A SIMULATION CASE STUDY OF EMAIL MANAGEMENT WITHIN A LARGE I.T. COMPANY IN GREECE

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ABSTRACT

The use of Internet technologies in business processes has significantly altered the way people communicate and interact with each other, introducing new manners of communications, such as e-mails. Thus e-mail processing has become a considerable part of the everyday workload in companies. The time spent in replying to customers' requests and the overall response times of various e-mail categories are critical operational indices that contribute to efficient management decision making and work planning. In this paper we present a case study of a Greek company which provides IT and financial products and services. The study is based on a discrete event simulation model that represents the system of professional e-mail flow and processing within the company. The model is used to investigate different scenarios with experimentation and statistical analysis of the output.

Keywords: e-mail, simulation, mailbox, corporation

1. INTRODUCTION

During the last decades the corporation operational environment is continuously changing due to technological progress in many fields, especially in that of Information Technology and Internet. The use of Internet in business processes has significantly altered the way people communicate and interact with each other, introducing new manners of communications, such as e-mails. A study by Rogen International (Thomas et al., 2006) reported that from 1995 to 2001 e-mail communication grew by 600% and also that executives spent approximately 2 hours each working day checking and sending e-mails.

Using e-mails in the business context and the benefits of such use have been widely discussed and documented in the literature. These benefits originate from the relatively low cost of e-mails and a number of other characteristics such as the fact of being asynchronous (Thomas et al., 2006), i.e. the communicating parts do not have to be simultaneously present in order to interact. Furthermore, e-mails are text-based, can be forwarded or shared, depending on the recipient's needs, can be easily stored and traced and they are considered quite efficient according to various studies in the literature (Tyler & Tang, 2003; Dabbish & Kraut, 2006; Clark, 1996; Monk, 2003; Renaud, Ramsay & Hair, 2006). For the aforementioned reasons, electronic mail has proven to be an incredibly appealing and eventually a necessary means of communication not only in the corporate discipline but also in the interpersonal every day relations.

Since managers and business staffs are depending on e-mails to a great extent, researchers are trying to recognize and study problems associated to the aspects of this type of communication (Weber, 2004; Whittaker et al. 2005). One out of several challenges, managers have to cope with, is the handling of a high volume of mails that arrive on daily bases at their firms. Because of the increased volume of mails, working staff spends more time on e-mails than they used to, as is shown by several surveys. Particularly, the American Management Association in 2004 conducted a survey from 840 Organizations and reported that 47% of the Organization workers spent around 2 hours per working day.

Despite the positive aspects and the facility e-mail communication brings, it also leads to significant work time shortages and information overload (Denning 1982; Markus 1994; Berghel 1997; Jackson et al. 2003). Generally the mail response rates are quite low, however in Jackson et al. (2003) is shown that the accumulative time loss is considerable when we refer to very large organizations with very high e-mail flows.

Furthermore, many studies in literature have designated simulation as one of the most effective tools for management decision making **(**Hovey and Wagner, 1958; Green et al. 1977). Extended work has also taken place related to the practical application of simulation in industry and in the field of business and management (Watson, 1978; Christy and Watson, 1983; Lee et al. 1981; Millichamp, 1984; Hillier and Liebman, 1986).

This paper presents a study of a Greek company with a large number of departments and working employees. The collaboration allowed us to collect information about the amount of e-mails they deal with at a daily basis, the way they manage their mailbox and the importance of using e-mails for the operation of the organization. The aim was to develop a discrete event simulation model in order to study the real system of e-mail communication and to enlighten management

operations regarding the impact of e-mails on employees' engagement.

In Section 2 we analyze the problems rising by the entrance of e-mails in a company's working flows. Section 3 presents the methodology used in order to develop our simulation model. Section 4 presents the results of our simulation with the corresponding validation and verification of the model. Section 6 describes some results after applying regression analysis to data derived from different scenarios we conducted. Finally we conclude with some reflections end discussion of our results.

2. PROBLEM DEFINITION

Discrete Event Simulation has been widely applied in business processes. Some of the research areas include decision making in military applications, health systems, economic studies, social analysis etc. A respectable amount of work also exists in simulation in sociology, which is extended in areas like iterated game theory, neural networks, multilevel simulation, simulation of social networks, policy oriented tax-benefit micro simulation etc. (Halpin, 1999). However, disproportionately with the importance of the role of e-mail in business operations, limited work has been performed with respect to mailbox simulation and management.

Specifically, Gupta et al. (2004) performed simulation based studies and concluded that if other tasks are more important and e-mail communication is secondary, e-mail messages should be checked 4 times a day with each processing period not exceeding 45 minutes. A significant contribution was made by Greve et al. (2007) with the eSIM model, who provided a decision support tool for testing the effectiveness of alternative e-mail processing strategies, given individual knowledge workers' e-mail environments. Another study working in the same direction is that of Narasimha (2007), which focuses on e-mail behavior of knowledge workers.

These studies may benefit in the area of productivity reduction and the more efficient e-mail management by the employees; it could be very helpful on the other hand though to study the system at a much higher level, that is that of the company's manager or CEO. Thereby, we have issues regarding the knowledge of managers about the real time the employees dedicate to e-mail processing and the combination of occupation time slots in order to achieve better e-mail processing.

Another point is that in different working environments and operational areas the findings might be surprisingly different, always according e-mail load management. In this direction the study of a specific case could benefit the case itself and also help us reflect further over the problems of information flow inside a company.

In the context of conducting a master thesis, we contacted a large company, with its headquarters in Thessaloniki, Greece, in order to be able to discuss with the administration and employees about topics concerning the amount of e-mail they deal with every day and the way they manage it. We also wanted to extract information in relation to the impression they had about the time their employees spend handling e-mails.

The organization began its course of action in 1992, providing educational seminars regarding tax and labor issues. The company entered the computer market in 1997, having today three main operational directions: software production, network implementation and business training. Main axes of activities of the company are:

- Application of its long-time knowledge in order to accomplish high technology IT products.
- High quality services, implementation, operation support and training for systems and computer programs.
- IT consulting, organization and implementation of financial, management and other corporation studies.
- Establishment of educational seminars and lectures for the training of business staff on financial and taxation issues.

Several issues had to be taken into account; concerning the volume of e-mails the company coped with on a regular basis and which were straightly connected with the functionality of the company. These topics deserve thorough investigation within an operational research framework because they have direct impact on the available working time of the organization employees and their working performance and productivity.

The present simulation study is an attempt to describe the system systematically, as a model, in order to determine and measure various functional characteristics such as the time needed for e-mail processing and closure and the time needed from the employees to process the e-mails regarding their field of expertise. Moreover, the simulation gives the opportunity to study hypothetical functioning scenarios and also to determine and analyze the crucial factors that affect mailbox management

3. METHODOLOGY

For the purposes of our simulation we chose SIMUL8® (http://www.simul8.com). This software package is used by the academic users mainstream (Hlupic, 2000) for its editing capabilities, the animated processes and the visualization of the results (Johansson, 2002). Moreover, where statistical analysis was needed and performed, we used the statistical package PASW® (http://www-01.ibm.com/software/analytics/spss/).

After presenting the characteristics of the organization and defining the problem, the study was conducted in phases, presented in the subsequent sections, regarding: the system description, the designing of the simulation model, the collection and

processing of the input data, the implementation of the simulation model and finally the analysis and interpretation of results.

In favor of simulation process correctness we conducted verification and validation of both model and results.

3.1. System Description

As already pointed out, the main objective of this simulation process is to identify the level of engagement of employees on e-mails and how that engagement can affect the organization. The paths an e-mail follows and the time consumed for its processing will be analyzed using internal information, retrieved by the company under study. By the term "company e-mails" we refer to the communication channels within the company, among customers and partners. The e-mails processed by the organization can be divided into two main categories: inbox and sent messages. The received e-mails include:

- customers' questions, i.e. queries on specific technical programming issues
- customers' requests on further functions for their software packages or the capability to extend them
- customers' suggestions to include new functions for future versions of logistic packages
- people's application forms for seminars participations.

As for outgoings mails, they include:

- company information directed to customers or vendors regarding the company seminars
- organization's promotion messages about its new software releases.

When an e-mail arrives in the company's inbox, it is classified in three major folders which are referred to as "Technical", "Business" and "Financial". Quite often employees promote an e-mail to other relative departments. They always save data about older, already processed messages as they desire to maintain the profile of each client. Finally, the failed-to-deliver e-mails are saved in a folder named "Error reports".

For the needs of the study we dealt with "Technical", "Business", "Finance", "Feedback", "New Editions", "Seminars" and "Error reports" company e-mail folders (Figure 3). E-mails for which their processing has been completed, are saved in specific folders, named "Closed", i.e. "Closed technical", "Closed business", "Closed finance" etc.

The information provided by the organization regarding an e-mail path is described as follows. The e-mail enters the inbox and waits in a queue to be categorized by the secretary. Afterwards, it is processed by the Directors' Department or is forwarded to other departments in order to reply to clients' requests. Finally, it is moved to one of the so-called "Closed" folders.

On the other hand, the procedure for outgoing e-mails unfolds as follows. The R&D department writes and sends e-mails about new software releases, while Business Trainers prepare and send e-mails about educational seminars. Most of the times, the company's staff tries to reply to customers as soon as possible (usually within a workday). If this is not possible, they prefer to communicate their reply by phone for faster service supply.

3.2. Model Building

For the reasons analyzed above, the system was divided into two separate independent subsystems. The first one refers to incoming messages while the second one to the Organization's outgoing mails. Each one was modeled with the Activity Cycle Diagrams (ACD), which represent the main entities and their mutual interactions. ACDs constitute a technique of modeling the interactions of system objects and are particularly useful for systems with a queuing structure, using only two symbols to describe the life cycle of the system's objects or entities (Paul, 1993). A green square illustrates the "active state" where collaboration of different classes of entities takes place and the red circle illustrates the "dead state" where an entity is waiting. Figure 1 illustrates the described schema:

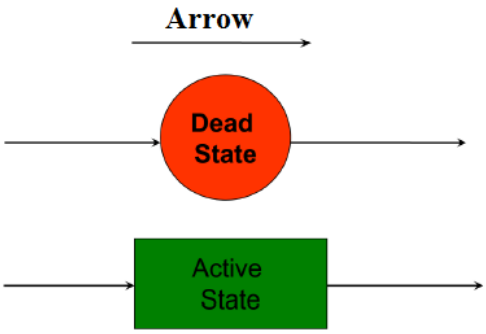

Figure 1: Symbols used in ACDs.

The procedures of arriving and sending e-mail systems are shown in the corresponding ACDs in Figure 2 where a number of abbreviations are used (see Table 1).

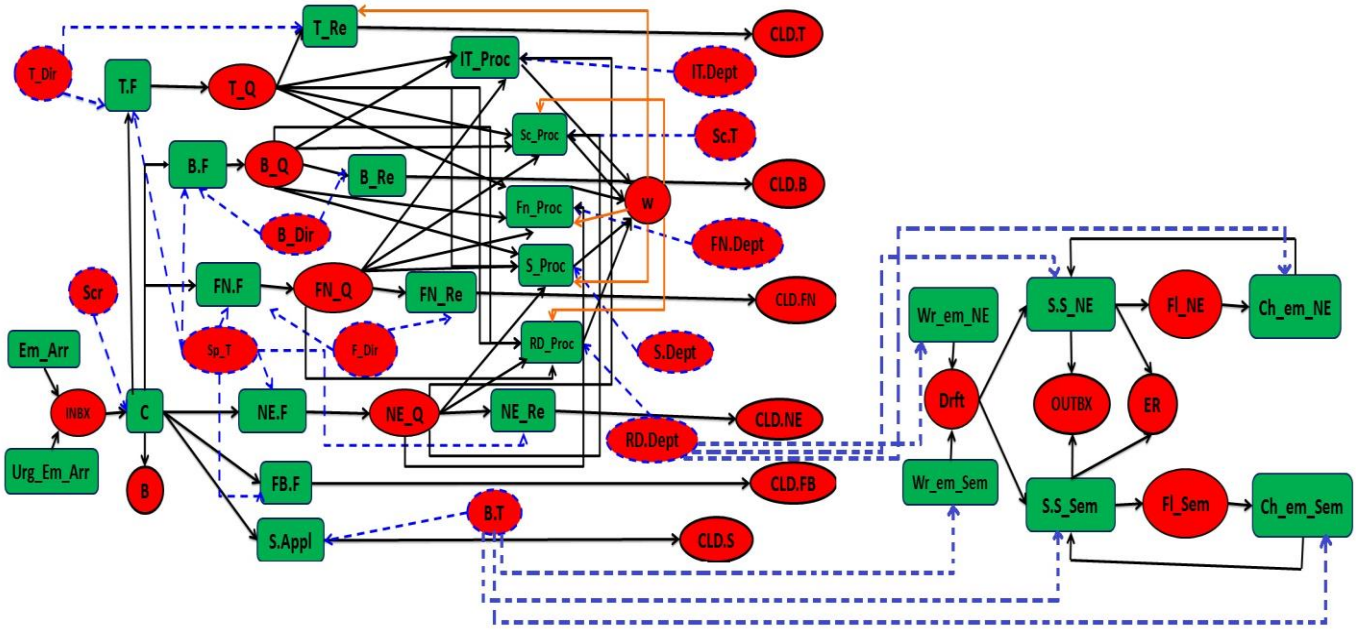

Figure 2: The activity cycle diagram of e-mail paths in the company

Table 1: System abbreviations

Em_Arr	**Urg_Em_Arr**	**C**	**T.F**	**B.F**	**FN.F**	**NE.F**	**FB.F**	**S.Appl**
E-mail Arrivals	Urgency Emails Arrivals	Categorization	Technical Files	Business Files	Finance Files	New Editions Files	Feedback Files	Seminars Applications
Sc_Proc	**Fn_Proc**	**S_Proc**	**RD_Proc**	**INBX**	**B**	**T_Q**	**B_Q**	**FN_Q**
Science Process	Financial Process	Sales Process	R&D Process	INBOX	Bin	Technical Queue	Business Queue	Finance Queue
CLD.FN	**CLD.NE**	**CLD.FB**	**CLD.S**	**Scr**	**T_Dir**	**B_Dir**	**F_Dir**	**B.T**
CLOSED Finance	CLOSED New Editions	CLOSED Feedback	CLOSED Seminars	Secretary	Technical Director	Business Director	Finance Director	Business Trainer
S.Dept	**RD.Dept**	**Wr_em_NE**	**Wr_em_Sem**	**Drft**	**OUTBX**	**S.S_NE**	**S.S_Sem**	**Fl_NE**
Sales Department	R&D Department	Write emails New Editions	Write emails Seminars	Draft e-mails	OUTBOX	Select-Send New Editions	Select-Send Seminars	Failed New Editions
T_Re	**B_Re**	**FN_Re**	**NE_Re**	**IT_Proc**	**NE_Q**	**w**	**CLD.T**	**CLD.B**
Technical Reply	Business Reply	Finance Reply	New Editons Reply	IT Process	New Editions Queue	waiting	CLOSED Technical	CLOSED Business
Sp_T	**IT.Dept**	**Sc.T**	**FN.Dept**	**Fl_Sem**	**ER**	**Ch_em_NE**	**Ch_em_Sem**	
Support Team	IT Department	Science Team	Financial Department	Failed Seminars	Error Reports	Check emails New Editions	Check e-mails Seminars	

As we can see from the systems' ACD, there are two entrances in the incoming e-mail subsystem: "E-mail arrivals" and "Urgent e-mail arrivals". Subsequently, the e-mails are categorized by the secretary and then processed by the department directors (technical, business and financial), by the support team and by the business trainers. If an e-mail needs further input or feedback, it is forwarded to the

residing department (IT, Sales, R&D, Financial or Science Team). Moreover, in this simulation model the e-mail moves to the corresponding "closed" folder.

Regarding the outgoing mail subsystem, we also have two system entrances. One entrance new releases and the other for upcoming seminars. The resources that are utilized by this system are the R&D Department employees and Business Trainers, who write the corresponding e-mails, select the receivers and finally send the e-mail In the case of successful delivering, the aforementioned e-mails are moved to the "outbox". Otherwise, if failure occurs, the responsible department undertakes the re-check of the e-mail header elements (i.e. receiver's e-mail address etc.) and resends the faulty e-mail. If the problem persists (i.e. e-mail address no longer exists or the incoming mail server of the receiver is not working), the e-mail ends up to the "Error reports" folder. This helps the company to be able to check faulty address entries and update them.

Each one of the resources follows specific shifts (specific hours in workdays and weekends) according to their work-loads, that can manage e-mails. Something that is always important to be mentioned is that there always is at least one employee to service a client's request in each category and we assume that urgency e-mails are first in queues while the others follow FIFO (first in first out) distribution. In storage bins certain capacity or minimum wait-time has not been defined.

3.3. Input Data

In order to collect input data regarding the arrivals and the processing of e-mails, one of the authors had continuous collaboration with the company and arranged several meetings and interviews with employees, according to the needs of the study. Our conversations focused on the quantity, quality and the type of e-mail data, trying to represent efficiently the e-mail flow. During these meetings, the operations of the company were explained and also the basic paths that an e-mail followed between clients and company staff, or among organization departments. Furthermore, a meeting with the company's CEO concerned the company's policies on the management of the e-mails, the replying procedure, the folders and sub folder used in their mailbox and their use.

Overall, we were able to obtain data from e-mails for a period of four months. As already mentioned, the accumulated data concerned especially the "technical", "financial", "business", "feedback", "New Releases" and "Seminars" folders of the company mailbox. In total, we counted 6,136 e-mails, while only 5,560 of them were processed and used for this study.

Each e-mail consists of three parts:

- Conversation ID: This is the id number that each e-mail receives once it is sent, either from a client or from an employee. That id remains the same as long as it is forwarded or replied.
- Time stamp: This declares the date and the accurate time that the e-mail entered the system, was replied or was forwarded to the organization's departments.
- Location: This is the folder where each e-mail registers, according to its subject-topic.

Some other points that should be taken into account are:

- The ordinary working timetable of the company is from 8:00 to 16:00 every day, 5 days per week (however sometimes it is overcome because of excessive work necessities).
- The e-mail address of the company is able to accept mails 24 hours per day.
- The company's most important target is to reduce the volume of e-mails. That is why they occasionally prefer to reply to senders via telephone.
- Urgent e-mails are replied in much less time than the common ones.

3.4. Simulation Model

The simulation model was formulated by the activity cycle diagram in Figure 2 and implemented with SIMUL8®.

In order to use the collected data for our simulation model, we analyzed and classified them respectively. The percentages of the concluded e-mail categories are shown in Figure 3.

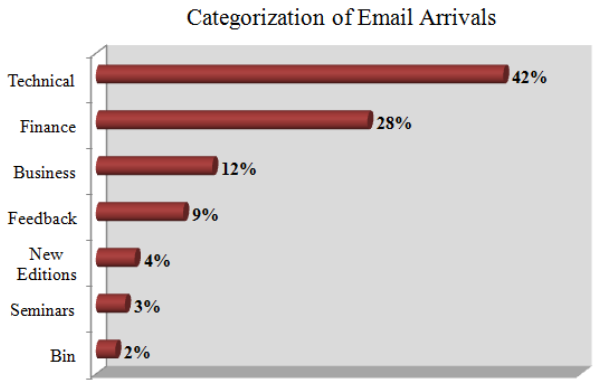

Figure 3: Main types of e-mails in the Organization mailbox (in %)

Once analyzed, the data were divided into four time intervals. Based on these intervals, the following time dependent distributions were defined:

- 8:01-12:00 (morning period with increased arrival rate)
- 12:01-16:00 (afternoon period with relatively lower arrival rate)
- 16:01-20:00 (evening period with significantly arrival rate)
- 20:01-8:00 (night with very slow arrival rate)

For the data classified in these intervals according to their time stamp, we estimated their arrival

distributions. Furthermore, we extensively studied the time it takes an e-mail to get answered.

4. RESULTS

The time-unit used in the system is the minute; the simulation model runs 24 hours per day and 7 days per week. 3 working days were defined as warm-up period. Moreover, the time period simulated is 4 months.

The simulation model ran 100 times in order to have average values for the model entities and consequently information about e-mail manipulation from the company. We were interested in observing the occupation of the company's working units in the direction of e-mail processing on one hand and the time needed for e-mails to be considered as "closed". These two aspects could show if managers have a realistic image of employee's utilizations from the e-mail processing point of view and additionally would give us a clear picture of the quality of service of the company, expressed in e-mail processing time.

According to the data provided by the company and used as input, the simulation gave information regarding the utilization of the directors and the support team as presented in Table 2. We can see that the utilization ranged from 63% to 71%,.

Table 2: Department Directors and Support Team Utilization

Model Resource	Utilization %
Technical Director	69.23
Business Director	62.98
Finance Director	66.06
Support Team	70.65

The results indicate that the utilization of the department directors and the support team although are not low, they are not aligned with the general impression that their available e-mail processing time is fully exploited and in some occasions it is insufficient. The utilization of each department staff is shown in Table 3 and the results were surprisingly low.

Table 3: Department employees Utilization

Model Resource	Utilization %
IT Department	11.52
Science Team	3.84
Financial Department	11.53
Sales Department	5.33
Business Trainer	14.63
R&D Department	6.77

According to the incoming mail flux information and according to the processing time for each e-mail in average, the department employees' utilization does not concord with the manager's perception. This outcome reveals how difficult it is for managers to have a complete and clean view of the operation times needed in the organization context. As for the e-mails to be declared as closed, the average time in the system did not exceeded one hour. We have to point out that the system resources are available to process e-mails as suggested from the company itself and the model simulation concerns strictly e-mail manipulation and does not take into account other jobs employees might have in hands. It would be much more realistic to have a broader view of the company's activities and the according information in order to be able to infer more reliable results. In this case the e-mails would have been taken into account as interrupts in the system.

4.1. Verification and validation of the model

The quality of a simulation model depends on the content, the process and the outcome of the simulation itself (Robinson, 2001). This can be achieved through validation and verification techniques for each modeling step and its results.

The verification and validation needed for every phase were conducted with several tests after each step. To make the evaluation easier, features of Simul8 were utilized, such as animation, step by step monitoring and debugging. Also, during the model development's phase, sub model testing was conducted with extreme condition tests. Finally, at the phases of simulation model and results, statistical techniques, consistency tests and extreme condition tests were applied, which were supported by the simulation software.

Additionally, the parameters affecting the performance of the model were examined. Sensitivity analysis was applied, that is the process of testing the significance of the data input parameters and their impact on the system. We set up two tests to evaluate the impact of the arrival rates to the number utilization rates and the average time in simulation of the categorized e-mails. The results are shown in Tables 4 and 5. In Test 1 we increased e-mail arrival rates while in Test 2 we decreased them. In Table 4 the "+" shows if the change in the arrival rates affects the time in system of the e-mails. The opposite is shown with the "-" symbol.

Table 4: Sensitivity analysis results measuring the time in simulation

	Impact on time in system	
Categorized e-mail	Test 1	Test 2
Closed technical	+	+
Closed business	+	+
Closed finance	+	+
Closed N_Releases	+	+
Closed seminars	+	+
Closed feedback	+	+

Table 5: Sensitivity analysis results measuring employee's utilization

	Standard results	Impact on employee utilization (%)	
Resource		**Test 1**	**Test 2**
Secretary	74.28	83.69	37.70
Technical Director	69.23	76.96	40.85
Business Director	62.98	70.94	33.26
Finance Director	66.06	73.80	37.23
Support Team	70.65	79.80	34.40
IT Department	11.52	12.29	8.49
Science Team	3.84	4.09	2.85
Financial Department	11.53	12.31	8.47
Sales Department	5.33	5.63	3.96
Business Trainer	14.63	15.75	11.99
RD Department	6.77	7.13	5.26

In both cases, Test 1 and 2, the time in system is significantly affected by the change in the arrival rates.

Validation has to do with the assessment of behavioral accuracy of the model (Balci, 2003). It is the technique that allows us to demonstrate that the simplified built model, behaves with satisfactory accuracy, consistent to the study objectives. Therefore the results of the simulation were compared with observations from the realistic environment of the company and were discussed with the staff and the manager. Also, the software provided the statistical analysis, i.e. confidence intervals needed for the validation of the model, so no further analysis was conducted.

5. SCENARIOS AND REGRESSION ANALYSIS

We conducted an experimental design in order to test hypothetical scenarios and their affect to some of the system's aspects. The organization interest and concern mainly regarded the average time an e-mail stayed in their inbox before being replied. We found interesting though, to investigate how the queues are affected when changes take place in the available e-mail processing working hours.

To achieve the aforementioned task, we divided each working day in 8 equal time slots, lasting one hour each. Afterwards, depending on the working hours of each resource for the e-mail processing activity, we designed and conducted 40 scenarios. The structure of the scenarios is indicatively shown in Table 6, only for one of the scenarios. Hence all scenarios are similar matrices which can also interpreted as working timesheets. The existence of "1" in a cell shows that the corresponding resource works at the specific time slot.

Table 6: Structure of conducted scenarios

Time slots	Secretary	Technical Dir.	Business Dir.	Finance Dir.	Support Team	IT Dep.	Science Team	Financial Dep.	Sales Dep.	Business Trainer	R&D Dep.
1. 8:00-9:00	1	1	1	1							
2. 9:00-10:00		1	1	1	1						
3. 10:00-11:00											
4. 11:00-12:00	1										
5. 12:00-13:00	1	1	1	1	1						
6. 13:00-14:00					1						
7. 14:00-15:00		1	1	1		1	1	1	1	1	1
8. 15:00-16:00											

Thereby, we were able to monitor the aspects of the system mentioned in the first paragraph of this section, namely the exits of the e-mails and their average time in the system, in relation to the conducted scenarios. In detail, we investigated dependency tendencies of: (a) the average remaining times in the system of the technical, business and finance e-mail categories and (b) the average queue sizes of the same categories, in relation to the working timesheets performing regression analysis. Our aim was to model the aforementioned relationships rather than to perform prediction. It is important to mention at this point that our variables were not normally distributed. So, in order to be able to perform a parametric method we transformed the variables using Blom's rank transformation (Blom, 1958). For our regression analysis, we used PASW® (SPSS) with the stepwise predictor selection method.

According to the regression results regarding the average remaining time in the system of technical e-mails, we had a significant model with $p<<0.005$, explaining the 44% of the variability of the dependent variable ($R^2=0.44$). All the independent variables selected were statistically significant. In this case we observed that the average remaining time is negatively affected (it increases) when the support team and the

business director work between 13:00 and 14:00 o'clock. For the average remaining time in the system of the business e-mails we had a statistically significant model explaining 59% of the variability of the dependent variable. In more detail, we observed that the average time decreases when the finance director works between 8:00-9:00 o'clock ($p<<0.001$), the support team between 10:00-11:00 o'clock ($p=0.001$) and the business director between 12:00-13:00 o'clock. On the other hand the occupation of the IT department between 8:00-9:00 o'clock seems to delay the remaining of business e-mails in the system.

Finally, regarding the category of finance e-mails and their average remaining time in the system we found a statistically significant model explaining 49% of the total variability of the dependent variable; that is the average remaining time, with three statistically significant independent factors. In this case we observed that the occupation of the finance director between 13:00-14:00 o'clock predisposes the increase of the average time of these e-mails in the system, while the occupation of the technical director and support team between 12:00:13:00 and 10:00-11:00 correspondingly seams to decrease the average remaining time in the system of finance e-mails.

As already mentioned we found also interesting to investigate the queue sizes of the technical, business and finance e-mail categories in relation to the conducted scenarios. In this direction ($R^2=0.824$, $p<0.001$) we observed an increase of the technical e-mails queue when the support team, finance director and finance department work between 11:00-12:00, 8:00-9:00 and 10:00-11:00 o'clock correspondingly. On the other hand the occupation of the finance director between 12:00-13:00 o'clock and of the IT department 8:00-9:00 o'clock seems to ease the queue load. Additionally, for the business queue average size we found a statistically significant model explaining 89% of the variability of the dependent variable. This model revealed that the business average queue size tends to increase when the finance director works between 11:00-12:00 o' clock and the secretary between 9:00-10:00 o'clock.

Finally, regarding the average size of the finance queue we came to the following results. The model ($p<0.001$) explained 84% of the total variability of the dependent variable with the subsequent remarks: the average size of the queue decreases when the finance director is occupied between 11:00-12:00 o'clock and 14:00-15:00 o' clock; the technical director is occupied between 13:00-14:00 o'clock, the support team between 9:00-10:00 o'clock and the secretary between 11:00-12:00 o'clock.

In general one can build numerous models with different dependent variables each time in order to obtain insight of how the structure of a timesheet affects the functional characteristics of an e-mail manipulation system.

6. DISCUSSION

Simulation provides low cost methods that allow us to gain detailed understanding of the processes of e-mail handling. Additionally, it allows the experimentation with scenarios that can benefit cost and time saving.

This simulation model which was built on a specific e-mail handling system of an IT company is an accurate depiction of the processes, based on necessary simplifications, which do not reduce the validity of the model and the exported information. Of course similar models can be constructed for any other company according to its needs and functionalities.

The experience gained by this research outlined a number of advantages of simulation in the e-mail management procedure. The IT organization was more than willing to assist this research which gave them the opportunity to perceive the nature of their complex system and study in organized manner its operational processes.

Overall we came to two main conclusions. The simulation model, which was based on historical data and information provided by the company, showed that the actual occupation of resources was divergent from the manager's impression. Secondly, with the assistance of linear regression analysis, we were able to explore several combinations of resources working hours (timesheets) and their impact in the queue sizes and average e-mail remaining times in system of the categories that mostly were in the interest of the company's manager.

These results are potentially very useful and should be carefully and methodically studied by the company manager taking into account other parameters which were not included in the present simulation model. These parameters can be financial, operational, even related to personal relationships. The comprehensive view of a system through the results of a model combined with the personal experience of a manager can lead to accurate and effective decision making of how to handle e-mails in a company.

Of course these models have limitations due to restrictions in the available information. However additional improvements could be achieved by creating and using a larger historical database in order to harvest more accurate data for the simulation.

Conclusively, this study can be seen as a first step to develop more sophisticated methodologies that can provide decisions concerning human resource time planning, in the direction of having efficient e-mail processing management.

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