of the link through FGD. For example, 80% of participants agreed that there is a positive (+) relationship between EAI standard (policy bodies) and Organization Goals. The values regarding validation indicate that there indeed is a correlation between different stakeholder perceptions for EAI evaluation. The nature of this correlation is both positive and negative, implying there is causal behavior between EAI evaluation stakeholders and their perceptions.

Source	Target	Polarity	Validation
EAI Standards (Policy Bodies)	Organization Goals	+	80%
Organization goals	-System Requirements -End User Perception -Evaluation Effectiveness	+ + -	65% 70% 76%
End-User	Evaluation Effectiveness	+	90%
System Requirements	-Vendor Solutions -End User Perception	- +	72% 80%
Vendor solutions	-Evaluation Effectiveness -User Evaluation Tool	+ -	85% 80%

Collaboration	-Vendor Solutions	+	67%
User Evaluation Tool	-Evaluation effectiveness -Organization Goals	+ +	60% 69%

Tab. 4: Polarity Validation

Correlations[a]

			ICT satandards and Policy Bodies	Magnitude of Organization goals	EAI system Requirements	Suitable EAI vendor Solutions	EAI Evaluation Tool for suitable Vendor slolutions
Spearman's rho	ICT satandards and Policy Bodies	Correlation Coefficient	1.000	.657**	.118	-.133	.306
		Sig. (2-tailed)	.	.000	.534	.484	.100
	Magnitude of Organization goals	Correlation Coefficient	.657**	1.000	.381*	-.297	.529**
		Sig. (2-tailed)	.000	.	.038	.112	.003
	EAI system Requirements	Correlation Coefficient	.118	.381*	1.000	-.662**	.624**
		Sig. (2-tailed)	.534	.038	.	.000	.000
	Suitable EAI vendor Solutions	Correlation Coefficient	-.133	-.297	-.662**	1.000	-.789**
		Sig. (2-tailed)	.484	.112	.000	.	.000
	EAI Evaluation Tool for suitable Vendor slolutions	Correlation Coefficient	.306	.529**	.624**	-.789**	1.000
		Sig. (2-tailed)	.100	.003	.000	.000	.

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
a. Listwise N = 30

Figure 11: Spearman's Rho Correlation Analysis of EAI Evaluation Criteria Variables

The table of Figure 11 presents the results of Spearman's rho correlation analysis which is used to describe the strength and direction of the relationship between variables. Spearman's is a nonparametric measure of statistical dependence between two variables; also appropriate both continuous and discrete variables, including ordinal variables. A likert scale was used to illustrate the correlation between variables based on the propositions in Section 4.3. The result of the study shows that all five variables, ICT policy bodies, Organization goals, EAI system requirements, EAI vendor solutions and EAI user evaluation tools, are correlated to the EAI evaluation variable in both positive and negative manners." When examining Figure 11, the rank coefficient (r) indicates the strength and direction of the relation between the independent and dependent variables. As values approach -1 or +1, the relation becomes stronger. The Sig. (2-tailed), known as p-value, indicated by * or ** means we can reject the null hypothesis that there is no relation between the variables if it is smaller than 0.05. Next, we prove or reject the propositions in section 4.3 using the table of Figure 11.

In the case of proposition (i.), the correlation coefficient is 0.657 with a p-value of 0.000, which is below the significant level of 0.01. As such, we REJECT the Null Hypothesis. The observed difference between ICT standard policy bodies and Organization goals is highly significant. Hence, an increase in regulations (ICT Standards/Policy Bodies) increases the level of attainment of organization goals.

In the case of proposition (ii.), the correlation coefficient is 0.381 with a p-value = 0.038, which is below the significant level of 0.05. As such, we REJECT the Null Hypothesis. The observed difference between organization goals and system requirements is significant. Hence, an increase in organization goals implies an increase in system requirements.

In the case of proposition (iii.), the correlation coefficient is -0.662 with a p-value = 0.000, which is below the significant level of 0.01. As such, we REJECT the Null Hypothesis. The observed difference between system requirements and vendor solutions is highly significant. Hence, an increase in EAI system requirements implies a decrease in suitable vendor solutions clearly indicating a negative correlation of -0.662.

In the case of proposition (iv.), the correlation coefficient is -0.789 with a p-value = 0.000, which is below the significant level of 0.05. As such, we REJECT the Null Hypothesis. The observed difference between user evaluation tools and vendor solutions is significant. Hence, the success rate of user evaluation tools decreases with a diversity of vendor solutions.

In the case of proposition (v.), the correlation coefficient is 0.306 with a p-value = 0.100, which is above the significant level 0.05. As such, we REJECT the Null Hypothesis. The observed difference between user evaluation tools and ICT standards/policy bodies is not significant. Hence, we are not confident that there is a correlation between user evaluation tools and ICT standards/ policy bodies.

5.0 CONCLUSION

Enterprise Application Integration (EAI) has been adopted at East African Banks to permit seamless intra-and inter-bank connectivity to support evolving business diversification and complexity. However, it is still very difficult to manage and evaluate EAI, mainly because of existence of legacy systems, lack of EAI knowledge and diversity of an EAI solutions market. On top of this, existing EAI evaluation models do not cater for systemic feedback between stakeholders and their perceptions; they simply provide piece meal insights from independent stakeholders. As such, we performed a large case-study at East African banks. A collection of data from 800 EAI stakeholders was ascertained, identifying the different stakeholder perceptions such as reasons for integration and challenges. We then used this data to develop a systems thinking model for EAI that takes into account the identified stakeholders, their perceptions, and the causal relations between them. By analyzing the subsequent causal loop diagrams, we can support dynamic decision making for commercial banks and allow researchers and IT staff to understand EAI adoption from multi-stakeholder perceptions. The resulting model was subsequently validated by another 30 EAI stakleholder experts distributed into focus group discussions (FGD) with each having a representation of at least one EAI stakeholder. The results confirm systemic feedback analysis between EAI stakeholder perceptions and contribute towards the general understanding of EAI evaluation dynamics. Further research direction will endeavour to simulate EAI evaluation using Systems Dynamics (SD) to provide comprehensive insights towards addressing the following policy problem characteristics of any system behavior as outlined by (Ghaffarzadegan et al., 2011):

a) Feedback is the major source of policy resistance: accumulations (stocks) are essential to understanding policy resistance. SD can exemplify why some intuitive policies lead to policy resistance and allow for the design and testing of more robust policies by exhaustive experimentation and sensitivity analysis, wise interpretation of parameters and parameter changes.
b) Achieve consensus between different stakeholders: Feedback diagrams and qualitative analysis can contribute to policy discussions. Aggregate approach facilitates presentation of lessons to others. Highlights feedback and endogenous sources of problem behavior. SD will provide useful insights towards building consensus around difficult policy problems that may otherwise have multiple interpretations. SD facilitates presentation of lessons to others through short exposition and holistic view of all stakeholders.
c) Over confident policymakers: feedback diagrams reveal new insights and challenge policymakers to be wary of over- confidence. Failure to understand the dynamics of accumulation is a common source of policy error. Simulations effectively communicate the counterintuitive nature of policy problems to policymakers who otherwise may remain unpersuaded. SD ensures that model insights are fully understood, allowing policy makers to appreciate and address their own over confidence.

ACKNOWLEDGEMENT

This research paper is made possible through the help, advice, supervision and support from several associates and please allows me to dedicate my acknowledgment of gratitude towards the following:

a) NUFFIC Phase II Project that sponsored the data collection and analysis activities.
b) Prof. Marco Aiello and Mr. Heerko Groefsema for the support and help with the research and writing of the paper.

REFERENCES

AKBULUT, A. Y. (2002). An investigation of the factors that Influence electronic information sharing between state and local agencies. Pages 2454{2460. 8th Americas Conference on Information Systems, Dallas, Texas, USA,.

AMY, H. J. and HITT, M. A. (1999). Corporate political strategy formulation: A model of approach, participation, and strategy decisions. Academy of Management JSTOR, 24(4):825-842.

BARBACCI, M. (2003). Software-quality attributes and architecture trade-offs. Technical report, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA.

BENSLIMANE, Y., CYSNEIROS, M., and BAHLI, B. (2007). Assessing critical functional and non-functional requirements for web-based procurement systems: a comprehensive survey. The Requirements Engineering Journal, 12,:191-198.

BINILDAS, A. C. (2008). Service Oriented Java Business Integration. Packt Publishers.

BRODIE, M. (2006). Integration in A Service-Oriented World: The Big Picture Presentation. Verizon Communications.

BULLET, B. C. (1991). Thinking Collaboratively: Questions and Answers to Help Policy Makers Improve Services for Children. Washington, DC: Education and Human Services Consortium, Institute for Educational Leader-ship.

CHAPPELL, D. (2004). Enterprise Service Bus. O'Reilly.

CHECKLAND, P. (2000). Systems thinking, Systems practice. John Wiley and Sons, New York, NY.

CHEN, C. and DAI, W. (2005). A Multi-Agent Infrastructure for Information Systems Integration. Pages 1-3, Beijing, China. In Proceedings of First International Conference on Semantics, Knowledge and Grid (SKG'05), IEEE computer society. November 26-28, 2005. Beijing, China.

CHEN, Y. and WONG, A. (2004). E-business: Factors of EAI adoption in an Australian Electricity Company. Pages 1289-1294. The Fourth International Conference on Electronic Business (ICEB2004), Beijing.

CLEMPNER, J. (2010). A hierarchical decomposition of decision process Petri nets for modeling complex systems. Int. J. Applied Mathematics and Computer Science,, 20(2):349-366.

COMELLA-DORDA, S., DEAN, J. C., MORRIS, E., and OBERNDORF, P. (2002). A process for COTS software product evaluation. Pages 86-96, Orlando, Florida.

CYSNEIROS, L. and LEITE, J. (2001). Using UML to reflect non-functional requirements. Proceedings of the 2001 conference of the Centre for Advanced Studies on Collaborative research, Toronto, Ontario, Canada: IBM Press.

CYSNEIROS, L. and LEITE, J. (2004). Non-functional requirements: from elicitation to conceptual models. The Journal of Software Engineering, IEEE Transactions Engineering, 30(5):328-350.

CYSNEIROS, L., SAMPAIO, J., and NETO, J. (2001). A framework for integrating non-functional requirements into conceptual models. Requirements Engineering Journal, 6(2):97-115.

DDEMBE, W. W. and KENNEDY, M. (1998). A viewpoints conceptual frame-work for improving the organizational information requirements process: A system dynamics perspective. Pages 1-9, Istanbul, Turkey. The 15th International Conference of the System Dynamics Society.

ERASALA, N., YEN, D. C., and RAJKUMAR, T. M. (2003). Enterprise application integration in the electronic commerce world. Journal Computer Standards and Interfaces, 25(2):69-82.

FRANKFORT, N. C. and DAVID, N. (2008). Research methods in the Social Sciences:. Seventh Edition New York, NY: Worth Publishers.

GHAFFARZADEGAN, N., LYNEISB, J., and RICHARDSONA, G. P. (2011). How small system dynamics models can help the public policy process. System Dynamics Review, 27(1):22-44.

GHOLAMHOSEIN, N., SAYED, Y. S., AMIN, H., and ATA, H. (2010). Competitive advantage of enterprise resource planning vendors. Information Systems,, 35,(3):271-277.

GILLOT, J.-N. (2008). The complete guide to Business Process Management. Business Process Transformation Or a Way of Aligning the Strategic Objectives of the Company and the Information System Through the Processes.

GORTON, I. and LIU, A. (2002). Streamlining the acquisition process for large-scale cots middleware components. Volume 2255 of Lecture Notes in Computer Science, pages pp 122-131, Florida. Springer-Verlag, in Proceedings of 1st International Conference on COTS-based Software Systems,.

GULLEDGE, T. (2006). What is integration. Industrial Management and Data Systems, 106(1):5-20.

HARRIS, B. and WILLIAMS, B. (2005). System Dynamics Methodology. W.K. Kellogg Foundation.

HASSELBRING, W. (2000). Information system integration. Communications of the ACM, 43(6):33-38.

JENSEN, M., JOHNSON, B., LORENZ, E., and LUNDVALL, B. (2007). Forms of knowledge and modes of innovation. Research Policy, 36(5):680-693.

KAMAL, M. (2006). IT innovation adoption in the Government sector: identifying the critical success factors. Journal of Enterprise Information Management, 19(2):192-222.

KAMAL, M. and THEMISTOCLEOUS, M. (2006). A conceptual Model for EAI Adoption in an E-Government Enviroment. In European and Mediterranean Conference on Information Systems (EMCIS'2006), IEEE. July 6-7, 2006. Costa Blanca, Alicante, Spain, pages 1-11, Costa Blanca, Alicante, Spain.

KAMAL, M. and THEMISTOCLEOUS, M. (2007). Investigating EAI adoption in LGAs: A Case Study Based Analysis. Pages 1-13, Keystone, Colorado. USA. Thirteenth Americas Conference on Information systems, IEEE'07, August 09 - 12 2007. Keystone, Colorado,USA.

KAMAL, M., THEMISTOCLEOUS, M., ELLIMAN, T., and ELNAGHI, M. (2008a). Prioritising factors influencing enterprise application integration adoption in local government authorities on the adoption lifecycle phases. The 4th e-Government Workshop.

KAMAL, M., THEMISTOCLEOUS, M., and MORABITO, V. (2008b). Extending e-government infrastructures through enterprise application integration., chapter Evaluating Information Systems. Butterworth-Heinemann.

KAMAL, M. M. (2009a). A multiple case study on integrating it infrastructures in the public sector. International Journal of Electronic Government Research, 5(3):1-20.

KAMAL, M. M. (2009b). A multiple case study on integrating it infrastructures in the public sector. International Journal of Electronic Government Research, 5(3):1-20.

KAMAL, M. M. (2009c). ICT-enabled transformational government: A global perspective. In: Weerakkody, V., J. M. and Dwivedi, Y. e., editors, Mapping factors influencing EAI adoption on the adoption lifecycle phases in the LGAs., pages 140-162. Information Science Reference.

KAMAL, M. M., THEMISTOCLEOUS, M., and ELLIMAN, T. (2008c). Mapping factors influencing EAI adoption in the Local Government Authorities on different Phases of the Adoption LifeCycle. pages 1-17, Al Bustan Rotana Hotel, Dubai, UAE. European and Mediterranean Conference on Information Systems (EMCIS'2008), IEEE. May 25-26, 2008, Al Bustan Rotana Hotel, Dubai, UAE.

KAMAL, M. M. and WEERAKKODY, V. (2009). Investigating the Role of Stakeholders in EAI adoption in Local Government Authorities. pages 1{12, San Francisco, USA. IEEE.

KAMAL, M. M., WEERAKKODY, V., and JONES, S. (2009). The case of EAI in facilitating e-government services in a Welsh authority. International Journal of Information Management, 29(2):161-165.

KAREN S. BAKER, STEVEN J. JACKSON, J. R. W. (2005). Strategies supporting heterogeneous data and interdisciplinary collaboration: Towards an ocean informatics environment. volume 8, HICSS '05: Proceedings of the Proceedings of the 38th Annual Hawaii International Conference on System Sciences (HICSS'05). Publisher: IEEE Computer Society.

KARIM, A. J. (2011). Evaluating the influence of reliability, usuability, usefulness and website design on the satisfaction of online consumers. Research Journal of Economics, Business and ICT, 2:28-32.

KETCHELL, J. (2003). E-business standards - re-intermediating the end users. International Journal of IT Standards and Standardization Research, 1(2):53-56.

KHOUMBATI, K. and THEMISTOCLEOUS, M. (2006). Integrating the IT Infrastructures in Healthcare Organisations: a Proposition of Influential Factors. The Electronic Journal of e-Government, 4(1):27-36.

KIM, H. M. and RAMKARAN, R. (2004). Best practices in e-business process management: Extending a re-engineering framework. Business Process Management Journal, 10(1):1-14.

KIRSTAN, V. (2004). XML-Based Integration with XAware: Unifying Applications and Data in Today's E-business World. Maximum Press.

L. CHUNG, B. NIXON, E. Y. J. M. (1999). Non-Functional Requirements in Software Engineering Series: The Kluwer International Series in Software Engineering. Kluwer Academic Publishers.

LAM, W. (2005). Investigating success factors in enterprise application integration: a case- driven analysis. European Journal of Information Systems, 14. 175–187

LAM, W. (2007). Information Systems Integration and Enterprise Application Integration(EAI) Adoption: A case from financial services. Journal of Information Systems Education, 18(2):149-158.

LAPLANTE, P. (2009). Requirements Engineering for Software and Systems (1st ed.). Redmond, WA: CRC Press,.

LEE, Y., CHOI, E., and MIN, D. (2006). A delay time-based peak load control for stable performance. pages 329{340, Springer-Verlag Berlin, Heidelberg. Proceeding ISPA'06 Proceedings of the 4th international conference on Parallel and Distributed Processing and Applications.

LEMON, K. N., WHITE, T. B., and WINER, R. S. (2002). Dynamic customer relationship management: Incorporating future considerations into the service retention decision. Journal of Marketing, 66(1):1-14.

LI, Q. (2009). Bank Application System Integration Based on SOA and EAI. pages 271-274, Dalian, China. International Conference on Industrial and Information Systems (IIS)'2009, IEEE Computer Society. July 10-11, Dalian, China.

LINTHICUM, D. (2003). Next Generation Application Integration: from simple information to Web Services. Addison-Wesley.

LOSAVIO, F., ORTEGA, D., and PREZ, M. (2005). Comparison of EAI frameworks. Journal of Object Technology, 4(4):93-114.

MACHARIA, J. and NYAKWENDE, E. (2010). Factors affecting the adoption and diffusion of internet in higher educational institutions in Kenya. Journal of Communication and Computer. 7(10):72-82.

MANTZANA, V., THEMISTOCLEOUS, M., IRANI, Z., and MORABITO, V. (2007). Identifying health care actors involved in the adoption of information systems. European Journal of Information Systems, 16:91-102.

MELAVILLE, A. I. and BLANK, M. J. (1993.). Together We Can: A Guide for Crafting a Profamily System of Education and Human Services. (ERIC Document Reproduction Service No. ED 357 856).

MORADI, H. and BAHREININEJAD, A. (2010). A new framework for evaluating the functional capabilities of intra-enterprise application integration technologies. Journal of Systems Integration, 1(4):50-61.

MORADI, H. and BAHREININEJAD, A. (2013). Toward a comprehensive framework for evaluating the core integration features of enterprise integration middleware technologies. Journal of Systems Integration, 4(1):13-29.

PATRICIA K. LAWLIS, KATHRYN E. MARK, D. A. T. and COURTHEYN, T. (2002). A formal process for evaluating cots software products. Volume 34, pages 58-63. IEEE Computer Society.

PEPALL, L., RICHARDS, D., and NORMAN, G. (2008). Industrial Organization: Contemporary Theory and Empirical Applications, Wiley-Blackwell.

PUSCHMANN, T. and ALT, R. (2004). Enterprise application integration systems and architecture-the case of the Robert Bosch Group. The Journal of Enterprise Information Management, 17(2):105-116.

RAMAKRISHNAN, L. and REED, D. A. (2013). Predictable quality of service atop degradable distributed systems. Cluster Computing, 16(2):321-334.

RIBEIRO, J., MOREIRA, A., and ALMEIDA, A. M. (2011). Stakeholders' perceptions of the use of ICT in the education of students with sen. International Journal of Technology Enhanced Learning, 3(3):242 -254.

ROBINSON, S. (2003). Simulation. The Practice of Model Development and Use. John Wiley and Sons, Ltd.

RWASHANA, A. and WILLIAMS, D. (2006). An evaluation of healthcare policy in immunization coverage in Uganda. A case study on Uganda healthcare provision. Proceedings of the 24th International System Dynamics, 23-27 July, 2006, Nijmegen, the Netherlands. System Dynamics Society, ISBN 978-0-9745329-5-0.

SANDEEP PURAO, S. P. and SMITH, S. (2007). Understanding enterprise integration project risks: A focus group study. Volume ISBN:0-7695-2932-1, pages 1-5, IEEE Computer Society Washington, DC, USA. Proceeding DEXA '07 Proceedings of the 18th International Conference on Database and Expert Systems Applications.

SAURABH, K. (2010). Software development and testing: A system dynamics simulation and modeling approach. In: 9th WSEAS-SEPADS '10, UK.

SEREBRENIK, A., MISHRA, A., DELISSEN, T., AND KLABBERS, M. (2010). Requirements certification for off shoring using LSPCM. Pages 177{182, Oporto, Portugal, 7th International Conference on the Quality of Information and Communications Technology (QUATIC), IEEE Computer Society.

SHARIF, A. M., IRANI, Z., and LOVE, P. E. (2005). Integrating ERP using EAI: A model for post hoc evaluation. European Journal of Information Systems, 14:162-174.

SICE, P. and FRENCH, I. (2006). A Holistic Frame-of-Reference for Modeling Social Systems. Kybernetes, 35(6):851-864.

SILVEIRA, R. and PASTOR, J. A. (2006). A Model for Enterprise Application Integration Tools Evaluation. pages 1{8, Costa Blanca, Alicante,Spain,. European and Mediterranean Conference on Information Systems (EMCIS) 2006,July 6-7 2006, Costa Blanca, Alicante, Spain.

STERMAN, J. D. (2000). Business Dynamics: Systems Thinking and Modeling for a Complex World. McGraw-Hill, Irwin.

TATARI, O. and SKIBNIEWSKI, M. (2011). Empirical analysis of construction enterprise information systems: Assessing system integration, critical factors, and benefits. Journal of Computing and Civil Engineering, 25(5):347-356.

TERRY, M. (1991). Politics and the theory of organization. Journal of Law, Economics, and Organization, 7.

THEMISTOCLEOUS, M., I. Z. and LOVE, P. (2004). Evaluating the integration of supply chain information systems: A case study. European Journal of Operational Research, 159.

THEMISTOCLEOUS, M. (2004). Justifying the decisions for EAI implementations: A validated proposition of influential factors. Enterprise Information Management, 17(2):85-104.

THEMISTOCLEOUS, M. and IRANI, Z. (2001). Benchmarking the Benefits and Barriers of Application Integration. An International Journal, 8(4):317{331 with DOI: 10.1108/14635770110403828.

THEMISTOCLEOUS, M. and IRANI, Z. (2002). Towards a novel framework for the assessment of enterprise application integration packages. IEEE- Proceedings of the 36th Hawaii International Conference on System Sciences, Hawaii, IEEE Computer Society.

THEMISTOCLEOUS, M. and IRANI, Z. (2006). Towards a methodology for the development of integrated it infrastructures. pages 1-9, Proceedings of the 39th Hawaii International Conference on System Sciences. Brunel University, Uxbridge, UB8 3PH, UK, IEEE.

THEMISTOCLEOUS, M., IRANI, Z., KULJIS, J., and LOVE, P. E. (2004a). Extending the information system lifecycle through enterprise application integration: A case study experience. pages 1-8, Proceedings of the 37th Hawaii International Conference on System Sciences - 2004. IEEE.

THEMISTOCLEOUS, M., IRANI, Z., and LOVE, P. (2005). Developing E-government integrated infrastructures: A case study. pages 1-10, Big Island, Hawaii,. System Sciences, 2005. HICSS '05. Proceedings of the 38th Annual Hawaii International Conference.

THEMISTOCLEOUS, M., IRANI, Z., and LOVE, P. E. (2004b). Evaluating the integration of supply chain information systems: A case study. European Journal of Operational Research, 159(2):393-405.

VANGEN, S. and HUXHAM, C. (2003). Nurturing collaborative relations: Building trust in inter-organizational collaboration. Journal of Applied Behavioral Science, 39(5):5-28.

WIEGERS, K. E. (2003). Software Requirements; Practical techniques for gathering and managing requirements throughout the product life cycle. Microsoft Press, 2nd edition.

WILLIAMS, D. (2000). A Framework for Improving the Requirements Engineering Process Effectiveness. Operational Research Society.

WILLIAMS, D. (2003). Challenges of system dynamics to deliver projects: faster, better and cheaper. In: 21st Int. Conf. of the System Dynamics Society.

YIN, K. R. (2003). Case study research design and methods. Thousand Oaks, CA: Sage.

ZHEFU, S., CORY, B., and KEN, M. (2009). Analytical models for understanding misbehavior and mac friendliness in csma networks. Performance Evaluation, 66(9-10):469.