A Metric for Evaluating Information System Management

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ABSTRACT
Everything that is created including Information systems IS, starts to age from the moment of birth. The ageing progresses gradually or rapidly depending on management, control and maintenance (MCM) strategy adopted. The MCM affects the ageing and determines how fast IS becomes outdated and seizes to promote or realize the service goals that it's aimed at providing. This paper provides a framework for evaluating the MCM processes of IS by providing a metric for effective and efficient measurement of IS management. Regardless of the technical or organisational environment of the IS, its primary objective is to serve the organisation it is situated. But the world around it is in constant change, eventually causing changes in the technical environment and the overall effectiveness and efficiency of the systems. The framework that is presented in this paper is conceptual in nature; it provides a facility for understanding, explanation and anticipation the state of IS in any organisation. It uses IS entity: functions and technology to describe and qualify the past/present and to anticipate the future development path of an IS, so as to maintain or increase the return on investment while reducing its ageing and eventual death process lag.

Keywords: Evaluation, Information Systems, Management, Situation, Metrics, Description and Qualification.

1. INTRODUCTION

During the development of information systems or any other type of complex application, most of the effort expended is on getting the system to run, incorporating novel features, and allocating resources to accomplish project goals in a timely fashion. Many times evaluation of these systems is viewed as something that can be postponed until the end of the process, but all too frequently there is no time to do the needed testing then; at other times, evaluation is not even factored into the goals of the development effort. If convenient, easy to use methods were available in an environment in which evaluation were being fostered, then evaluation might be an activity that serves as an end-point for development [2].

Even in ideal cases where all requirements are met by perfect design, the system starts to outdate from the very day of its completion, due to changes in its use environment, that is, the domain area the system was designed to cover changes after the system was implemented.   When people come and go through organization, the rules provide a constant for handling routine situations. Thus rules not only transfer past learning, they also control behaviour within the organization [8] **.**

There is the need according to [10] for Metrics; measurable standards that monitor the effectiveness of goals and objectives to be established for IS. The metrics measure the implementation of IS policy, the results of services and the impact of management on an enterprise's mission. Victor et al stated that IS metrics can be obtained at different levels within an organization and that detailed metrics collected at the system and network level, can be aggregated and rolled up to progressively higher levels, depending on the size and complexity of an organization. If such measurements are instantaneous snapshots of a particular measurable parameters, then the metrics are more complete pictures, typically comprised of several measurements, baselines, and other supporting information that provide context for interpreting the measurements.   Good metrics are *goal-oriented* and should have the following features: *specific, measurable, comparable, attainable, repeatable,* and *time dependent*.

In this framework for evaluating IS, the entire organisation management processes are divided into it primary entities and examine from management perspective. The step of evaluating an organisation IS starts from describing the present situation (PS) of the IS entities: the Real System (RS), Information Technology (IT) and the Management, Control and Maintenance (MCM). Further a description of their Relationships and Influences were outlined.

These steps are necessary if a get clear picture of the PS is to emerge. We need to distinguish between issues that are critical for IS from those issues that are non-critical. The next stage is the qualification of each entity; here the issues that we need to qualify and how to qualify them in the PS situation are discussed. The procedure is to determine what issues to qualify in each entity and the next step is to state how to qualify the issues, in the respective entities.

Having described and qualified the entities, the next is to apply the metrics, using the weighting process attributes approach [11] to differentiate process attributes that are considered more important from those that are less important according to the perceptions of the person(s) conducting the qualification in line with organisation goals. The proposed metrics format presented, with which one can apply various uses statistics to determine the status of management at each entity and decide on lines of actions to address the outcome, which if implemented will take the IS to the desired situation.

2. THE DESCRIPTION OF THE ENTITIES IN PRESENT SITUATION (PS)

2.1 Real System (RS):
In the RS entity key issues that should be of concern to the evaluator include: user requirements and preconditions imposed by Information technology (IT) utilization and the management. User requirements to consider are availability, flexibility, maintainability, performance, reliability, and security of IT. Other issue include preconditions imposed by utilization and management, information policy and planning (IPP), centralization and de-centralization of activities, concentration and de-concentration of IT, financial resources, personnel allocation, safety of staff and users, standardization of IT, and service level agreements concerning IT services.

These preconditions make up the initial framework from which other factors contingent upon the case study is examined. Other concepts related to IT in the entity RS include the situational or contingency factors, which impact on the utilization and management of IT. These include size and location [6], the technology environment, organizational culture, and the general level of communication infrastructure in and around the organisation.

Information Technology (IT):
In the IT entity, the issues considered vital for inclusion are the hardware, software and the network components based on their demand, common utility and usage. The user requirements for IS, i.e. availability, maintainability, performance, reliability, and security of IS, are included to correspond to IT service support and service delivery processes.

A service is defined herein as an essential intangible set of benefits or activities that are sold or provided by one party to another. Further the IT issues may be depicted to determine their states in the Extended Model. In such a case the focus include development, utilization, exploitation and maintenance of IT as these concern users more directly than other states. In addition to the above, complexity factors associated with IT may be examined. It is desirable that for less costly IS management, the level of complexity be reduced, however, not all complexity factors need be to reduced, but with knowledgeable understanding, proper assessment of the complexity factors becomes easier to handle.

2.1 Management, Control and Maintenance (MCM)
In MCM entity, functional management (FM), application management (AM), and technical management (TM), at Strategic Level (SL), Tactical Level (TL) and Operational Level (OL), form an important part of management of information systems. They are included to emphasize the important role that they play in IT service provision; however, discussion of tasks, task areas and task fields at the three levels is implicitly assumed within MCM processes. It is considered desirable that the goals of the MCM entity should be aligned to the goals of the entity RS for effective and efficient management and utilization of ICT to achieve the overall mission and objectives of the organization. In summary, the following relationships between the entities are defined (the arrow → indicate the relationship between entities):

RS→ICT RS *exploits* ICT	users in the entity RS require resources in the entity ICT to enable users to perform their day-to-day activities
ICT → RS ICT *supports* RS	Resources in the entity ICT support the activities in the entity RS through enhancing effectiveness and efficiency
ICT→MCM (ICT *supports* MCM)	Resources in the entity ICT provide useful information required for ICT management to the personnel staff in the entity MCM
MCM→ICT (MCM *manages* ICT)	Personnel in the entity MCM manage the resources in the entity ICT
RS→MCM; (RS employs MCM)	The entity RS *employs* the entity MCM to manage its information and communication technology resources.
MCM→RS:	technical staff members in the entity MCM *respond to* requests in RS

3. THE EVALUATION METHODOLOGY

3.1 Describing the PS of IS
The second step in the description function is to determine how the PS is depicted. The criterion used for description is *existence*. This criterion is predicated on the premise that before we can determine what issues within the IS framework are required or should be improved upon; there is the need to determine if the issues do indeed exist. If the issue *exists*, then a value 1 is assigned and if it does *not exist* a value *0* is assigned. A checklist of all the above IS related issues in the framework is then created and the values are tallied accordingly. The overall result indicates the number of issues that exist in the PS IS. This depiction, which includes verification of the issues, forms the basis upon which qualification of the PS, definition of the desired situation DS and transformation from PS to DS state depend.

In summary each entity is examined from the perspective of the entire IS State in as follows:

RS: - User requirements, Preconditions and Situational factors

IT: - Hardware, Software, Network components, Extended State Model (ESM) and Complexity Factors (CFs).

MCM: - Functional Management, Application Management and Technical Management at Strategic, Tactical and Operational levels.

Service support processes: - Change, Configuration, Help desk and Problem Managements.

Service delivery processes: - Availability, Capacity, Contingency, Cost and Service level managements

Relationships between entities: - RS & IT, MCM & IT and RS & MCM

Influences: - Managerial, Donor, Technological, economic and Cultural.

3.2 Qualification of the PS
Here we seek to qualify the issues depicted above. In doing so, we isolate the issues in each of the entities. In the entity RS, the main focus is on the *actors (*or players), who make demands, referred to as requirements, for IT to enable them perform their activities. Hence, in *user requirements*, the focus is on whether the users (staff) are aware of their own requirements. Also, we seek to determine whether user requirements have been formulated.

In *preconditions,* we seek the levels of user awareness and the formalization of user requirements in a framework, called preconditions, by senior management officials, that has been achieved. These include IPP, centralization/decentralization of activities, concentration of IT, de-concentration of IT, financial resources, personnel allocation, safety of staff, standardization of IT, and service level agreements. In *situational factors,* we seek an indication of whether the factors have had an impact on the utilization, exploitation and maintenance of IT, in the organisation.

In the entity IT, the focus is on the quality and states of the *objects* or IT resources, i.e. if and to what extent the hardware, software, and network components are utilized, exploited and maintained by the organization. In considering the availability of hardware resources, i.e. basic application, under the prevailing situational factors as depicted in the PS situation. It is critical to reflect on whether these resources are effectively and efficiently utilized, exploited and maintained or not. In the entity MCM, the primary focus is on the forms of management and processes**.** In determining what to qualify in this entity, the capability maturity model approach by [12] is adopted. Using this approach, each process is qualified according to whether the processes are: recognized, planned and practiced, the technical staff are trained, enforced and measured, performed rationally, cost effective and on schedule. Furthermore, whether before any process commences, there are any preparedness criteria, documented, standardized, peer reviews are conducted. On completion of any process, are: there any criteria for its completion, the services provided predictable, structured actions and organized as a service.

In the relationships between entities, we seek to determine the strength of the relationships between entities. Clearly, strong and positive relationships between entities are more desirable than weak or negative ones. Strong relationships indicate greater awareness of IS issues in the organization as opposed to weak or negative relationships, which indicate a lack of awareness and thus possible source of problems in the organization with regard to IS issues. It is, therefore, worth investigating and designating values to the relationships with a view later to understanding the level of involvement of various entities in the support and delivery of IS services in the organization.

In examining the relationship between entities, the key issues are whether:

- the Organisation *exploits* IT for its own benefit and the IT *supports* the activities in the Organisation
- the IT *supports* management activities and the management in the Organisation *employs* and offer support to technical staff
- the technical staff members have the required skills and knowledge to *manage* IT
- the technical staff *respond to* user requirements and demands
- the influences impact on IT utilization, exploitation and maintenance

The discussion on what to qualify in the PS covered all the five entities of the management paradigm of looijen (2001). Rather than qualifying individual aspects separately, the procedure examined the issues in relation to their impact on the utilization, exploitation and management of IT in an organization. In effect, this approach yields more informative qualification than the sum of individual qualification taken separately. Next, we examine the manner in which the qualification of the same issues is carried out.

3.3 Qualifying the IS PS

Different design approaches for standardization are proposed in the qualification of the PS for different entities. Standardization provides a benchmark against which measurements or comparisons can be made. This is necessary for the fact that issues in different entities differ remarkably and can also differ within the same entities. These issues, therefore, require different frameworks for qualification.

Since standards of comparison of IT related issues have not been developed to a significant degree, for issues in the entity RS, a normative approach to qualification is proposed [1]**.** This implies that, in the absence of an existing standard by which to compare the present situation, we base the qualification on what, in our opinion, it should be which we take to be the norm for that particular issue. The norm becomes the standard measure, and according to the issues in the entity RS, the norm is assigned the values High (or 3), Medium (or 2), and Low (or 1), relative to the norm. In the absence of the issue in question, the value Absent/Missing (or 0) is assigned.

3,4 The qualification of RS issues

ABSENT implies -No user requirements, no user awareness, no preconditions, no positive impact of situational factors on utilization, exploitation and maintenance of IT with no operational plans to deal with them. No financial resources, no personnel allocation of any kind and the overall contribution of the issue to organizational effectiveness and efficiency is *zero*.

LOW implies- low level of user awareness, unformulated preconditions, low positive impact of situational factors on utilization, exploitation and maintenance of IT with limited or no operational plans to deal with them. Inadequate financial resources, low-skilled personnel with irrelevant (non-IT) qualifications and in insufficient allocations are made. Here the overall contribution of the issue to organizational effectiveness and efficiency is *low*.

MEDIUM implies- limited definition of user requirements, moderate level of user awareness, limited formulated preconditions, and moderate positive impact of situational factors on IT utilization, exploitation, and maintenance with tactical or operational plans to deal with them. Barely adequate financial resources, moderately skilled personnel in IT limited numbers. Here the overall contribution of the issue to organizational effectiveness and efficiency is *medium*.

HIGH - This implies well defined user requirements, high level of user awareness, well formulated preconditions, and high positive impact of situational factors on utilization, exploitation and maintenance of IT with strategic, tactical and operational plans to deal with them. Adequate financial resources, highly skilled personnel in IT fields in sufficient numbers are allocated. Here the overall contribution of the issue to organizational effectiveness and efficiency is high.

In the case of IT, we seek to specify the level of hardware/software technology in use, the extent to which IT is utilized, exploited and maintained to support the Organisation in its activities. Therefore, we need to determine:

- The quality and standard of the available IT resources - hardware, software and network components
- The stage of implemented IT resources and how well defined the management tasks are
- The impact of complexity factors on utilization, exploitation and maintenance of IT

3.5 The qualification of IT issues

ABSENT implies:
- no hardware, software and network components - only manual system
- no utilization, exploitation or maintenance of any kind
- no presence of complexity factors, i.e. quantity, diversity, distribution, dynamics, cohesion, ownership, utilization, and functionality

Here the overall contribution of IT issue to organizational effectiveness and efficiency is *zero*.

LOW implies:
- outdated non-standard hardware, software and network components by more than 10 years functions are not well utilized, exploited and maintained
- poor IT utilization, exploitation or maintenance and management tasks are not defined
- low levels of complexity factors - quantity, distribution, diversity, dynamics, utilization, ownership, cohesion between IT components, and functionality - all with low negative impact on IT utilization, exploitation and maintenance.

The overall contribution of IT issue to organizational effectiveness and efficiency is *low*.

MEDIUM:
- lagging state-of-the-art the resources are partially utilized, exploited and maintained
- limited IT utilization and tasks are barely defined
- moderate levels of complexity factors

The overall contribution of IT issue to organizational effectiveness and efficiency is *medium*.

HIGH:
- up-to-date state-of-the-art standardized IT components by less than 5 years across organization whose functions are well utilized, exploited and maintained
- enhanced IT utilization and tasks are well defined
- high levels of complexity factors.

The overall contribution of IT issues to organizational effectiveness and efficiency is *high*.

3.6 The qualification of MCM

In the entity MCM, the approach used in the qualification of the PS is based on the concept of capability maturity model (CMM) levels. While the concept of CMM is defined in terms of software development, in this paper, the first three capability maturity model levels are defined in terms of IT management according to [4] as follows:

Level 1(Initial): Reactions to events happen in an *ad hoc* manner at this level, and there are no management processes. The management is completely in the hands of operational "authorities" who decide what has to be done. The workload is most of the time high, and the work is carried out in an uncoordinated manner. This doesn't necessarily mean that all efficiency is ignored. The point is that it cannot be measured, because each separate realization is strongly influenced by the individuals who carry it out.

Level 2 (Repeatable): At this level the work is done in a processes-like manner, but there are no formal process descriptions. The management recognizes the importance of processes like incident management, problem management, change management, configuration management and software control and distribution, and carries them out in a pragmatic way. The decision-making with regards to this is mostly inspired by the fact that similar processes in other organizations or in other situations seemed useful and looked susceptible to repetition, hence the name *repeatable*.

Level 3 (Defined): At this level the management processes are documented and standardized, they are related to Service Level Agreements (SLA), which are established between the management and the users of the services. This implies that the services of the management are more predictable and actions are taken in a structured way on issues like performance improvement, problem resolution, transmission of data and data storage capacity. Here the service users consider IS management to be a service organization.

3.7 The qualification criteria

ABSENT- No processes, no authorities, no work, no IT management. No tasks. The contribution of process to organizational effectiveness and efficiency is *zero*.

LOW- No processes, ad hoc and chaotic situation, 'authorities' decide, uncoordinated work, efficiency not measured, personalized command/control and bureaucratic form of IT management. No tasks defined. The overall contribution of process to organizational effectiveness and efficiency is *low*.

MEDIUM - Processes are on schedule, cost-effective, planned, practiced, trained, enforced, measured, process-like, recognized, pragmatic processes which repeat earlier successes. Tasks here are Moderately-defined. Overall contribution of process to organizational effectiveness and efficiency is *medium*.

HIGH- Preparedness criteria, documented, standardized across organization, peer-reviewed, completion criteria related to SLAs are predictable, structured actions, and tasks well-defined. The overall contribution of the Process to organizational effectiveness and efficiency is *high.*

These attributes constitute the process parameters required to qualify individual processes. We then use the following four numerical values to qualify attributes within the maturity levels: 2 and 3 for the purposes of computing capability maturity levels for the MCM processes, based on effectiveness and efficiency criteria:

    0 if the attribute is absent
    1 if the attribute is rated LOW
    2 if the attribute is rated MEDIUM
    3 if the attribute is rated HIGH.

Effectiveness of a purposeful entity is conceptualized in terms of the degree to which it attains its end-objectives and that for most entities having multiple end-objectives; overall measures of effectiveness must invariably be multi-dimensional [9]. The criterion *effectiveness* here implies the extent to which the goals and objectives of an organization are being achieved. It addresses the outputs from the organization or its units.

To be effective, therefore, management of entities must be able to address the needs of their user systematically, and in a participative and responsive manner. In [7] *efficiency* is defined as putting emphasis on reducing the labour required to achieve a certain objective, with the result of reducing routine and tedious work. The benefits are greater speed in output, greater accuracy, better customer service, and greatly reduced costs

4. THE EVALUATION METRIC

The evaluation uses attributes weighting of process, which is necessary to differentiate process attributes that are considered more important from those that are less important according to the perceptions of the person(s) conducting the qualification. There is no fixed rule governing the weighting (Wi) hence it can be varied as desired. The method involves multiplying process attribute weights by the values entered (Xi) and summed up to $\Sigma(Wi * Xi)$, for all the attributes at both Level 2 and Level 3. The process capability level, L, is computed from the weights according to the equation below in line with [11]**.**

$$L = \Sigma(Wi . Xi) / \Sigma(Wi)$$

The values for each process are added up and the average value for each process is determined. The value indicates the capability level for the specific process. These values are rational and range from 1.0 to 3.0 inclusive. The standard deviations from the mean are also calculated. In principle, all capability maturity level values below 1.0 are regarded as being at Level 1. These are the values that are entered in the qualification sheet as LOW, if less than 2.0, as MEDIUM, if 2.0 or more but less than 3.0 and HIGH if 3.0.

The format for capability maturity levels, CPL, is presented in table1. In the table, the attributes of the management processes are listed in the first column, each within its level. The second column consists of weighted values of the attributes, which may be adjusted. In this example, the weights take integral values 1, 2 and 3. The management forms FM, AM, and TM are treated as management processes for purposes of evaluation. The other processes are Service Support processes and Service Delivery processes.

Entries are made in the table for each process. If a process is absent, a value 0 is entered in each of the attributes. Otherwise, values 1, 2, or 3 are entered according to whether they are judged to be LOW, MEDIUM or HIGH, respectively.

TABLE 1: Format For IT Management Processes

	WT	Func. Mgt			Appl Mgt			Tech Mgt			Service Support					Service Delivery mgt				
Level 3		SM	TM	OM	SM	TM	OM	SM	TM	OM	chg	conf	hlp	prb	scd	av	ap	cf	ct	Sl
Seen as service	3																			
Structured action	3																			
predictable service	3																			
related to SLA	3																			
completion criteria	2																			
peer reviewed	2																			
standardized	2																			
documented	1																			
preparedness criteria	1																			
Level 2																				
Repeats earlier successes	3																			
performed rationally	3																			
Process is recognised	3																			
Activities are performed processes-like	3																			
measured	2																			
enforced	2																			
Trained	2																			
Practiced	2																			
planned	2																			
cost-effective	1																			
on schedule	1																			
Mean Process Level																				
Mean overall level																				
Standard dev.																				

Table Key: Function, Application and Technical: SM=Strategic mgt, TM=Tactical mgt, OM=Operational
Service Support Process: Change, Conflict, Help desk, Problem, SW control & Distribution
Service Delivery Process: Availability, Capability, Contingency plan, Service Level Agreement

5. DISCUSSIONS

The calculations for CPL for each process are made and entered at the bottom of each column. An overall average value for the capability maturity model level for all the processes is also calculated to give an indication of the general level of IS management. The average CPL for all the processes may be obtained to show, in general terms, the extent to which the organization has implemented the processes. This will provide some information about what processes require improvement and the extent of the improvements required.

The main objective of this function is to specify the future; the Desired situation DS for actors, objects or processes, in effect, what needs to be done to get to the DS. To achieve this, it is necessary to examine each issue and identify the aspects that are missing. For example, if the PS for a given issue is LOW, then the DS for that issue should be at least MEDIUM, if PS qualification is MEDIUM, then the DS situation should be defined as HIGH. In the event that the PS is HIGH, then the DS is defined as HIGH. This procedure applies to the issues that have positive impact on IT.

In case of those issues that have negative impact on management of IT such as preconditions (centralization of activities, concentration of IT), situational factors, and external influences, the reverse is true, in which case the DS should aim at minimizing their impact. These concepts are illustrated in Tables 2 and 3 below.

Table 2: Definition of DS (positive impact)

Qualification of PS	Definition of DS
Low	Medium
Medium	High
High	High

Table 3: Definition of DS (negative impact)

Qualification of PS	Definition of DS
Low	Low
Medium	Low
High	Medium

Using this process for each phase, the transformation of the PS to DS becomes realistic and attainable. The following steps are recommended:

Step 1: Establish the objectives for improvement and set up a team to oversee it. The team should be composed of a senior management official, IT management staff, and a trained capability maturity assessor.

Step 2: Analyze and reach a consensus regarding the gaps between the PS and the DS, that is, between where the State is today and where it wishes to be in future. Use the next higher capability maturity level as a reference land mark to identify what needs to be improved.

Step 3: Outline the specific activities required to make the transition between PS and DS. In particular, clearly defined remedial tasks which must be assigned, these are:
- deliverables or expected results
- responsibility/ownership of improvement processes
- timeframes for the accomplishment of tasks
- resources needed to perform the tasks
- risks involved in carrying out the tasks
- measurements of the achievements

Step 4: Set criterion to evaluate success of attainment bearing in mind the goals/objectives in step 1. This step also serves as a means to determine how and why some objectives are not being achieved.

Step 5: Devise ways to maximizing the desirable activities (enablers) and minimizing inhibitors (disablers). This step is the most difficult to achieve and requires strict discipline, and commitment on the part of implementers.

6. SUMMARY AND CONCLUSION

The aim of this paper is partly to answer the following research question. – How to develop a model of IS support that can describe and qualify PS, define DS for an achievable transform from PS to DS. For this an assessment process based on the management paradigm was applied to the functional specifications – description and qualification of PS, definition of the DS, and the transformation from PS to DS. Within the management paradigm, the issues in the entities RS, IT, MCM, and relationships between entities, were identified. The criteria for depiction and qualification of the PS were given, and the manner of qualification of the issues was also presented. One of the aims of the metric is to make the model relevant to the environments in which it will eventually be used. The other aim is to pursue the objectives of this paper – provision of a metric for the evaluation of IS against organization existing situations.

Change is necessary if any improvement of the PS is to be realized, but with every change there is an adjunct of and requirement for new concepts, new skills, new patterns, new commitments, new strategies and new resources in terms of training, financial resources and time needed to control and manage the realization of new situation and to prevent it from getting out of hand. Skills and financial commitments are needed to stabilize and sustain the new situation once it has been realized so that it can last for as long as the users and the organization require. But the identification of changes that are needed to improve the situation is not sufficient.

To be able to transform from PS to DS, we must examine the benefits that justify the costs associated with changing the situation. In this respect, studies have shown that, economic gains alone may neither be necessary nor sufficient to judge institutional performance or to justify investment in changes aimed at improvement [3]**.** A process improvement procedure is required to transform the PS to the DS. It is essential that the process improvement model be practical, feasible, cost effective and within the financial and technical abilities of the organization to implement.

REFERENCES

[1]   Checkland, P.B (1981): Systems Thinking Practice, John Wiley & Sons, Chichester, p.3.

[2]   Emil L Morse(2002): Evaluation Methodologies for Information Management Systems D-Lib Magazine September 2002, Volume 8 Number 9, ISSN 1082-9873   Emile L. Morse

[3]   Kaplan, R.S., and D.P. Norton,(1992): The Balance Scorecard-Measures that Drive Performanc

[4]   Looijen Wanyembi G. (2000): A Model for Improving ICT Management, Proceedings of the 2000 IEEE International Conference on Management of Innovation and Technology, Singapore, 12-15

[5]   Looijen M. (2001): Information Systems Management and Culture Experiences from a Chinese perspective Information Systems, Management, Control and Maintenance P.37, **http://alexandria.tue.nl/extra2/200410651.pdf**

[6]   Mintzberg 1979: The Structuring of Organizations: A Synthesis of the Research, Englewood Cliffs, N.J.: Prentice-Hall

[7]   Remenyi, D.S.J., A. Money, A. Twite, A, (1993): Guide to Measuring and Managing IT Benefits, 2/e, NCC Blackwell

[8]   Saastamoinen Heikki (2005): Exception Based Approche for Information Systems Evaluation: The Methods and its Benefits to Information System Management" The Electronic Journal of Information systems Evaluation, Vol. 8, Iss 1 pp 51-60.

[9]   Sudit Ephraim (1996): Effectiveness, Quality and Efficiency: A Management Oriented Approach, Kluwer Academic Publishers.

[10]   Victor- Valeriu P, Lustin P. ,Sabastian Nicolaescu(2006): Security metrics for Enterprise Systems. Journal of Applied Quantitative Methods

[11]   Wanyembi G. N. (2002): Improving ICT Management in Public Universities in Kenya – PhD Thesis

[12]   Whitten J. L, Lonnie D.s Bentley and Kevin C. Dittman: Systems Analysis and Design Methods 5th Edition. McGraw-Hill, Irwin, pp.76.