Conceptual Design and Evaluation of Maintenance Management Information System

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Abstract

The goal of the research study is the analyses of published research on business process modeling and then conceptually design a business process model for Management Information system for Maintenance in South East European University (SEEU). Maintenance of facilities represents more services such as: recording of defects, reconstruction of defects, warehouse, budget, regular checkups, flexible overtime, etc and therefore classical ways to manage it do not meet the needs of University and there is a need for electronic services. The research study aim is to present coherent ways to transform and to improve the old way of workflow of processes and maintenance with new changes and its integration with other electronic services. The research study investigates the need for implementing Management of Maintenance, analyze the current state, design "SEEU Maintenance" model and evaluate it. The 3 (three) study hypothesis have been investigated and statistically analyzed. Insights and recommendations are provided.

Keywords

Management Information system, Enterprise Resource Planning, Maintenance, conceptual design.

1. Introduction

Business process modeling (BMP) enables a common understanding and analysis of a business process. A process model can provide a comprehensive understanding of a process. Business Process modeling is at the core of each of these approaches [Bro10]:

- Business Process Reengineering (BPR)
- Business Process Management (BPM)
- Activity Based Costing (ABC)
- Business Activity Monitoring (BAM)

The arrival of modeling standards is now resulting in the rationalization of process analysis methods and the creation of a knowledge base that can be shared by market participants. Substantial progress has been made in business process standardization.

However, it is clear that the wide range of domain covered by business process modeling requires more that a single compacted standard. This study attempts to present the current status and the need to embrace the multiple dimensions of business process approaches. The perspectives given in the report of ISO standards [Dum13] are based on MEGA customer experience and are analyzed as such. Business Process Model and Notation (BPMN) is the global standard for process modeling and one of the most important components of successful Business-IT-Alignment.

BPMN has been primarily developed to support technical implementation of processes ("Process Automation"). The more important the IT is in a company, the more helpful the use of BPMN becomes.

Maintenance is crucial for a university. Maintenance of facilities represents more services such as: recording of defects, reconstruction of defects, warehouse, budget, regular checkups,etc and therefore classical ways to manage not meet the needs of organizations and the industry so there is a need for electronic services. Therefore the study focused on investigating new coherent ways to transform and to improve the old way of workflow of processes and maintenance with new changes and its integration with other electronic services in University.

2 Literature Review

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There's a broad published literature reviewed on business process modeling. The term "business process" is often used in relation to very different types of projects. Of these, we are addressing the following three according to [Nel12]:

• The creation of a customer-oriented business management method. This means running the company via its business processes or value chains.

• The creation of procedures to oversee the organization's operations.

• The integration of IT resources using a business process approach.

According to [Ald11] BPM helps divide complex business processes into smaller, less complex sub-processes. [San12] Declares that BPM makes it easier to understand the business process and achieve the desired outcome.

In planning a company's operations, one factor is the relationship between strategy and business processes. For example, a bank can decide to focus on the financial products market over the retail banking market. The business process "Provide financial products" thus becomes the bank's major value added product line. Bank operations must be reorganized according to this business process so that each branch focuses on satisfying customers who buy financial products.

According to [San12] Standards for analyzing business processes must meet certain criteria that apply to any modeling standard:

• An intuitive notation that is easily adopted for use by those involved with business analysis: a good diagram is worth a thousand words.

• A metamodel and vocabulary—a group of concepts and relationships—that are strictly and consistently defined to provide a solid foundation for the various business process approaches.

• A breakdown of the metamodel and notation for each level of analysis of business processes: value chain, organization, and IT integration. This breakdown must be accompanied by a mechanism for navigating between the different levels of analysis.

• An exchange format for both the process models and their diagrams.

The key operational processes (also called primary processes) that a software maintenance organization uses are initiated at the start of software project development, beginning with the Transition process [Bre07].

This process is not limited, as is the case with some standards [Bor09], to the moment when developers hand over the system to maintainers, but rather ensures that the software project is controlled and that a structured and coordinated approach is used to transfer the software to the maintainer. In this process, the maintainer will focus on the maintainability of this new software, and it means that a process is implemented to follow the developer during the system development life cycle. Once the software has become the responsibility of the maintainer, the Event and Service Request Management process handles all the daily issues, Problem Reports, Modification Requests, and support requests [IIB09], [Men07]. These are the daily services that must be managed efficiently. The first step in this process is to assess whether a request is to be addressed, rerouted, or rejected (on the basis of the SLA and the nature of the request and its size) [Bro10]. Supplier agreements is concerned with the management of contractual aspects (i.e.escrow, licenses, third-party) etc.

Accepted requests are documented, prioritized, assigned, and processed in one of the service categories:

1)Operational Support process (which typically does not necessitate any modification of software);

2)Software Correction process; or

3)Software Evolution process.

Certain service requests do not lead to any modification of the software [Men10]. In the model, these are referred to as operational support activities, and these consist of: a) replies to questions; b) provision of information and counseling; and c) helping customers to better understand the software, a transaction, or its documentation. The next primary processes as discussed from [Ald11] concern the Version Management process that moves items to production, and the Monitoring and Control process, ensuring that the operational environment has not been degraded. Maintainers always monitor the behavior of the operational system and its environments for signs of degradation. They will quickly warn other support groups (operators, technical support, scheduling, networks, and desktop support) when something unusual happens and judge whether or not an instance of service degradation has occurred that needs to be investigated. The last primary process addresses rejuvenation activities to improve maintainability, migration activities to move a system to another environment and retirement activities when a system is decommissioned [Bru13], [Deb06].

3 Research Methodology

The research methodology involved fundamental research and representation design of the workflow of processes in SEEU and the strategy that will be used throughout this work is given below. In general the research study aim is to present coherent ways to transform and to improve the old way of workflow of processes with new changes and its integration with other e-services of SEEU and my SEEU.
The following research question were studied:
1. How to improve the current workflow of processes in maintenance of south East European University?
2. What are the potential benefits from implementing Management of Maintenance?
3. Which aspects of the organization will be affected?
Main Hypothesis: If we use one new system design of the process workflows that represent a coherent way to transform the old way of maintenance management in the form of e-service we will have better management of maintenance.
Independent variable: New System
Dependent variable: Management of Maintenance
Indicator: Current situation, review of existing documentation
H1: If we use a new system for recording costs then we will have better management of maintenance which can be measured by the reduction of the costs.
Independent variable: a new system for recording
Dependent variable: Management of Maintenance
Indicator: Difference in costs
H2: If we use such a system for alarms (periodic tasks) then we will have better management which can be measured by the number of forgotten tasks in past.
Independent variable: Systems for alarms (periodic tasks)
Dependent variable: Management of Maintenance
Indicator: Reduction of forgotten tasks to zero
H3: If the current state of materials in the warehouse will be followed then the optimal quantity of materials will be under control.
Independent variable: New Systems
Dependent variable: Management of Maintenance
Indicator: Optimal quantity of materials.

4 The Business Process Model Management of Maintenance "SEEU Maintenance"

"SEEU Maintenance" model has the following structure:

Warehouse

1. Register Materials received from Supplier
2. Alarm Quantity
3. List in grid view with quantity for each material in warehouse
4. Order for materials that are near to end
5. Received Order
6. Edit materials according to the tasks – according to the task employee will take materials
7. Reports

Maintenance

1. Define Category
2. Create activity(Help Desk)
3. Periodic Activity
4. View Activity
5. Reports

Task List

6. Task list in grid view
7. Alarm notification for open tasks

Overtime

8. Define employee payment for overtime
9. Add overtime
10. Reports

Budget

11. Define Budget category and subcategory
12. Define budget value for categories
13. Register costs
14. Reports

The warehouse page is used only from maintenance department, all materials are registered in database from SEEU Campus Warehouse and they are defined as standard materials, if the maintenance department needs for material that is not standard then informs SEEU Campus Warehouse with activity in task list.

TABLE 1. Register received materials from Main Warehouse

No.	Fields	Data Type/ Short Description
1	ID	Text Box - **Disabled**
2	Date	Text Box – dd.mm.yyyy
3	Material	Drop Down List – Materials Table in DB
4	Quantity	Text Box – Number
5	Supplier	Text Box – automatically

		from Materials Table in DB
6	Price	Text Box – from Materials Table in DB

1.1 Alarm Quantity for all materials

For each material in this page will set alarm quantity, this means that when a quantity of material in warehouse will be equal with alarm quantity which is defined in this page we will receive notification that should make new order for that material.

TABLE 2. Set alarm quantity

No.	Fields	Data Type/ Short Description
1	ID	ID Number
2	Material	Drop Down List- automatically from Materials Table in DB
3	Alarm Quantity	Text Box -Number

2. ID – Text Box: this text box will be disabledd and will get automatically value
3. Material – Drop Down List: user will select material from list
4. Alarm Quantity – user will set alarm quantity for material (number)

1.2 List in grid view with quantity for each material in warehouse.

This page will use only like a report for quantity for each material in warehouse.

5. ID –:text box will be disabled and will get value automatically(from 1 to number of materials)
6. Material – Name of material
7. Quantity – Sum of all materials that are received minus all materials that are taken from warehouse

Example: A = sum of all quantity that are received
B = sum of all materials that are taken
C = quantity in warehouse, C= A-B

NOTICE: If Quantity of materials is equal with Alarm Quantity than user will receive alarm message (message on page) and should make new order to SEEU Campus Warehouse, also row in grid view which display materials which quantity is equal with alarm quantity will have red color background.

1.3 Order to SEEU Campus Warehouse for materials that are near to end.

After user will receive quantity alarm for any material in warehouse should make new order to SEEU Campus Warehouse which is main warehouse, making new order page.

a. ID – Text Box: text box will be disabled and will get automatically value .
b. Date – Text Box: textbox will be disabled and will gate today date automatically.
c. Material – Drop Down List: user will select material from list .
d. Quantity – Text Box: user will write material quantity for order.
e. Received Date – Text Box: user will write date when they need to receive a material from order.
f. Description: user can write description for material or something else.
g. Status –Text Box: when we are making new order for any material status automatically will have value Open and when we will receive that material status will change from Open to Close

NOTICE: SEEU Campus Warehouse (main warehouse) will receive order like a regular task in their task list. If needed material is not standard then user will select in drop-down list material with name "other" (which previously should register in DB Table of materials like e material category) and in description text box will write name and description about material that they need.

1.4 Received Order

After that we make new order for material and we receive that material in Maintenance Warehouse by help of this page we should register received order,we need to register date when order is received and description for order. **NOTICE:** If the order received is not the same with our order than should write textual description in the text field dedicated for that.

Warehouse – Process

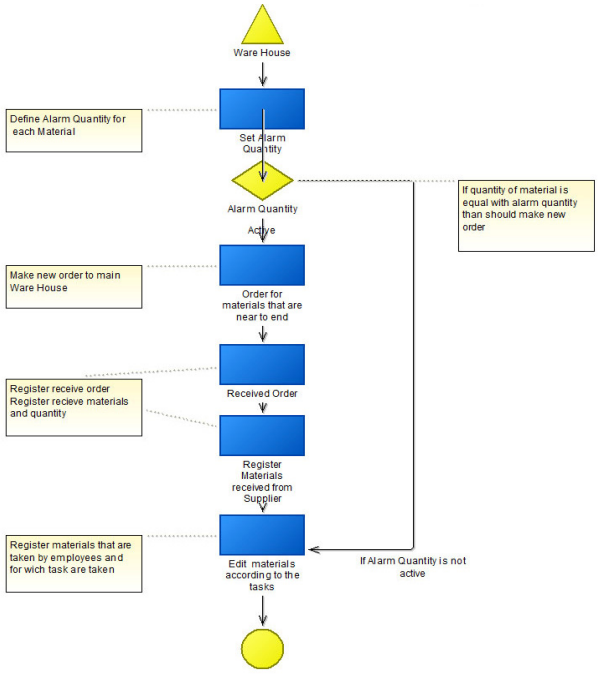

Figure 1: Business Process Model: Warehouse – Process

Maintenance – Process

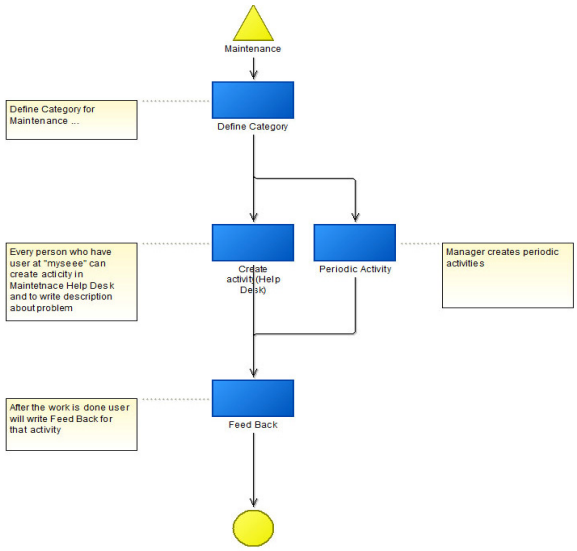

Figure 2: Business Process Model: Maintenance – Process

Task List – Process

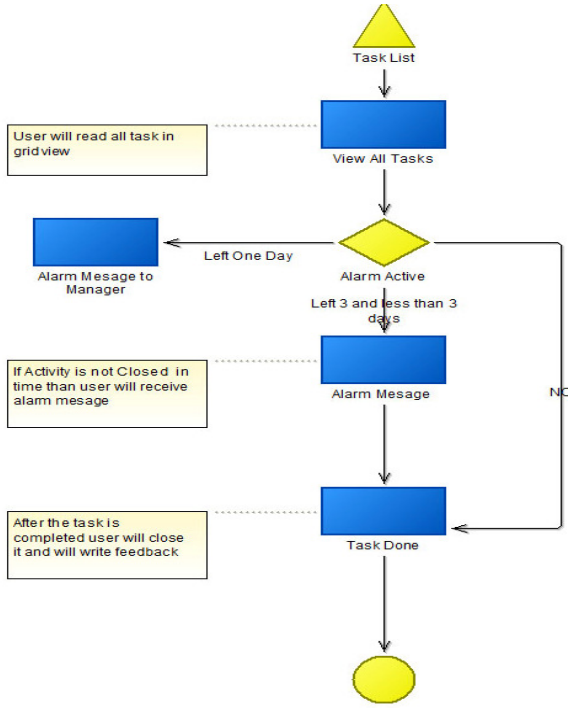

Figure 3: Business Process Model: Task List – Process

Overtime – Process

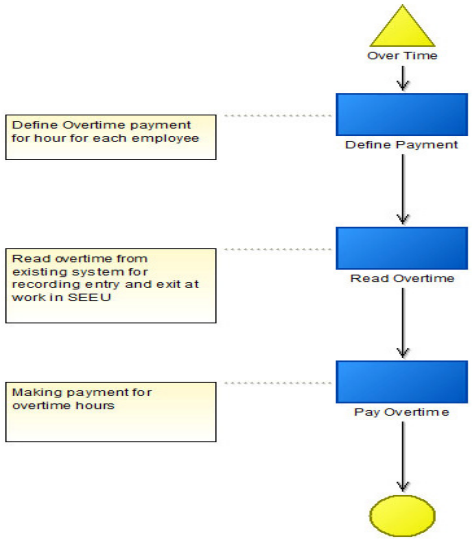

Figure 4: Business Process Model: Overtime – Process

Budget – Process

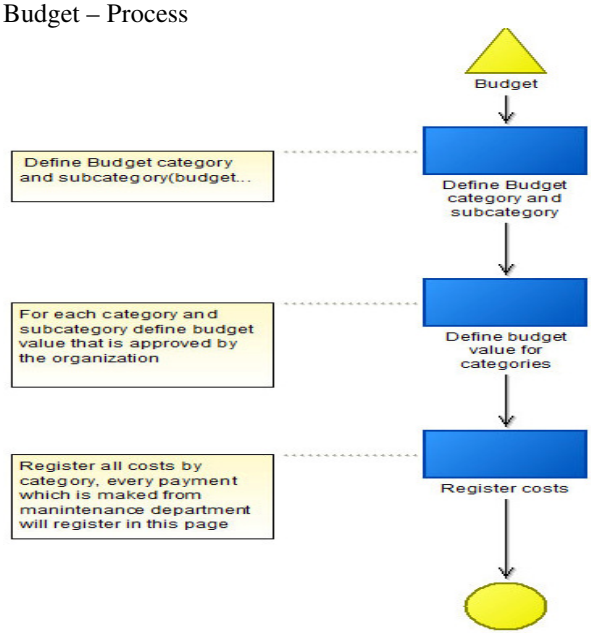

Figure 5: Business Process Model: Budget – Process

5 Results of Hypothesis Testing

Within the study used the questionnaire as evaluation method to asses the hypothesis. The sample size was 22 participants. We have used the analysis of variance (ANOVA) which is a collection of statistical models used in order to analyze the differences among group means and their associated procedures. The statistics distribution is given in the tables below.

Regarding the hypothesis one (H1) and hypothesis two (H2) which are about the effect of perceived usefulness (PU) on behavioral intention (BI) and attitude (A) the results are as follows: perceived usefulness (PU) is positively related to behavioral intention (BI) ($\beta = 0.39$; $t = 4.39$), therefore H1 is accepted. Perceived usefulness has a positive influence on attitude of social media ($\beta = 0.34$; $t = 3.41$), therefore H2 is found to be significant and it is also accepted.

For the hypothesis three (H3) effect of perceived ease of use (PEU) on perceived usefulness (PU) and attitude the results are as follows: perceived ease of use is positively related to perceived usefulness ($\beta = 0.29$; $t = 3.28$), therefore H3 is accepted. The relationship between perceived ease of use and attitude ($\beta = 0.08$; $t = 0.92$) is found not to be significant, therefore H3 is rejected.

Table 3. Hypothesis results

Hypothesis	Effect	T-value	Results
H1	PU -> BI	4.39	Accepted
H2	PU -> A	3.41	Accepted
H3	PEU -> PU	3.28	Rejected

Table 4. Correlation of reliability of Management Information System with IT Skills level and have a computer at home

Benefits of using the developed e-service system	**IT Skills level**					
	1 low		**2 intermediate**		**3 advanced**	
	What is the benefit of using the new developed system?					
	yes	**No**	**yes**	**no**	**yes**	**no**
Unsatisfactory	1.8%			1.5 %		
Satisfactory	10%		6%	1.5 %		
Good	8.1%		3.1%			
Very good	1.7%	1.7 %	15.7%		12.7 %	
Outstanding	1.5%		23.00 %		15.5 %	
Total	23.10 %	1.70 %	47.80 %	3.00%	28.20%	0.00%

TABLE 5.

Attitude expressed through level of satisfaction towards process modeling

Level of Satisfaction	X_1	X_2	X_3
Unsatisfactory	11%	8%	6%
Satisfactory	17%	17%	18%
Good	14%	19%	14%

Very Good	45%	24%	31%
Outstanding	12%	32%	31%

"The level of attitude towards you are in-time: informed, you can have access to all needed information". They were given five options to answer: Unsatisfactory(1); Satisfactory(2); Good(3); Very Good(4) and Outstanding(5). In order to investigate that, we had specific indicator questions marked as:

X1 - You get information in time.

X2- You are informed about the status of each process in time/ at any time.

X3 – You are informed about each new process in time/ at any time.

6 Conclusions

The conclusion based on the review analyses is that guidelines to improve the understand-ability of business process models are very important. They should be focused primarily on efficiency of modeling and should be described in a structured way using graphs and textual description. The realized research on the quality of the modeling process is quite scattered because of the many factors and its multidimensional nature. The main emphasis is put on enhancing the efficiency of modeling by means of promoting the reuse of existing process artifacts.

Parallel with the growth of the organization increases the need for Management of Maintenance systems, in the near future it will be necessary to implement the software system for maintenance management. The focused on the design of the system by trying to present coherent way to transform the old way of maintenance management incorporated with different e-services.

Based on the review analyses there is no generally accepted framework of model quality types: we refer to quality types using many different quality names and not a standard for quality. Only one fourth of the studies used a precise definition of quality. Among the used quality terms, most research focuses on understand-ability and maintainability for the product cluster and on efficiency and effectiveness of the modeling process for the process cluster. An interest in and demand for guidelines is substantiated by the fact that the paper "Seven process modeling guidelines (7PMG)" has been cited more than 250 times already since it was published only several years ago. Clearly, only seven guidelines can not cover everything that a modeler needs to know. For example, this particular paper does not tell how to decompose a business process model - only that is need to be decomposed it beyond a certain size of the model. Also, more research is needed with respect to quality metrics. In particular, the analysis of the results reveals that a large amount of research on metrics is not addressing guidelines and vice versa.

Existing quality metrics would need a critical review to make them applicable as a measurement to evaluate the outcome of applying guidelines.

The devised strategy proposed is continuous improvement, module by module. Any new software refresh is preceded by the user definition of the business process; thus the users drive development of the improvements.

Based on the literature review, as the most significant steps toward implementing and developing a successful management system are the users involvement in the business process analyses and acceptance of its processes, deciding which of the multiple features should be implemented, in order to assist specific groups and maintain their satisfaction. Also, identifying the optimal requirements and definitions is considered as a major step in order application to be powerful and reliable. A final research area that seems worthwhile to pursue further concerns the quality of the modeling process. Such research should not only look at the different tasks in a modeling process, such as elicitation, modeling and validation, but also look at the contextual factors.

Little research effort has been spent on assuring and understanding business process modeling quality. Among the various research methods, experimentation is the most popular one, followed by the use of examples and case studies. A little more than half of the papers performed empirical validations, and experiments were mostly conducted with students. Descriptive research methods are scarce in this research area.

The major opportunities for improvement within the work-flow that were identified for highest potential impact included:

–Analyzing the content of applications (both scientific content as well as involved individuals/institutions)

–Scheduling meetings (calendaring software)

–General operations (downtime, slow performance, and lack of documentation and training)

–Identifying qualified reviewer pool and facilitating best match of reviewers to applications.

Critique templates that are more user friendly for both reviewers in composing and submitting their critiques and for staff in assembling and finalizing summary statements.

This system will be an important factor for the operation and organization of SEEU by eliminating the coincidence at work and creating standard for work-flow of the processes in maintenance.

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