Evaluating Geographical Information Systems: A Case of Uganda Public Sector

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ABSTRACT

Geographical Information Systems (GIS) are being implemented in the public sector because of their potential to improve service delivery. The impact of GIS is however, often not measured in practice. This study investigates the current GIS evaluation practices in the context of the public sector of Uganda. This encompasses the various methodologies employed in practice in GIS evaluation. This research adopts an interpetivist stance with an object to understand, learn and explain the evaluation and not only to perform the evaluation. The findings reflect that 40% of the surveyed organisations are evaluating their GIS. Questionnaire surveys, stakeholder needs assessment and project evaluations are the common evaluation methods. Lack of evaluation is attributed to human resource and financial constraints. This study reflects that GIS evaluation is still a concept under development in the context of the public sector of Uganda. The evaluations carried out in practice are mostly informal and summative.

Key words: GIS Evaluation, IS Evaluation, Interpretivist Studies, Public Sector GIS

1. INTRODUCTION

Geographical Information Systems (GIS) are being implemented in the public sector because of their potential in supporting planning and decision making according to [1:246, 2]. Prior research discusses the promises of GIS such as efficient management of data [3], information reuse [4] and public policy implementation. As a result of these promises, geographical information systems and related technologies have been widely adopted in Europe [5], the United States [6, 7] and Africa [4] within the public sector.

These geographical information systems also have a direct bearing on the communities in which they are implemented in or placed since information systems (IS) exist in a society. A concern is whether these systems are fulfilling their promises considering the huge investments they are associated with adopting IS in terms of hardware, human resources, finance etc stated by [5]. The cost of IT investments continue to grow at an accelerating pace while taking up a large proportion of organisational spending according to [8]. [9] argues that, the establishment of a GIS requires a sizeable initial investment such that the implementation requires solid documentation of the significant potential benefits.
Prior research in GIS has concentrated on evaluating GIS benefits such as efficiency [10-12] and effectiveness gains [6]. On the other hand, [1:284] cites lack of post implementation evaluations in the GIS domain, leaving uncertainty as to whether GISs are delivering their promises. This is supported by [13, 14] in the ICT domain. [13] acknowledges the inadequate evaluation of impact of ICT on individuals and argue that information technology is not always beneficial to society.

2. RESEARCH PROBLEM

Post implementation studies are lacking within the Geographical Information Systems domain according to [1, 7]. The same applies to the field of information systems in which most research has focused on ex-ante rather than ex-post evaluations [8]. [8] also argue that measuring the impact and outcomes of IT investments still remains a problem for many organisations in practice.

With the continued adoption of IT investments by organisations it becomes more important to justify the expenditure. It is important to assess the performance of GISs in the public sector since they are usually implemented using public funds [15]. This is in line with governments being accountable to the public they serve. On the other hand, uncertainty still prevails on whether Geo-ICT's in the public sector are beneficial to the societies they are supposed to serve according to [16]. Evaluation is one way to determine the value that is being derived from the information systems in use. This research focuses on assessing the evaluation methodology of Geographical Information Systems in the public sector of Uganda.

3. METHODOLOGY

The methodology comprises the case study research approach described by [17] with collection of both primary and secondary data. This approach is recommended for interpretive studies by [17, 18]. The phenomenon under study in this research is evaluation with the relevant social groups being public sector organisations using GIS and organisations within and outside the public sectors using the output from the various GIS. The social groups are the people or organisations that interact with the technology, in this case, the Geographic Information Systems. In this study, I consider information systems to be socially constructed and the relevant social groups assist in gaining deeper understanding of the technology in place.

Primary data was collected through face to face interviews, a questionnaire survey, observations and a focus group discussion during fieldwork. The respondents are classified to include managers (decision makers) and technicians (operators). A focus group discussion was held which allowed group discussions with participants from different organisations with GIS units to validate the responses from the questionnaire survey and interviews. Photographs were also taken to supplement the primary evidence. The secondary data collected during fieldwork included service delivery instruments, policy documents, information brochures and evaluation reports. Descriptive analysis is used to interpret the results in order to explain GIS evaluation in Uganda.

4. LITERATURE REVIEW

Evaluation

[19] defines information systems evaluation as *"process of establishing by quantitative and/or qualitative techniques the worth (or value) of IS/IT projects to the organization."* For the purposes of this study, GIS evaluation is defined as a process which incorporates understanding and assessment done to determine the impacts of the system in a particular context. I adopt this definition because evaluation is not a one-time activity but a process which incorporates data collection and interpreting in order to judge the impact. Information systems research is also context dependent as highlighted by [20, 21]. This means that the outcome of information systems evaluation is different from context to context.

Taxonomies of Information Systems Evaluation

[14] acknowledges that there has been a long tradition in evaluating whether technology improves organizational and policy performance within the studies of organizational theory and public administration. However, [14] argues that, beside this long tradition in studies, there has been no agreement regarding either preferred methods of evaluation or on ways of defining performance. [22] show similar findings in their review of prior information system evaluation articles which were compiled for a period of 11 years in the Electronic Journal of Information Systems Evaluation (EJISE).

[14] discusses approaches to evaluation such as ex ante and ex post as well as formative and summative evaluation. In this study, I will discuss ex ante and ex post, formative and summative as well as formal and informal information systems evaluation.

Ex ante evaluations are predictive evaluations performed to forecast and evaluate the impact of future situations of information systems [23]. Ex-ante evaluation attempts to forecast the outcome of information systems investments by using some indicators such as financial estimates.

Ex post evaluation can be referred to post implementation evaluations and these are conducted in order to assess the value of existing systems [23]. Post implementation evaluations analyse the current system performance against some previously suggested situation.

"Formative evaluation is conducted during the development or implementation of a specific ICT to inform developers and initiators the characteristics of the project and the progress (or lack of progress) in the development or implementation" according to [14: 113]. It is an iterative evaluation with an overall objective of achieving a more beneficial outcome from the system [23]. Formative evaluation continues throughout the life of a project and is done at several points in the developmental life of a project and its activities [24].

Summative evaluation is carried out after the system has been implemented [14: 113] and as such assesses the impact of the system. As a result, summative evaluation assesses the overall performance of the system as well as the attainment of objectives of the information system project according to [25]. Summative evaluation employs methods such as the returns on investment which are accounting in nature. Summative evaluation is also sometimes referred to as impact or outcome evaluation and is carried out when a project has been established and the timeframe posited for change has occurred [24].

For the purposes of this study, I distinguish between *formal* and *informal* methods for information systems evaluation. [25] describes informal or unconventional evaluation as assessment which uses techniques which do not fall within the recognised information system evaluation techniques. On the other hand, formal evaluation utilises recognised evaluation techniques in the IS domain. However, for the purposes of this research I define formal methods as *"well documented methods in terms of procedures and instruments"* for use in carrying out the evaluation. The formal evaluations are also carried out at specified time frames by specific individuals or groups. Informal methods on the other hand, may lack documentation with less defined procedures for execution and usually carried out at a *"need"* basis.

IS Evaluation Approaches

Formal Rational Approaches: [20] discusses the traditional rational views of information systems evaluation where she explains the technical/functional stream and the economic/financial stream. The technical or functional stream focuses on technical performance and control of resources while the economic or financial stream emphasises effectiveness measures using methods such as cost benefit analysis. However, [20] argues that, these approaches emphasise technology aspects at the expense of organisational and social aspects which are characteristic of the interpretive paradigm. These formal rational approaches view the technology under evaluation in the same sense as technological determinism in which technology is viewed as a problem solving tool [26] and as a means to achieving certain ends [27].

Mechanistic IS Evaluation Approach: Mechanistic information systems evaluation approaches are formal methods that are primarily concerned with monetary costs and benefits according to [28]. These approaches are primarily based on economics and employ financial indices which are based on economic performance such as return on investment, net present value and cost-benefit analysis. Mechanistic approaches aim to justify the financial value and benefits that accrue from information systems investments. However, these approaches are often used by company accountants, information systems management and functional management [28].

Interpretive Approaches: [20] views information system evaluation to be embedded in many social and organisational processes and acknowledge that evaluation can be formal or informal while taking diverse criteria. This motion towards an interactionist role of the technology shifts information systems evaluation to the analysis and understanding of the social and subjective nature of evaluation. Such an evaluation in which social actors are central to the evaluation process is referred to as interpretive evaluation [20]. Interpretive evaluation includes understanding organisational structures, cultures and stakeholders.

[28] describes interpretive information system evaluation approach as one in which the IS evaluation is a socially embedded process which depends on the opinions of the social actors who interact with the technology. The aim of interpretive information systems evaluation is to understand the information system from the views of the social actors who are directly involved with the information system within a particular

organizational context [28]. The concern is in measuring and understanding the success or lack of success of the system without the measurement of economic factors. Jones suggests that the interpretative approach could be more suitable for public sector information system evaluation where the objective is to serve the public and improve service delivery. The interpretive approach also facilitates organizational learning and information systems knowledge sharing.

5. FINDINGS

37% of the surveyed organisations are evaluating geographical information systems in their organisations while 63% are not. The instruments being used for evaluation include questionnaire surveys, interviews and stakeholder meetings. These instruments are used to collect views from users of GIS technology which form the basis of the evaluation. Availability of service facilities, number of trainings in GIS and feedback from customers form part of the criteria used. There are no standard criteria for evaluation in the public sector of Uganda, thus methods differ from organisation to organisation. Fieldwork findings reflected that 50% of the surveyed organisations were utilising formal evaluation methods while 40% employed informal methods and the rest, public sector methods.

GIS Operators are more involved in the evaluation process for the majority of the surveyed organisations. It is only in a few cases that policy makers and key stakeholders were involved. Fieldwork findings show a greater proportion, 63%, of respondents who are not evaluating their systems. The major reasons cited for lack of evaluation included: lack of evaluation knowhow, lack of facilitation and the absence of standards to be employed as benchmarks.

Remarks on Evaluation Methods

GIS evaluation in the Uganda public sector is informal although fieldwork findings reveal that the majority of GIS evaluations seem formal. However, this is in contrast with the definitions of what constitutes formal and informal evaluation which are given in the literature review. Despite the fact that some organisations perceive their evaluations as formal, the assessments are informal according to fieldwork observations. At the same time, the majority of organisations have no documentation of the instruments used for data collection for the evaluation process and those for performing the evaluation itself.

GIS evaluation is still a new concept in the public sector of Uganda. This is evident from the reasons given by the surveyed organisations. On the other hand, the GIS industry in Uganda is still young, with different levels of adoption in each organisation. Some of the reasons for lack of evaluation include inadequate knowledge for carrying out the evaluation, lack of facilitation and the absence of guidelines for evaluation. To further justify that GIS evaluation is still a new concept, the response rate is low in the evaluation section of the questionnaire tool used for data collection.

GIS evaluation is not being allocated time and human resources as any other program within an organisation. The evaluation techniques used are very simple for example, through questionnaire surveys and stakeholder needs assessments. The evaluation indicators in some cases are vague. On the other hand, formal rational approaches to evaluation are complex and require specialised staff to undertake them. This is typical with methods which require accounting techniques and financial indices. However, the application of these methods in the public sector is questionable since the goals are not for profit making. Literature offers the methods such as Returns on Investment (ROI) [25] and Cost Benefit Analysis [28] for information systems evaluation. However, none of these are being used in the Ugandan public sector. This is due to knowledge, human resources and financial constraints. This confirms the lack of use of economic methods to approaches because of their demands for professional labour stated by [28] and lack of use of formal methods in practice discussed in IS literature by [29]. However, at the same time, there is no evidence on whether organisations have knowledge of formal methods but simply do not use the methods. As a result the claim from literature that there is in practice lack of use of formal methods may not be valid. Formal evaluation approaches are available in Uganda but particularly for monitoring and evaluating programs.

Evaluation Approach

Organisations in the public sector of Uganda are performing summative evaluation in assessing the performance of GIS. Fieldwork findings reveal that the evaluations are being carried for GISs which have been fully implemented. The alternative explanation is that the evaluation procedures resemble summative evaluation. The underlying objectives of the evaluations are to determine whether GISs are performing in accordance to their use goals. These goals include mapping projects and service delivery which encompasses information services and public service facility delivery. Fieldwork results reported that less than 40% of the respondents are evaluating geographical information systems. It is in this proportion of the surveyed population that summative evaluation is also dominating. The summative evaluations reflect characteristics of goal based evaluation (for example, Department of Surveys and Mapping) and some criteria based (for example, Northern Uganda Data Centre). Goal based and criteria based evaluations are discussed in literature by [14].

However, fieldwork observations also show different developmental stages of Geographical Information Systems in the public sector. These are rudimentary, intermediate to fully fledged systems as discussed by [30]. This scenario of the classifications of GIS still exists to date. With systems at rudimentary and intermediate implementation levels, I expected formative evaluations to be carried out as well. It is typical for formative evaluation to be carried out before and during system development according to information systems literature. The lack of formative evaluations for systems under development has been attributed to inadequate capacity. This capacity includes human, financial and time resources. The human resource constraint has been observed during fieldwork as some organisations have less than three employees in the GIS section. The time constraint is related to the human resource constraint since if there is a huge workload for few workers then there may be no time allocation for evaluation. If lack of evaluation is arising from lack of interest or willingness then even guidelines or a framework will not foster any change unless it is a requirement by either the organisation or the government. After all, most of the GISs are developed using public funds as [15] suggests and evaluation provides some form of accountability on public funds used.

Subject of Evaluation (What to Evaluate)
There is heterogeneity in terms of what constitutes the subject of evaluation. Fieldwork findings identify GIS mapping projects and service delivery as the composite subjects of evaluation. Service delivery is however subdivided to include information services, GIS training services and public service delivery. This variation of subjects even within service delivery also introduces variation in the evaluation approaches and indicators. This in turn complicates the possibility of having a single set of evaluation guidelines.

Who does the Evaluation?
GIS operators are the most common participants in GIS evaluation as shown from organisations who are evaluating GIS according to fieldwork findings. This is possibly because GIS operators are the direct users of GIS who use it for daily work. An outsider to the GIS on the other hand, can perform an even more objective evaluation with minimum bias than internal GIS users. These outsiders to the GIS can be other departments within the same organisation. However, the view being portrayed in the Ugandan context is that evaluation is done by direct users of GIS only, which is inadequate. Rather, all groups with a stake in the GIS must be considered in the evaluation. However, participants from organisations currently not undertaking evaluation also suggested individuals and groups they considered relevant to be part of the evaluation team in GIS evaluation. There was however, great variation in the professionals suggested which include external consultants, key stakeholders and GIS users (both internal and external to the organisation). Such a wide array of social groups participating in the evaluation exercise is suggested in literature by [31]. Stakeholder involvement in evaluation is described to be necessary in theory by [25, 31] and in fieldwork by respondents from the Directorate of Water Resources Management and Uganda Bureau of Statistics. As a result, the stakeholder involvement in the evaluation in Uganda confirms the theory in information systems literature.

Evaluation Timeframe
Evaluation is viewed as a one-time activity in the context of Uganda rather than as a continuous process as stated in the definition of information systems evaluation by [25]. Even project evaluation is carried out at different stages of the project life cycle, but the one stated during fieldwork is only summative in which original goals are compared with achieved results from the project. However, such a project evaluation is very objective when carried out and resembles goal based evaluation described [14]. The evaluation is also carried out at an ad hoc basis confirming theory by [29].

6. DISCUSSION

Methods of Evaluation
Informal evaluations are being carried out on irregular basis. This confirms the discussion by [29] in which informal evaluations are the norms. At the same time, there is variation in terms of what is evaluated and the instruments for evaluation. Theory discussed the use of formal rational approaches which are formal such as cost benefit analyses. However, it is these same methods which are also labelled as difficult to execute in practice due to requirements for professional labour or consultants to perform the evaluation.

Type of Evaluation
Fieldwork evidence show that the evaluations being carried out are ex post or post implementation. They are being carried out to determine the impact of the systems (GIS). Post implementation evaluations were lacking from the GIS field according to [1]. However the conduct of the evaluation is underdeveloped so it is premature to state whether the Ugandan case reflects an improvement in GIS evaluation.

Approach to Evaluation
Evaluation is being carried out for systems being used and not those under development with the intend being to determine whether systems are achieving certain goals. In this case, GIS evaluation is summative.

Evaluation Indicators
Both financial and non-financial indicators are being used in practice. Financial indicators are resulting from organisations that offer geographic information services for a fee. The organisations that offer GI services for free are using non financial indicators. Prior research by [28] suggests that economic evaluations methods which use financial indicators are not appropriate for public sector IS evaluation. This is due to the difficulty in pricing the services since factors such as subsidies also come into play. However, there is wide variation in the indicators across different organisations as shown by fieldwork findings. This heterogeneity is part as a result from the difference of what constitutes services in the different organisations, for example information services and land delivery services. The Uganda public sector is using both financial and non financial indicators. Some theory in information systems evaluation argues that financial indicators are not appropriate for the public sector information systems evaluation. However, there is difficulty in the quantification or actual measurement basing on non financial indicators as these often resemble intangible benefits.

Completeness of Evaluation Exercise
The start and end points for evaluation are not clear or ill-defined. In this respect there are gaps in the evaluations conducted. This confirms studies by [29] in which evaluations which are carried out in practice are usually incomplete. Information systems evaluation literature has expressed concern that formal evaluations are seldom done and are usually incomplete. This is reflected in the Uganda public sector in which evaluation focuses on a particular subject out of a collection of processes and human actors. At the same time there are no checklists for comparing the progress of the evaluation against. As a result, there is no evidence to support that the evaluation carried out in practice is complete and encompassing all important aspects to the evaluation.

7. CONCLUSIONS

GIS evaluation is still a new concept in the public sector of Uganda. At the same time there is no evidence to suggest that the evaluation is in a stage of development in terms of methods and instruments for performing the evaluation. The majority of public sector agencies are not carrying out evaluation activities. The reasons for failure to perform evaluations are varied but include lack of willingness and knowhow as well as financial, time and human resource constraints. In cases where evaluation is carried out the evaluations are summative and informal. The instruments for carrying out the actual assessment are not properly defined. As a result there are neither no uniform

methods nor uniform indicators. However, some classifications can be done in which questionnaire surveys, stakeholder needs assessment and project evaluations are the major methods. Formative evaluations are also lacking since some of the GISs are still in their infancy such that formative evaluations would have been characteristic of those organisations.

The lack of formal evaluation in practice confirms theory from both information systems and GIS evaluation. The informal evaluations lack documentation for the conduct of the evaluation and information on who does what (the participants) in the evaluation. There is no regular timeframe for performing evaluations and as a result, it cannot be deduced bow often the evaluation activity is carried out. The evaluation practices in Uganda reflect that there is difficulty in identifying the part of the GIS to evaluate or the benefits to measure. This confirms theory in the information systems domain in which the boundary of the system being evaluated is often difficult to identify.

GIS evaluation in Uganda is informal and is carried out on irregular basis which confirm prior literature in information systems research. There is also retraction from use of formal methods such as cost benefit analysis. Post implementation evaluations are being carried out, but there is not enough evidence to conclude whether the Ugandan context presents an improvement in GIS evaluation. Stakeholder involvement in evaluation also confirms IS evaluation literature. The summative evaluation for GIS projects is better defined than that for service delivery and training assessments. Frameworks for monitoring and evaluating government programs can be a useful tool for developing home grown solutions for GIS evaluation. The part of the system which is evaluated is ill defined. The Uganda public sector has no frameworks or guidelines for performing evaluations. As a result of these problems, there is need for a more formalised or holistic approach to evaluation.

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