# Alignment of Information Systems to Strategy in the Health Sector Using a Systems Dynamics Approach

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## ABSTRACT
Alignment of Information Systems with organizational objectives and strategy is a key factor for the success of information systems. However, most health facilities have not aligned their Health Information Systems to organizational-wide strategic goals and objectives. This has led to challenges such us poor planning, lack of resources and above all the lack of direction by top management in implementing and using Health Information Systems. This research involved an assessment of the requirements for strategic alignment of health information systems in health facilities, development and validation of a strategic alignment model using selected health facilities.

A multi-method research approach involving the use of quantitative and qualitative methods was used. The quantitative approach provided quantitative data that was used to generate requirements for the development of the model, as well as validating and testing of the system dynamics model. A sample of 408 respondents was taken from 39 health facilities in Uganda to participate in the study. Data was analyzed using descriptive statistics and presented in tables and graphs. The requirements for strategic alignment of Health Information Systems were identified as proper planning, establishment of policies, frameworks and standards, resource mobilization, establishment of work processes, training and sensitization of staff members about Health Information Systems work processes. Further, there is need to minimize time lag between HIS and other integrated organization information systems, improve on useful features and functions of HIS and also ensure the system covers all functions of the health facility. The study proposes a model, which when well used can help to improve the strategic alignment of Health Information Systems in health facilities.

## Categories and Subject Descriptors
H.1.0 General



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## General Terms
Information Systems Development.

## Keywords
Health Information Systems, Strategic alignment, System Dynamics, Uganda

## 1. INTRODUCTION
Strategic alignment exists when the business and Information Technology (IT) strategies are in dynamic coherence with the systems that support strategy execution, which include; Information Systems and organization infrastructure (Lapiedra, Alegre, & Chiva, 2006). Although business to IT alignment has been among the top management concerns in organizations for over two decades, the practice remains a challenge to many implementers due to external forces, like cost , transformation of information technology (Luftman & Kempaiah, 2008) and lack of appropriate framework and models usable by management teams at different strategic planning levels (Coiera, 2009). These forces and issues interfere with the process of planning and development of Information Systems for strategy execution. Poorly aligned health information systems lead to under developed Health Information Systems which in turn lead to inadequate IS related execution of the National Health Service Strategy. Consequently, there has been poor performance of the National Health Service (Bush, Lederer, Palmisano, & Rao, 2009). Moreover, the existing models for strategic alignment have little concern for health information systems and only focus on isolated aspects, thereby leaving out some not very well known but critical factors for HIS success.

Existing methods do not have the capacity to analyze complex multifactor interactions involving non-linear relationships (Avila, *et al.*, 2009), and therefore have limited capacity to inform strategic alignment planning and implementation. The complex nature of the organization environment, and the need for continued monitoring and adjustment of alignment factors, has created a need for a shift from the traditional strategic alignment approaches oriented to understanding linear relationships among alignment factors to those that can capture dynamic multi factor interactions among alignment factors within the organization environment, (Issa-Salwe *et al.*, 2010; Chen, 2010; Avila *et al.*, 2010).

Further, the lack of an appropriate model for IS related strategic alignment analysis focusing on dynamic multi-factor interactions, has led to; inadequate involvement of managers in HIS strategic alignment analysis, planning and implementation (Heeks, 2006). Therefore, there is need for an HIS strategic alignment model that provides for the *capture of dynamic multi-factor interactions within the Health Information Systems strategic environment (*Silva, Figueroa, & González-Reinhart, 2007). According to Sahay (2005), dynamic multifactor interaction is a problem solving approach that aims at solving problems through the examine the effects cause when factors affecting the situation interact. It helps to identify the gaps between the actual and desired state in which the problem can be solved (Chang, Hsiao, Lee, & Chang; , 2009), hence, by using this approach, the researchers were able to cause interaction of the factors influencing strategic alignment of HIS and established the effects caused by their interactions as they brought about strategic alignment of HIS.

This study sought to develop a model for strategic alignment of health information systems in health facilities. The study set out to address the following research question: "What are the requirements for building a model for strategic alignment of Health Information Systems in health facilities?" The proposed model focuses on filling the strategic alignment gaps that hinder the successful planning, design and sustainability of health information systems. In addition, the proposed model provides an improved technique for determining factors and circumstances leading to HIS misalignment, define how to best achieve successful HIS alignment and reap the benefits that HIS alignment at different levels of the health service system. The model incorporates dynamic synthesis as an enhancement of the traditional techniques that are restricted to monitoring linear relationships between a limited set of strategic factors.

## 2. Uganda National Health Service

In Uganda, the need for strategic alignment within the National Health Service (NHS) arises from the existence of several Healthcare service providers deploying different IS. As earlier explained, the National Health Service (NHS) is constituted by: the Public Health Service (PHS) sector constituted by government owned Health Service Centres and the Private Health Service sector constituted by: the Private Not-For-Profit (PNFP), Private Health Practitioners (PHP), the Traditional and Complementary Medicine Practitioners (TCMP); and the Communities (MoH, 2005). The two sectors represent different institutional structures that define their Health Information Systems design and use. The government owned public HS Centres use the Health Management Information System (HMIS) designed to support the execution of the National Health Service strategy (MoH, 2005), and the private HS providers use largely, institution specific Information Systems that are designed with limited use of HMIS tools. These discrepancies have led to poor execution of the National Health Service strategy (PEPFAR report, 2010). Hence the need for a model that can be applied at different Health Service levels to enhance Information Systems to health facilities' strategic goals and planning processes.

## 3. Related Literature

This section looks at relevant literature on Information systems strategic alignment methods and limitations of the existing methods leads to the introduction of the concept of System Dynamics, in trying to appreciate the research problem.

### 3.1 Information Systems Strategic Alignment

Although, no specific information systems strategic alignment method exists, several general information technology strategic alignment methods and models have been developed to guide strategic alignment of information technology in organizations. Some of these include the Strategic Alignment Model (Henderson & Venkatraman, 1993) which has business and Information Technology domains and internal and external perspectives; the strategic fit model (Melville, Kraemer, & Gurbaxani, 2004), which is a multidimensional model and a tool for the analysis of IT-Business alignment; the multifactor productivity measurement model (Sahay, 2005) which focuses on analyzing alignment gaps at the strategic level while omitting the role of organizational processes in strategic alignment (Chang, Hsiao, Lee, & Chang, 2009).

The above models and methods have several limitations in terms of limited scope in HIS strategic alignment, competence alignment and do not adequately address governance issues in strategic alignment. There are also challenges with the architectural and processes designs such that they cannot ably solve the complexities involved in HIS strategic alignment, given the limited knowledge and skills of most users of HIS. Although strategic alignment requires involvement of all stakeholders, the listed models do not involve all actors, thereby making it difficult to manage the dynamic multi-factor analysis and influences in HIS strategic alignment. Therefore, a more flexible systems dynamics method was adopted in this study.

### 3.2 The Concept of Systems Dynamics

The System Dynamics Society define System Dynamics (SD) as "a methodology for studying and managing complex feedback systems, such as one finds in business and other social systems"( http://www.systemdynamics.org/sigs/energy/about.htm). System Dynamics has been described as a theory of the structure of systems and their resulting dynamic behaviour as well as a rigorous method for qualitative description, exploration and analysis of complex systems in terms of their processes, information, organisational boundaries and strategies (Wolstenholme,1990; Deakins, 2001); System dynamics provides a means to gain insights into the complex systems by understanding the linkages, interactions, feedbacks and processes between the elements that comprise the whole system. Using system dynamics, one is able to map all the variables and show how they affect each other and develop theories about such relationships (Harris & Williams, 2005). Given that Information Systems are socio-technical systems involving the interplay of technology components (hardware and software), people (with cognitive capabilities and associated shortcomings), data (to capture real-life situations) and organizational issues (processes and management). Dynamically complex, these interactions render SD modelling most suitable for tackling interesting IS situations, as they evolve through time.

Madachy(2008) argues that using system dynamics (SD) modelling methods to solve Information System research problems can help Information Systems managers to capture system requirements, design and develop high-quality Information Systems. This leads to improved success of Information Systems development projects, increased user satisfaction and business value. Further, Amaral & Uzzi (2007); Sterman (2000) argue that Systems Dynamics is useful in bringing out the dynamic effects of Information Systems and can

be used to design complex business systems, where the structure of feedback loop relations in a system gives rise to its dynamics.

# 4. RESEARCH METHODOLOGY

The section presents an explanation of the research design, including the procedures, processes and research methods used in conducting this study. This study employed the Dynamic Synthesis Methodology (DSM) as proposed by Rwashana and Ddembe (2008) which combines the System Dynamics and case study methodologies. DSM provides a more detailed step by step way of conducting the researchcombining qualitative (Sterman, 2000; Wolstenholme, 1990) and quantitative (Randers, 1980), research strategies in conceptualisation, data collection analysis and model building. In addition, DSM applies the case study approach allowing data collection on the current system in a natural environment. The data is used to inform definition of user requirements and definition of system specifications. Dynamic Synthesis Methodology has six stages including problem structuring, field study and model building, simulation, policy analysis, and validation as shown in Figure 1.

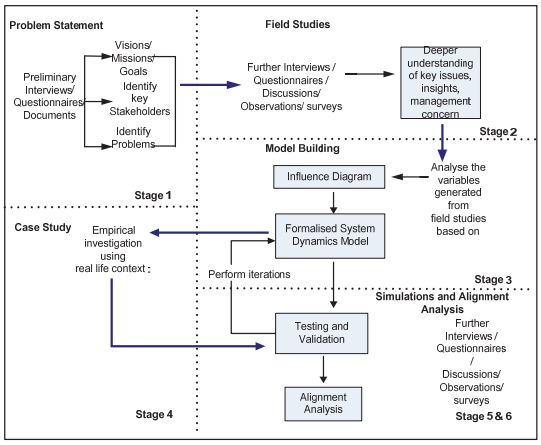


Figure 1: Research Design (Sterman 2000; Williams 2002; Rwashana & Williams 2008)

The following stages of the DSM were followed in the study.

## 4.1 Problem Statement

Problem statement stage enabled the researchers to focus the study of the entire system using a specific problem as an entry point into studying the behaviour of the entire system. Preliminary information and data was collected through review of policy documents, previous studies and stakeholder interviews. The HIS strategic alignment issues were defined and the scope and boundaries of the study identified. Definition of study objectives took into account perspectives of multiple stakeholders including system users and managers.

## 4.2 Field Study

Quantitative research design involved the use of a survey questionnaire to collect data on requirements for a strategic alignment model while the qualitative research was found most suitable to study beliefs and subjective behaviour.

### *4.2.1 Selection of the Sample Size*

Partially and 100% owned government health service facilities that had been in existence for at least 10 years and are currently using Ministry of Health supported Health Information Systems were selected using the purposive sampling method. The study covered a total of 39 district hospitals, referral hospitals, Health Centre IVs (HCIV), Health Centre IIIs (HCIII), Health Centre IIs (HCII) and one medical Centre of Excellence operating under Mildmay Uganda from various districts in the central region of Uganda. The central region of Uganda was selected because it has the highest of number of hospitals operating under Mildmay Uganda. From the above population, the purposive sampling method was used to select 5 respondents from each Health Centre II, 15 respondents from each district and referral hospital, 10 respondents from each Health Centre IV, 6 respondents from each Health Centre III and 5 respondents from each Center of Excellency resulting in a total sample of 296 respondents.

The above selection was based on the size of the participating healthcare institution. Although there is no known single population for any grouping as indicated above, the general structure these health organizations is such that a referral hospital has a bigger geographical coverage. For example a referral hospital covers an entire region of a country comprising of several districts and therefore has more staff and patients compared to the lower health units. While a district hospital covers a single district, .the HCIVs covers a county, HCIIIs covers a sub-county and HCIIs covers a parish. Mildmay Centre of Excellence, an independent non-governmental health center that offers specialized healthcare services to a limited clientele is smaller than any of the five described categories. In this study therefore, the number of respondents selected depended on the geographical scope of the participating healthcare institution, such that those covering a bigger geographical area contributed more respondents. This mechanism was used to achieve a reasonable representativeness of the study population within the selected sample size. Further, there was an effort ensure that the study sample was within the minimum requirement of 30 to 500 respondents for this kind of study as stipulated by Roscoe's (1975) rule of thumb.

### *4.2.2 Pretesting of the Research Instrument*

The research questionnaire was tested for validity and reliability before it was administered to respondents. Validity testing was done to ensure that the instrument measured what it was originally intended to measure while reliability testing was done to ensure the study findings could be relied upon as a true and whole representation of what was on ground (Rudner & Schafer, 2001). In this study, Content Validity Index (CVI) was used to test for validity, while Cronbach Alpha Reliability Coefficients were used to test for the reliability of the questionnaire. Table 1 shows validity and reliability results. Results reveal that the research questionnaire was valid and reliable given that all variable had a CARC and CVI above 0.7. The data collected was analyzed and summarized to identify user and specification requirements for the model; actors, activities, resources, products, key variables and associated system challenges.

**Table 1 Validity and Reliability**

| Variable | No of items | CARC | CVI |
|---|---|---|---|
| Business strategy requirements | 5 | .762 | .786 |
| Business process requirements | 8 | .821 | .752 |
| Information system design requirements | 6 | .744 | .766 |
| Information system strategy requirements | 6 | .711 | .788 |

## 4.3 Model Building

Data were collected and analyzed to establish the requirements for strategic alignment of health information systems and these were grouped according to the following constructs based on the modified strategic alignment model by Ribbers, (2008); business strategy requirements, business process requirements, information systems strategy requirements and system design requirements. Causal tree diagrams were then used to present the factors influencing the constructs. Vensim modeling software was then used to draw the causal loop diagrams showing the variables, their interactions and the feedback loops. Variable types (stocks, flows, converters etc.) were defined and stock and flow diagram was constructed for the different sectors of the model. A conceptual feedback structure for the model was developed and this in turn informed the development of the causal loop diagram with stakeholders' input, (Rwashana & Williams, 2008) in stage 3 and 4.

## 4.4 Simulation and Policy Analysis

Model testing and validation was done through simulations experimentation and discussions with key stakeholders, specifically health workers and administrators using the Health Information Systems at selected health facilities. A simulation tool was used to generate an abstract representation of the real world-view of a problem under investigation by mimicking key elements of the problem situation. Through experimentation the model enabled the investigator to demonstrate the likely effects of different policies by trial and error. Policies with the best results were subsequently adopted for use in routine analysis of HIS strategic alignment in Healthcare, (Williams, 2004; Rwashana & Williams, 2008), in stages 5&6. The simulation experiments were performed using STELLA Modelling software.

## 4.5 Model Validation

Despite the care and diligence in conducting the research and designing the model, research shows that no model is entirely "exact" (Sterman, 2000). According to Forrester ( 1994), no model can be expected to be valid in an absolute sense. Therefore, in the design and validation of this model, we focused more on model usefulness in meeting a set of objectives rather than its accuracy (Sterman, 2000). Model testing and validation involves a series of tests to obtain the confidence in the model based on both internal and external consistency tests.

Using the same health facilities where the study was conducted, two participants from each health facility were selected to validate the model resulting in a total of 39 respondents. Purposive sampling was used to select the head of the health facility and the head of ICT department. Where the head of a given health facility was not available, his or her deputy was contacted to validate the model. In the event that both the head and deputy were unavailable, the researcher contacted the third most senior person in the Health facility. On the other, hand, where the HMIS focal person was not available, or did not exist in the health facility, the most senior ICT official was selected to validate the model. The reason for using only senior people to validate the model was because they are the ones that understood strategic issues of their health facilities well and were involved in the planning and allocation of resources to various departments. Appendix 1 shows the validation sample.

# 5. ANALYSIS AND DISCUSSION OF FINDINGS

This section presents the findings from primary data.

## 5.1 Categories of Organizations

Data was gathered and analyzed to establish the categories of health facilities that participated in the study. Results in Figure 2 show that the majority of respondents came from Health Center IVs (49%); Regional Referral Hospitals came in second (27.7%) and Health Centre IIIs were third contributors (14.5%). Centre of Excellence and Health Centre IIs contributed less each having 5.1% and 3.7% respectively.

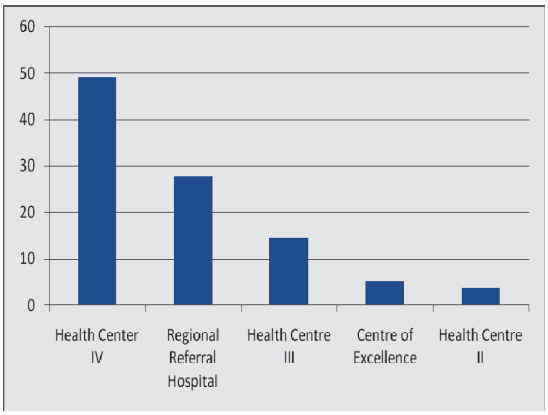


Figure 2 Organization Categories

## 5.2 Requirements for Strategic Alignment of HIS

This section explains the requirements for strategic alignment of health information systems.

### *5.2.1 Business Strategy Requirements*

Descriptive means were used to analyze business strategy requirements as seen in Table 2. Results show that respondents strongly agreed that for successful alignment of Health Information Systems, there should be top-level strategic planning for information systems in the Health facility (mean=4.2365); there should be a framework for HIS implementation in the Health facility (mean=4.0135); there should be standards to guide users in implementation and use HIS (mean=4.1149); there should be a policy for HIS activities in the Health facility (mean=4.1757); there should be high-level resource mobilization to fund HIS projects in the Health facility (mean=4.4054).

**Table 2 Business Strategy Requirements**

| Business strategy requirements | N | Mean | Std. Dev |
|---|---|---|---|
| There should be top-level strategic planning for information systems in the Health facility | 296 | 4.24 | .731 |
| There should be a framework for HIS implementation in the Health facility | 296 | 4.01 | .971 |
| There should be standards to guide users in implementation and use HIS | 296 | 4.12 | .674 |
| There should be a policy for HIS activities in the Health facility | 296 | 4.18 | .706 |
| There should be high-level resource mobilization to fund HIS projects in the Health facility | 296 | 4.40 | .846 |

### *5.2.2 Business Process Requirements*

Results in table in Table 3 show that respondents strongly agreed that for successful alignment of Health Information Systems, HIS work processes should be well defined to enable staff use HIS effectively (mean=4.2939); employees should be trained to understand the need for HIS in their work (mean=4.6486); there should be sensitization of users (mean=4.2534); HIS should minimize time lag between data input and output for batch processing (mean=4.2264); HIS should be equipped only with useful features and functions (mean=4.2399); HIS should cover all functions of the organization (mean=4.1453); HIS should be implemented using modern technology (mean=4.2635). The respondents also agreed HIS should be well integrated (mean=3.9797).

**Table 3 Business Process Requirements**

| Business process requirements | N | Mean | Std. Dev |
|---|---|---|---|
| HIS work processes should be well defined to enable staff use HIS effectively | 296 | 4.2939 | .74885 |
| Employees should be trained to understand the need for HIS in their work | 296 | 4.6486 | 1.13415 |
| There should be sensitization of users | 296 | 4.2534 | 1.02179 |
| HIS should minimizing time lag between data input and output for batch processing | 296 | 4.2264 | 1.01486 |
| HIS should be well integrated | 296 | 3.9797 | .81901 |
| HIS should be equipped only with useful features and functions | 296 | 4.2399 | 1.11381 |
| HIS should cover all functions of the organization | 296 | 4.1453 | .96858 |
| HIS should be implemented using modern technology | 296 | 4.2635 | 1.04386 |

### *5.2.3 Information Systems Design Requirements*

Results in table in Table 4 show that respondents strongly agreed that for successful alignment of Health Information Systems, HIS should be easy to use (mean=4.5878), HIS should be secure (mean=4.0709) and also that HIS should be error free (mean=4.5236). Further, the respondents agreed that HIS should be user friendly (mean=3.8277), HIS should be flexible (mean=3.7196) and also that HIS should be fast (mean=3.7770).

**Table 4 Information Systems Design Requirements**

| Information system design requirements | N | Mean | Std. Dev |
|---|---|---|---|
| HIS should be user friendly | 296 | 3.8277 | 1.25983 |
| HIS should be easy to use | 296 | 4.5878 | 1.06678 |
| HIS should be flexible | 296 | 3.7196 | 1.32477 |
| HIS should be fast | 296 | 3.7770 | 1.05330 |
| HIS should be secure | 296 | 4.0709 | 1.06008 |
| HIS should be error free | 296 | 4.5236 | 1.14364 |

### *5.2.4 Information Systems Strategy Requirements*

Results in table in Table 5 show that respondents strongly agreed that for successful alignment of Health Information Systems, HIS should be affordable (mean=4.1791) and that employees should be trained about HIS (mean=4.5439). The respondents also agreed that HIS should be easy to maintain (mean=3.2331); HIS should allow repairs and modifications (mean=3.9493); HIS should be easy to learn (mean=3.4764); there should be sensitization of users about HIS (mean=3.9493).

**Table 5 Information Systems Strategy Requirements**

| Information system strategy requirements | N | Mean | Std. Dev |
|---|---|---|---|
| HIS should be affordable | 296 | 4.1791 | .93792 |
| HIS should be easy to maintain | 296 | 3.2331 | 1.31860 |
| HIS should allow repairs and modifications | 296 | 3.9493 | 1.43591 |
| HIS should be easy to learn | 296 | 3.4764 | 1.09519 |
| Employees should be trained about HIS | 296 | 4.5439 | .75785 |

| | | | |
|---|---|---|---|
| There should be sensitization of users about HIS | 296 | 3.9493 | .72308 |

## 5.3 Summary of Findings

Findings on the requirements for strategic alignment of HIS as arranged in four categories were strongly agreement with (The Second National Health Policy, July 2010; and Heeks, 2006) that argue that for successful alignment of Health Information Systems, there should be top-level strategic planning for information systems in the Health facility; there should be a framework for HIS implementation in the Health facility; there should be standards to guide users in implementation and use of HIS; there should be a policy for HIS activities in the Health facility; there should be high-level resource mobilization to fund HIS projects in the Health facility. On the construct of business process of (Ribbers, 2008), the findings were also in agreement that HIS work processes should be well defined to enable staff use HIS effectively; employees should be trained to understand the need for HIS in their work; there should be sensitization of users; HIS should minimizing time lag between data input and output for batch processing; HIS should be equipped only with useful features and functions; HIS should cover all functions of the organization; HIS should be implemented using modern technology.

Several Information Systems and technology researchers including (Isabalija, Mbarika, & Kituyi, 2013) argue that the success of an information system or any other technology heavily depends on its design. Thus Information system design requirements are key, the findings from this study agree with literature that for successful alignment of Health Information Systems, HIS should be easy to use, HIS should be secure and also that HIS should be error free. Further, the respondents agreed that HIS should be user friendly, HIS should be flexible and also that HIS should be fast. Further, in line with (Ribbers, 2008) under information systems/technology strategy requirements, the findings revealed that HIS should be affordable and that employees should be trained about HIS. Findings also agreed that HIS should be easy to maintain; HIS should allow repairs and modifications; HIS should be easy to learn; there should be sensitization of users about HIS.

# 6. TOWARDS A MODEL OF HIS STRATEGIC ALIGNMENT

The previous sections explored literature on strategic alignment of health information system, research methods used and also presented findings from primary data and a discussion of findings. The following explains how the model for strategic alignment of health information systems was used developed using a systems dynamics approach.

## 6.1 Causal Tree Diagrams for Model Constructs

Using causal trees the factors influencing business strategy construct of the proposed model include frameworks, policies, standards and vision, alignment of HIS to business strategy, alignment of HIS to IS strategy, HIS design strategy, sensitization on the use of HIS and Information system strategy.

### *6.1.1 Factors Influencing the Business Strategy Construct*

Figure 2 shows the factors that influence business strategy construct.

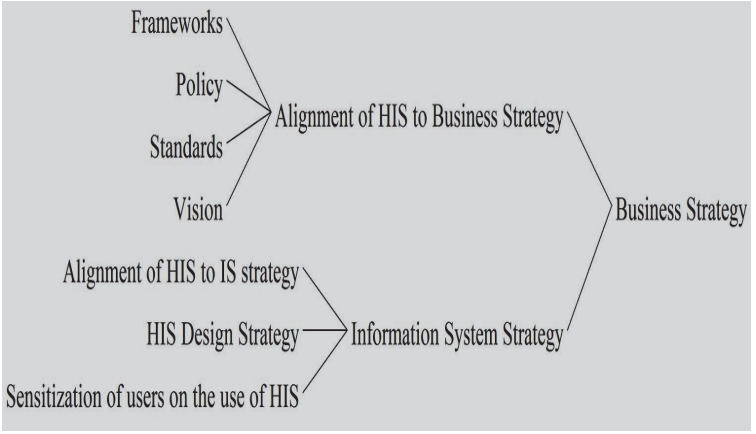


**Figure 1 Factors Influencing the Business Strategy Construct**

### *6.1.2 Factors Influencing the Business Process Strategy Construct*

Further, the Causal Trees tool was used to extract the factors that influence Business Process Strategy construct of the proposed model. These include alignment of HIS to Business Strategy, Information Systems Strategy, business Strategy, Knowledge of HIS work processes, useful features and integration of HIS and other systems. Figure 3 shows the factors that influence Business Process Strategy construct.

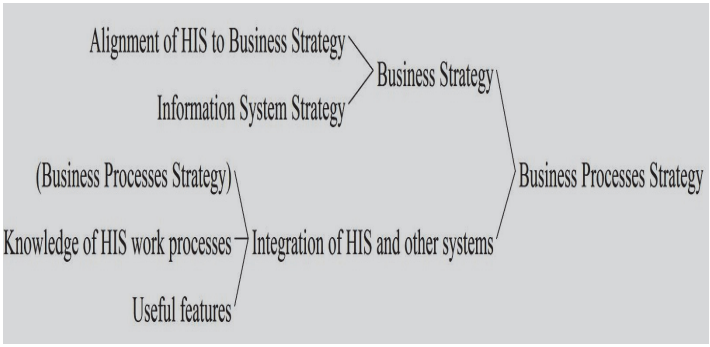


**Figure 2 Influencers of the Business Process Strategy Construct**

### *6.1.3 Factors Influencing the HIS Design Strategy Construct*

In addition to the above, Causal Trees tool of Vensim PLE was used to extract the factors that influence HIS design strategy construct of the proposed model. The factors as seen in Figure 4 include ease of use of HIS, alignment of HIS to IS design, business strategy, integration of HIS and other systems and business process strategy.

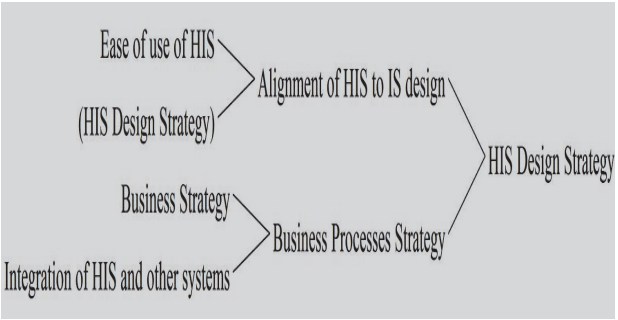


**Figure 3 Factors influencing HIS design strategy construct**

### *6.1.4 Factors Influencing the HIS Design Strategy Construct*

Finally, Causal Trees were used to extract the factors that influence information systems strategy construct of the proposed model. The factors include maintenance costs of HIS, alignment of HIS to IS strategy, alignment of HIS to IS design, business process strategy, HIS design strategy, training of users on the use of HIS, sensitization of users on the use of HIS. Figure 5 shows the information system strategy.

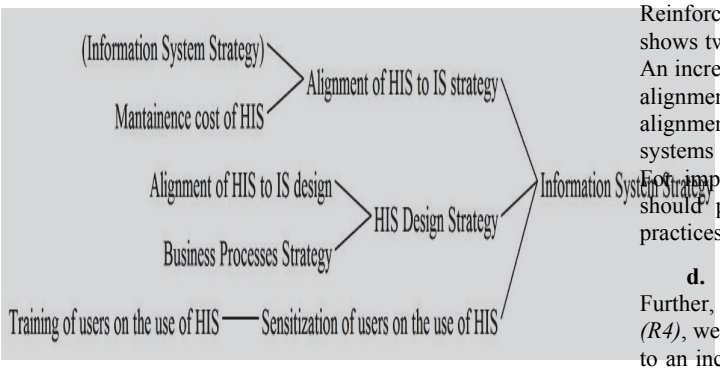


**Figure 4 Factors influencing Information System strategy construct**

## 6.2 Model for HIS Strategic Alignment

As earlier indicated, the model for strategic alignment of Health Information Systems in health facilities was designed using Vensim PLE Software. However, due to space limitations and for clarity of the constructs, the model is presented in Appendix 2. The HIS strategic alignment model as presented in Appendix 2 has six (6) Balancing or negative (-) loops and eleven (12) Reinforcement or positive (+) loops. According to Frangos (2012) and Osgood (2013), Balancing or negative (-) loops are those self-regulate, whereas Reinforcement or positive (+) loops are those that often lead to rapid changes in a system. A description of the model is undertaken in the following subsections.

### *6.2.1 Reinforcement Loops*

**a. Strategic fit for HIS alignment loop-R1**

The *Strategic fit for HIS alignment loop (R1)* is a central loop that comes as a result of interaction with five other loops. The variables for the central loop, which also leads us to the strategic fit for HIS include the four variables adopted and modified from Milis *et al.* (2008) i.e. business strategy, business process strategy, HIS design strategy and Information systems strategy. An increase in business strategy leads to an increase in business processes. Similarly, an increase in business processes increases the need for HIS design strategy and when HIS design strategy increases there is also an increase in the overall Information systems strategy, which also when increased increases business strategy, hence a positive loop.

For strategic alignment of HIS in health organizations, managers should try improve and update their business processes as the business strategies change. Also managers should ensure that whenever their organizational business processes change, HIS designs should also be update to suit the new changes. This helps to improve on overall HIS strategy in health facilities.

**b. Alignment loop 1 (R2)**

In the second reinforcement loop is the *Alignment loop 1 (R2)*. There are two variables affecting each other to cause the *Alignment loop 1 (R2)*. An increase in HIS design increases the need to align HIS to the design. On the other hand, when the need to align HIS design increases, there is also an increase in the HIS design strategy.

For improved alignment of HIS strategic alignment, managers should improve on HIS design while aligning it to the HIS design strategy.

**c. Alignment loop 2 (R3)**

Reinforcement loop three is the *Alignment loop 2 (R3)*. It also shows two variables influencing each other in the same direction. An increase in information systems strategy increases the need for alignment of HIS to IS strategy. Similarly, an increase in the alignment of HIS to IS strategy increases the need for Information systems strategy in the health facility.

For improved alignment of HIS strategic alignment, managers should periodically update their HIS strategy basing on best practices in information systems strategic alignment.

**d. Alignment loop 3 (R4)**

Further, in reinforcing loop number four, the *Alignment loop 3 (R4)*, we see that an increase in information systems strategy leads to an increase in business strategy, which also increases the need for sensitization of users on the use of HIS. Whenever there is an increase in sensitization of users on the use of HIS, there is also an increase in the overall information systems strategy.

For improved strategic alignment of HIS in health facilities, managers should update their HIS strategy in relation to changes in the business strategy. Once there are changes in business and HIS strategies, managers should sensitization users of HIS on the new changes. This is because sensitization leads to improved understanding of information systems and strategy.

**e. Training loop 1 (R5)**

In reinforcing loop five, *Training loop 1 (R5)*, an increase in the organizational goals of a health facility leads to an increase in the need for training of users in HIS. When the need for training of users on the user of HIS increases, there is also an increase in the need for resources, which also when increased lead to an increase in the goals of a health facility.

For improved strategic alignment of HIS in health facilities, managers should train users whenever there are changes in update organizational goals of a health facility. However, mangers should be careful in the utilization of resources since training of users will increase the need for resources.

**f. Planning loop (R6)**

The reinforcing loop number six, *Planning loop (R6)* also gives us the same directional causal feedback whereby an increase in the

vision of a health facility increases the goals of the same health facility. When the goals of a health facility increase, there is also an increase in the resources of the same. When the resources for HIS increase, there increased need for planning for HIS in the medical facility, hence a reinforcement loop.
For improved strategic alignment of HIS in health facilities, managers should managers should always endeavor to update and align the vision of health facilities with business goals. This should be done in such a way that optimizes resource usage through proper planning.

**g. Alignment loop 5 (R7)**

The causal results seen reinforcing loop seven, the *Alignment loop 5 (R7)* reveal that an increase in the vision of a health facility increases the need to align HIS to business strategy and an increase in alignment of HIS to business strategy increases the medical facility's overall business strategy. An increase in the health facility's business also leads to an increase the vision of the same heal facility, hence a reinforcement loop.
For improved strategic alignment of HIS in health facilities, managers should align HIS and business strategies to the vision of a health facility.

**h. HIS design loop 1 (R8)**

In addition, causality effects in reinforcing loop number eight, the *HIS design loop 1 (R8)* indicate that an increase in ease of use of HIS leads to an increase in user friendliness of the HIS and when user friendliness of an HIS increases, there is an increase in the speed of the HIS. An increase in the speed of the HIS leads to an increase in the ease of use of the HIS.
For improved strategic alignment of HIS in health facilities, managers should encourage users to use HIS so as to increase familiarity and user friendliness of HIS. Further, managers should ensure that user friendly HIS is designed in order to improve on the speed of the HIS since users will find it easy use and use HIS more effectively and efficiently.

**i. HIS design loop 2 (R9)**

In reinforcing loop nine, *HIS design loop 2 (R9)*, there are three variables; alignment to HIS design strategy, ease of use of HIS and flexibility of HIS. An increase in the alignment of HIS design strategy leads to increased ease of use of the HIS, which also increases flexibility of the HIS. When the need for flexibility of the HIS increases, there will be an increase in the need to align HIS to design strategy.
For improved strategic alignment of HIS in health facilities, managers should keep improving alignment of HIS design strategy in order to improve on ease of use of the HIS. This improves on the flexibility of HIS.

**j. HIS design loop 4 (R10)**

Reinforcing loop ten, *HIS design loop 4 (R10)* gives us two negative and one positive causal effect among three variables including errors in HIS, sensitization of users on work processes and training of users on work processes. When errors in the HIS increase, there will be an increase in the need to sensitize users on the HIS work processes, which will also increase the need for training of users on the HIS work processes. However, when training of users on HIS work processes increases, there is a reduction in the errors of the HIS.
For improved strategic alignment of HIS in health facilities, managers should try as much as possible to reduce errors in HIS during design so as to avoid training and sensitization costs.

**k. Coverage loop 2 (R11)**

Reinforcing loop eleven, *Coverage loop 2 (R11)* concerns the business strategy construct and constitutes three variable i.e. coverage, useful features and integration of HIS with other systems. An increase in integration of HIS with other systems leads to an increase in HIS coverage, which also increases the HIS useful features. An increase in HIS useful features results into an increase in the integration of HIS with other systems.
For improved strategic alignment of HIS in health facilities, managers should improve integration of HIS with other systems to increase HIS coverage and benefit from diverse HIS useful features.

**l. Coverage loop 1 (R12)**

The last reinforcing loop, *Coverage loop 1 (R12)* shows three variables with a single positive directional effect. An increase in the coverage of HIS leads to an increase in the knowledge of HIS work processes. An increase in the knowledge of HIS work processes also leads to an increase in the integration of HIS with other systems, which in turn increases coverage of HIS.
For improved strategic alignment of HIS in health facilities, managers should increase coverage of HIS in order to increase on the knowledge of HIS work processes. Managers should also work toward increasing the knowledge-base for HIS in health facilities for improved integration of HIS with other systems, which also helps to increase on coverage of HIS.

### *6.2.2 Balancing Loops*

**a. Alignment loop 4 (B1)**

The six negative loops include B1 to B6. In the *Alignment loop 4 (B1)*, an increase in business process strategy leads to a reduction in the need to integrate HIS with other systems. However, once the need to integrate HIS with other systems increases, there will be an increase in the business processes strategy of health facilities.
For improved strategic alignment of HIS in health facilities, managers should improve business process strategy in order to reduce on the need for HIS integration with other systems since integration requires resources.

**b. Coverage loop 3 (B2)**

On the other hand, the causal effects in balancing loop number two, *Coverage loop 3 (B2)* reveal that an increase in time lag of an HIS leads to increased need for modern technology, which also increases the useful features of the HIS. However, once the useful features of the HIS have increased, there will be a reduction the time lag of a HIS of a health facility.
For improved strategic alignment of HIS in health facilities, managers should reduce the time lag of HIS using modern technology. Using modern technology will also help in increasing the useful features of the HIS.

**c. Sensitization loop (B3)**

In balancing loop three, *Sensitization loop (B3)*, when ease of learning of a HIS increases, there is a reduction in the need for training of users on the use of HIS. However, when training of users on the use of HIS increases, there will be an increase in sensitization of users on the use of HIS and when sensitization of users on the use of HIS increases, there will be an increase in ease of learning of a HIS.
For improved strategic alignment of HIS in health facilities, managers should ensure HIS is easy to learn so as to reduce on training and sensitization costs.

**d. Costing loop (B4)**

Results in *Costing loop (B4)* give us a similar picture such that when there is increase in the alignment of HIS to IS strategy, the initial costs of HIS will reduce. However, when the initial costs of HIS reduce, there is an increase in reparability of the HIS. Reparability of HIS reduces maintenance costs, which, when increased, they will reduce the alignment of HIS to IS strategy.

For improved strategic alignment of HIS in health facilities, managers should improve alignment of HIS to IS strategy so that they can reduce the costs, including initial costs, system repair and maintenance costs.

**e. HIS design loop 3 (B5)**

Further to the above, the results in *HIS design loop 3 (B5)* show that an increase in flexibility of the HIS reduces the errors in the HIS, which also, when increased, reduced the security of the HIS. When the security of an HIS is increased, there will be a reduction in the flexibility of the HIS.

For improved strategic alignment of HIS in health facilities, managers should increase in flexibility of the HIS by reducing on errors and increasing security in the HIS.

**f. Training loop 2 (B6)**

In *Training loop 2 (B6)*, an increase in sensitization of users on work processes will reduce the need for training of users on work processes. However, when training of users on work processes is increased, there is an increase in the knowledge of users on the HIS work processes, which in turn increases sensitization of users on work processes of HIS in the health facility.

For improved strategic alignment of HIS in health facilities, managers should sensitize users on work processes in order to reduce on the need for training of users on work processes. On the other hand, the managers can work towards improving the knowledge of users on the HIS work processes through training.

## 6.3 Model Validation for Quality

Data were collected and analyzed in order to establish whether the model was of good quality. Descriptive statistics were used to analyze the data as seen in Table 6. Results indicate that the respondents strongly agreed that the model is easy to understand (mean=4.7973); the model is well designed (mean=4.9054); the model is easy to use (mean=4.0000); the model is complete (mean=4.1486); different parts of model are well interconnected (mean=4.3919); the model has good appearance (mean=4.2027).

**Table 6 Model Quality**

| | N | Max | Mean | Std. Dev |
|---|---|---|---|---|
| The model is easy to understand | 74 | 5.00 | 4.7973 | .40476 |
| The model is well designed | 74 | 5.00 | 4.9054 | .89395 |
| The model is easy to use | 74 | 4.00 | 4.0000 | .00000 |
| The model is complete | 74 | 5.00 | 4.1486 | .73433 |
| Different parts of model are well interconnected | 74 | 5.00 | 4.3919 | 1.21427 |
| The model is has good appearance | 74 | 5.00 | 4.2027 | .40476 |

# 7. Conclusions

Based on the collected requirements, the researchers developed and validated the proposed model for strategic alignment of HIS in health facilities. The model postulates that a holistic approach to problem solving gives more flexibility and success in handling complex problems. For this matter, a system dynamics approach was adapted and used in this study. Using the systems dynamics approach, several factors/variables listed above were modeled with help of the causal-effect diagrams of Vensim PLE software. The interaction of variables at different levels yields into a strategic fit for alignment of HIS in health facilities as seen in R1 loop in Figure 7.

Further, the model was tested with IT/IS and hospital administrators. The validation results were in support of the model, indicating that it can be applied in strategically aligning HIS in health facilities. The health facilities are advised to follow the guidelines presented in the model for successful strategic alignment of health information systems in their organizations. Seeking strategic HIS alignment has important implications for attainment of national health objectives. First, attainment of HIS strategic alignment will impact on the management of national health information due to the positive influence of adopted standards, policies and frameworks. Standards, policies and frameworks are primary artifacts in the realization in the development; implementation and realization of the national health strategy (see (Braa & Hedberg, 2002). As a component of the proposed model, this is associated with the loops from and to the Business Strategy and Information Systems Strategy.

The second implication recognizes that adopting and embedding information technology in health facilities, work processes and routines is likely to result in improvement of health procedures. This is likely to enhance decision making (Goldschmidt, 2005), thereby impacting on the National Health Business Process Strategy, which is a key component in the realization of national health objectives. As a component of the proposed model, this links to the loops that emanate from and link to Business Process Strategy. Thirdly, seeking strategic HIS alignment need to be seen as an important and sustainable process of designing national health systems that are responsive to changing national health objectives. As a component of the proposed model, this links to and from the HIS Design strategy loops whose emphasis is on design aspects of HIS. Thus in recognizing HIS design as instrumental in realizing national health objectives, the proposed model seeks to emphasize the need to achieve proper HIS design as an antecedent to realizing national health objectives. Prior research has recognized the importance of HIS design, such as (Heeks, 2006) whose design–reality gap model which focuses attention on the need for emergent change and improvisation in HIS.

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# APPENDIX 1: VALIDATION SAMPLE

| Category | Number of health facilities | Number of respondents | Total |
|---|---|---|---|
| Referral hospitals | 1. Buikwe Hospital<br>2. Mityana Hospital<br>3. Naggalama Hospital<br>4. Nakasongola Military Hospital<br>5. Nkokonjeru Hospital | 2x5=10 | 10 |
| Health Centre IVs | 1. Bukulula HCIV<br>2. Kalagala HCIV<br>3. Kasana HCIV<br>4. Kassanda HCIV<br>5. Kiwangala HC IV<br>6. Kiyumba HCIV<br>7. Kyantungo HCIV<br>8. Luwero HCIV<br>9. Mpigi HCIV<br>10. Mukono HCIV<br>11. Mukono Town Council HCIV<br>12. Nakasongola HCIV<br>13. Ndejje HCIV<br>14. Nyimbwa HCIV<br>15. Wakiso HCIV<br>16. Butenga HCIV<br>17. Ssembabule HC IV<br>18. Kiwangala HC IV<br>19. Mpigi HC IV<br>20. Maddu HC IV<br>21. Kasangati HC IV<br>22. Buvuma HCIV<br>23. Butenga HCIV | 2x23=46 | 46 |
| Health Centre IIIs | 1. Bishop Asili HCIII<br>2. Buwama HCIII<br>3. Holy Cross HCIII<br>4. Kinoni HC III<br>5. Ngogwe HCIII<br>6. Rwebitakuli HC III<br>7. Kireka SDA HC III<br>8. Lukaya HCIII<br>9. Mateete HC III | 2x9=18 | 18 |
| Health Centre IIs | 1. Kabubbu HCII | 2*1=2 | 2 |
| Centres of Excellency | 1. Mildmay Uganda CoE | 2*1=2 | 2 |
| **Sample size** | | | **78** |

## APPENDIX 2: MODEL OF HIS STRATEGIC ALIGNMENT