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Implementation Evaluation Metrics for Enterprise Resource Planning Solution – A Case of Kibabii University

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Most institution of higher learning are implementing and Enterprise Resource planning (ERP) in automating various activities. The architecture of most of the ERP is based on the Service Oriented Architecture (SOA) where each module can be called as service. In most of the contract signed between the vendor and the university, payment is tied to the level of implementation. The Question is how to then measure the level of implementation? This paper proposes a metric that could be used in evaluation of the degree of implementation. The metric was derived based on an acceptance test on each of functionality of module as per terms of reference. The result of a test was rated as a Fail, Pass, or Query The result was then coded such that a fail was assigned a zero (0), pass one (1) and query a half (½). From which a metric was derived which measures the level implementation.

Keywords: ERP; metrics; implementation; SOA; test; module; user; acceptance.

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1. INTRODUCTION

Kibabii University started as University College and became a chartered University in 2015 as the 23rd Public University in Kenya [1,2]. On inception in 2012, the University had incomplete, unfurnished classrooms, laboratories and offices. The ICT infrastructure that is structured cabling had been laid in the Administration block and University Library only. Several computers were purchased for student and staff on which basic Microsoft application were installed. The Finance department used Quick Books and payroll software. The University outsourced for website development hosting.

The ICT infrastructure was later enhanced by use of the last mile radio link to provide internet to the organization at 10Mbs, this link is today used as back link. This data rate was increased to 21Mbs then 66Mbs, 82Mbs, then 110 and at the present speed is 400 Mbs. The University now receives internet bandwidth through a last mile fibre link. The Campus network continues to be enhanced with campus fibre backbone in place. Several hotspots have been installed to allow the students and members of staff access the net. The University has a Directorate of ICT whose mandate is to [3]:

- Establish and maintain ICT infrastructure and services.
- Advance the intellectual and human resource capacity through use of E-resources.
- Publicize University programmers, activities and promote its public image.
- Automate University wide services

The Directorate has purposed continue automating most services through the use of an Enterprise Resource Planning (ERP) solution. The implementation of the ERP was not without challenges which informs the need of this paper to share the challenges to proposed solution.

The paper consist of an Introduction, Description of the ERP case, Challenges realized in the implementation, proposed solutions.

2. ERP CASE DESCRIPTION

The University initiated the procurement process, by request of expression of interest (EOI) for ERP solution. In EOI, a brief overview of the University, including staff levels, student and number computers available, processes and their input and outputs were provided.

The EOI set evaluation criteria for bidders, one of them was that the bidder must have evidence of having implemented a similar system in a University environment. Out of the twelve bidders who responded to the call, only three qualified to the next stage. In this stage, a request for proposal was submitted to the successful bidders and with terms of reference (TOR). After evaluation of bidders, ABNO Software international was awarded the tender and signed contract based on the TOR. It was decided that payment was to be staggered, and paid based on degree of implementation. However, nobody provided specific method of measurement or metrics.

After signing the Contract the stakeholders agreed on a project implementation management structure. The Deputy Vice Chancellor (Academic and Student affairs) (DVC (ASA)) was designated the patron of project. DVC (ASA) was to chair the ERP implementation committee that was tasked with monitoring and solving implementation issues as they did arise. DVC (ASA) was also to report to University Management board [4] on ERP implementation progress and issues arising.

The Director ICT was designated as project manager. He was to report to ERP implementation committee on progress and any issues that may require resolving. After evaluation of the work done, he was to report back to committee. After validating the report, the committee could use it to advice the University management on the amount to be paid to vendor.

2.1 Challenges Encountered in Implementation of the ERP

The ERP implementation is largely complete, and is now in the support phase. Three of the major challenges experienced were:

(a) Attitude change. The ERP forces people to adopt a certain workflow. The acceptance that there is a system is in place, that it is not business as usual, has been constant source of friction.

(b) Training of users. Initially users took training casually and hence took too long to adopt the system and continue making errors as they use the system. Also because there are many concurrent activities happening at the University, then training within campus has not been very effective.
(c) Lack of metrics for measuring the level of implementations. There is need to assess the degree of implementation for modules. There were no metrics in place to solve this problem, looking at available Service oriented metrics [5] and ERP metric available. Yet university management required an absolute figure to enable them determine the payment.

2.2 Need for Metrics

The University ascribes to ISO 9001:2015 [6] where one of the principles is evidence based decision making. Hence the measurement and proposed metrics must be of quality and objective. Software metric is a measure of software characteristics which are quantifiable or countable. Metrics can enable planning, organization, control and improvement. Software metrics should have the following Characteristics [7]. They should be

- Simple and computable.
- Objective.
- Consistent.
- Independent of programming language.
- Easy to calibrate and adaptable.
- Easy and cost effective to obtain.
- Able to be validated for accuracy and reliability.
- Relevant to the development of high quality software products.

We ascribe to these characteristics of metrics and these were put into consideration as the metrics were designed.

3. RELATED STUDIES

CGN [8] carried out a research on ERP project measurements where they found out that the most successful projects were those where there was a high degree of Political and Operational achievement. On the contrary, the ones that had high Technical and Economic achievement, but low Political and Operational achievements were perceived as less successful in the long term. They argued that to determine the true success of an ERP project, firms must make a paradigm shift that, incorporates a holistic approach and multi-dimensional view that includes targets, constituents, and a sequence of measurements over a long-range time frame. Only by transcending the traditional, singular financial view of return of investment (ROI) can one truly identify and differentiate successful ERP programs that provide long-term strategic value.

On technical aspect the rating was on whether the implementation is:

- Fully achieved
- Mostly achieved
- Partially achieved
- Failed to achieve

Siriku [9] presented a paper titled measuring implementation success with a balanced Scorecard. He argued that Large Scale ERP implementation success factors consists of project management competence, knowledge sharing, ERP system quality, understanding, user involvement, business process engineering, user involvement, top management support and organization support.

Ahad et al. [10] have written on ERP Post implementation Success Assessment: An Extended Framework. In the paper they emphasis the importance of post implementation success assessment and propose an extended model based on the original model by Ifinedo et al. [11]. That did encompass service quality, system quality, information quality, individual impact, and workgroup impact and organization impact surrogates.

There are many more authors who have highlighted various others aspects of ERP and metrics but none has attempted to measure the level of implementation of degree of implementation which is the key contribution of this paper.

4. PROPOSED SOLUTIONS TO THREE CHALLENGES IDENTIFIED

4.1 Attitude

Moutaz and Henrik [12] did carry out a research on user resistance. They identified factors that cause people to resist a new system. The factors were: people, system, interaction approaches, perceived risk and habit. They also identified strategies that can be used reducing user resistance such as participative training and top management commitment. We are in support of these finding and continue to state that change of altitude will take time to be realized but as staff continue to use the system they will gradually buy into the system and their attitude will gradually change. Also continues enforcement of the workflow by the senior management will force those who are reluctant to adopt to do so.

It has also been recommended that most the services be automated and integrated within the ERP. Top management has discouraged any process being undertaken outside the ERP that involves service already included in the modules.

4.2 Training of Users

Derek [13] argues that training must be implemented in the right way, and it must be tailored to staff in order to maximize its effectiveness. He lists the following eight training pitfalls to avoid:

- Training the wrong people
- Not training enough people
- Incorrect mix of eLearning
- Opting for public vs. private training
- Training at wrong times
- Having wrong training partner
- Incomplete training
- Not training at all

The authors concur with the above since the errors being experienced in the system are user based, and this could be tied up to effectiveness of the training. Generally most of the users are demanding for more training. This should be done either formally or informally by the vendor and ICT staff. It has also been recommended by users that future training been done away from campus to allow the participants to fully concentrate.

4.3 Lack Metrics

To determine the level implementation Directorate of ICT (DICT), the ABNO team and the internal auditor, visited the various users in the various departments for user acceptance tests. User acceptance tests are tests carried out by the end use to validate if all business requirements are fulfilled or not. Use of live data and real uses cases makes this testing an important part of the release cycle [14]. The question then was how to evaluate the level implementation in face of nonexistent metrics. The solution then was to come up with implementation metrics.

4.3.1 ERP implementation metrics

The metric has to be sufficiently objective to satisfy both the vendor and the client. The vendor had prepared a questionnaire on user acceptance. But had not provided an objective transformation of the questionnaire into a metric.

The team carried out an acceptance test based on each of functionality of module as per terms of reference (TOR) which informed the contract. The result of the test was then rated as Fail, Query or Pass. Fail if it failed outright, query if the user was fully satisfied and Pass if a given functionality performed as required.

The result was then coded such that a fail is assigned a zero (0), a query (½) and pass one (1). The ½ assigned to query which the arithmetic mean of 0, and 1.

The concept was borrowed from the Tristate logic in Digital logic where we have high (1), low (0) and high impedance (Z) states [15].

The metric for implementation was then defined as

Implementation % = {((no pass +½ (no of queries))/ (total number of tests))*100}

4.3.2 Validation of metrics

Validation of metrics can be done both theoretically and empirically. Muketha et al., [16] posits that main goal of theoretical validation is to establish the theoretical soundness of the metrics. Several researches such Fenton et al. [17], Weyuker [18] and Briand et al. [19] have studied the metrics for quite some time.

The proposed metric is a size metric because the level implementation increases from 0% when there is no implementation to 100% for full implementation. Theoretical validation shows that it may not be possible for implementation to be below zero (0) % or above 100%.

Considering zero case then

Implementation % = {((no pass +½ (no of queries))/ (total number of tests))*100}

No of passes = 0
No of queries = 0

Substituting into the equation

Implementation % = {((0 +½ (0))/ (total number of tests))*100} = 0

Considering the case of complete successful implementation

No of passes = total number of tests
No of queries = zero (0)

Substituting into equation

Implementation % = {((no pass +½ (no of queries))/ (total number of tests))*100}

Implementation % = {((total number of tests +½ (0))/ (total number of tests))*100}
= total number of tests/total number of tests *100
= 1*100 = 100%

Empirical tests can also be based on Weyukker criteria and /or the Lionel Briand criteria.

But as has been, argued by Muketha [16] and others, Weyukker criteria is best for complexity metrics. Since the proposed metrics are size then Weyukker criteria may not apply here.

Briand et al. [19] postulates that a size metric can be assessed based on, non-negative, null and additive properties. For non negativity it means that the size of metric should > 0, and this applies to the proposed metrics. The metric null value for an empty set and the metrics from the modules can be additive. Hence we may conclude that the metrics are theoretically sound.

4.4 An Application of Metrics on Instances of the Implementation

Table 1 gives the results for result of application of the metrics where serial no 8 -18 represents the sub-modules in the integrated finance module.

From Table 1 the total number of tests were 331 of which 200 were passes while 25 were queries and 106 were fails.

From the above data the percentage user acceptance = ((25*1/2) +200)/331)*100 = 64.2%

However it should be noted that the following modules were not tested because they were not in use: Project, IGA, Fixed asset, and scored zero.

Payroll module was scored zero but the user had requested for two days before the tests would be done.

It should be noted that the recommendation on payment to the vendor, at this point in time was 64.2% of bided sum.

Table 1. ERP user acceptance results

S/NO	Module name	Fail	Query	Pass	Total no functionalities
1	Student Management	2	0	13	15
2	Student academics	2	0	20	22
3	Student Portal	2	3	6	11
4	Hostel And Accommodations	3	0	14	17
5	Human Resource	0	5	30	35
6	Procurement and Inventory	14	3	31	48
7	Time tabling	1	0	15	16
8	Finance -student finance	0	1	24	25
9	IGA	12	0	0	12
10	Account payable	0	1	17	18
11	Imprest management	2	0	10	12
12	Cash management	3	2	10	15
13	Bank Reconciliation	2	3	1	6
14	Projects	4	0	0	4
15	Budgeting modules	3	0	7	10
16	Fixed assets	24	0	0	24
17	Payroll	31	0	0	31
18	Finance -Reports	1	7	2	10
19	Total	106	25	200	331

4.5 Application of the Metrics to Specific Modules

4.5.1 Student Management

In this module 15 functionalities were tested out of which 2 failed. The tests that failed were: generating of admission/registration reports and generation of admission /regrets letters. The users acceptance from module was **(13/15)*100 =86.7%**

It was suggested that users of module should upload students' photos and other details.

4.5.2 Student academics

In this module 22 functionalities were tested out of which 2 failed. The tests that failed were

- Capture class attendance by lecturers
- Generating departmental mark sheets
- The users acceptance from module was **(20/22)*100 =90.9%**

It was also suggested that system control should be enhanced on the student unit registration so that units to be registered once.

4.5.3 Student portal

In this module 11 functionalities were tested out of which 2 failed. The tests that failed were

- Students can view their attendance records on line.
- Students can view the fee records on line.
- The users acceptance from module was **(7.5/11)*100 =68.2%**

In this module, the following had not been utilized:

- Viewing exam results on line and printing of unofficial transcript online.
- Viewing class and exam time tables online.

It was noted that functionalities that are not clear should be reviewed.

4.5.4 Hostel and accommodations

A total of 17 functionalities were tested of which three failed. These were:

- Capture damages caused by students and invoice appropriately
- Occupancy rate
- Accommodations fees collected per hostel/campus/school etc.

Online booking and room rates had not been used.

The users acceptance for this module was **(14/17)*100 =82.4%**

4.5.5 Human resource

A total of 35 functionalities were tested out which 5 had queries.

- Employee service history
- Monitoring employee suspension, discharge and disciplinary actions
- Keep record of employee training awards and appraisals
- Track employees performance reviews
- List of employees due for appraisal

The users acceptance for this module was **(32.5/35)*100 =92.9%**

4.5.6 Procurement

A total of 48 functionalities were tested out of which 14 failed. These were:

- Ability to consolidate departmental procurement plans and link it university budget
- System should allow different types of costing methods for inventory
- They system should be able to show rejected or good returned records
- Produce report on price list and price updates per supplier
- Produce reports on cancelled PRNs
- Produce reports on cancelled LPOs
- Produce reports on rejected or goods returned
- Rating of appraisals of suppliers
- Have full audit trail of all stock movements
- Expiry dates tracking in case of perishable goods
- Generate report inventory movement
- Generate stock taking reports
- Generate report on inventory evaluation summary's

The users acceptance for this module was **(32.5/48)*100 =67.7%**

4.5.7 Time tabling

A total of 16 functionalities were tested out of which 1 failed. It was not possible to produce time table reports based on lecturer.

The users acceptance for this module was **(15/16)*100 =93.8%**

4.5.8 Student finance

A total of 25 functionalities were tested with one query. The query was ability to generate invoices to eligible students only.

The users acceptance for this module was **(24.5/25)*100 =98%**

It was noted that the system took time to generate reports. Also configuration of emailing demand notices to student had not been configured.

4.5.9 Finance IGA

In this module none of the 12 functionalities were tested.

The users acceptance for this module was **(0/12)*100 =0%**

4.5.10 Accounts payable

A total of 18 functionalities were tested with only one query and no fail. The query was ability to vote and stop payment of cheques especially where there exists:

- Double entries on suppliers names
- List of suppliers contact is not complete e.g. pin no’s
- No separation of capital and recurrent creditors

The users acceptance for this module was **(17.5/18)*100 =97.2%**

4.5.11 Imprest management

A total of 12 functionalities were tested with 2 fails. The fails were

- Automatic alerts for overdue unaccounted for imprest.
- Online approval. The users acceptance for this module was **(10/12)*100 =83.3%**

4.5.12 Cash managements

A total of 15 functionalities were tested with 3 fails. These were:

- Create alarm features for a predetermined amount payable at time in each bank account.
- Ability to keep cheque disbursement register.
- Uncollected cheques list available.
- The users acceptance for this module was **(11/15)*100 =73.4%**

4.5.13 Bank reconciliation

A total of 6 functionalities were tested with 2 fails and 3 queries. These were:

- Full bank and cash reconciliations including deposits disbursement and adjustments.
- Flexibility to import transaction from various banks systems.

The users acceptance for this module was **(2.5/6)*100 =41.7%**

4.5.14 Projects

In this module none of the 4 functionalities were tested. There was no user.

The users acceptance for this module was **(0/4)*100 =0%**

4.5.15 Budget

A total of 10 functionalities were tested with 3 fails. These were

- Send alerts to vote holders whose balances are significantly low
- Print a vote holder ‘s statement
- Vote expenditure summary

The users acceptance for this module was **(7/10)*100 =70%**

4.5.16 Fixed assets

In this module none of the2 4 functionalities were tested. There was no user.

The users acceptance for this module was **(0/24)*100 =0%**

4.5.17 Payroll

In this module none of the 31 functionalities were tested because the user requested for more time before assessment of module could be done.

The users acceptance for this module was **(0/31)*100 =0%**

4.5.18 Finance reports

A total 10 functionalities were tested with one fail and seven queries. The fail was notes to the financial statement with comparative figures.

The users acceptance for this module was **(5.5/10)*100 =55%**

5. EVALUATION OF METRICS

The office of Auditor General in Kenya has the mandate to audit within six months after end of each financial year, any entity funded by public funds [20]. Kibabii University is one such organization. In September 2018 officers from the Auditor general visited Kibabii University to exercise their mandate. In their audit they wanted to find out what criteria was used in payment of ERP. We informed that the payment was based on the application of the above define metrics, which determined the percentage of implementation. This percentage of implementation was then used to determine the percentage of payment. They sampled several payment vouchers and we showed them the metric used in computation of the level of implementation and corresponding payment. The officers were satisfied that metrics were valid. Hence confirming and evaluating the metrics. They also did not raise any audit query.

6. CONCLUSION

In conclusion we set out to identify the key challenges that are experience during ERP implementation were mainly altitude, training of the users and lack of implementation metrics.

On altitude we proposed ways to win over users and borrowed from what other authors have found out on overcoming resistance. On training we also found out what were effective strategies and we proposed further training and if possible away from the University to allow for the participant to fully engaged.

On metrics we found out that metrics that measured the level implementation and tied it to the payment for work done were missing. We defined our own, theoretically and empirically validated them. The office of Auditor General did not raise any audit query on the way we applied out metrics to decide on amount to be paid to the vendor. We believe this is an evaluation of our metrics being fit for purpose. We believe this metric will go a long way in assessing the level implementation.

However, we are aware that measure of query was all rounded up to half, irrespective of how near or far from implementation the query was, this is a limitation of the metric.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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