AN EXPLORATORY ANALYSIS OF EMAIL PROCESSING STRATEGIES

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ABSTRACT

An indispensable mode of communication and information sharing in modern organizations is email. In particular, emails have been known to cause interruptions in the processing of knowledge workers' primary tasks, thereby increasing information overload. There is a penalty, in terms of extra reimmersion time, associated with every task that gets interrupted by email. So, how often should one process email? In this study, we have modeled and compared different ways in which this interruption effect of emails can be reduced. We use simulation to study the interruption effects on two different types of tasks (longer tasks and shorter tasks). Prior research has suggested that the best policy to respond to emails is every 45 minutes. Contrary to prior research, the findings of this study seem to suggest that, in most cases, knowledge worker performance could be improved by responding to emails 4 times in a given working day. Another major contribution of the paper is a contingency framework that prescribes a policy to use in responding to emails in various working environments so as to reduce the effect of interruptions caused by emails.

Keywords-Emails, interruptions, information overload, task analysis & simulation.

INTRODUCTION

Over the past few years, email has become the most prevalent mode of information exchange and sharing in modern business organizations. The prime reason for this immense popularity enjoyed by emails can be attributed to its asynchronous nature of communication that has many reported advantages over synchronous communication (telephonic communication, face-to-face meeting, etc). This excessive information-processing load due to emails is often termed as Email Overload and has been reported in many other studies [12] [13] [1] [7]. Recently, IDC reported that the number of email exchanges will be reaching 35 billion per day by 2005. These numbers highlight the growing importance of email as an indispensable mode of communicating and sharing information in today's organizations. This problem becomes even more aggravated when interruptions occur in an overloaded work environment. Email has become more of a habitat than an application where people spend much of their workday [3].It has been found that the normal tendency of a knowledge worker is to respond to an email as soon as it arrives. This often results in the interruption of a primary task. Jackson and colleagues [7] [8] [9] reported that a knowledge worker takes an average of 1 min and 44 seconds to react to a new email by activating the email application, with 70 percentiles taking less than 6 seconds and 85 percentiles taking less than 2 min. The time needed to switch from the current work medium to the email medium is often referred to as interruption lag [18]. Before resuming a task interrupted by emails, a knowledge worker spends some extra time due to reimmersion. The reimmersion or recovery time due to interruptions caused by emails is also referred to as resumption lag [18] or penalty. This penalty has been reported to be around 64 seconds for each interruption [7]. Due to the large number of emails arriving everyday, the cumulative interruption lag and resumption lag can become large and hence increase the non-value added time of a knowledge worker. This results in decreased efficiency of the knowledge worker. Overall, the disadvantage of responding to emails as soon as they arrive may become substantially large and cannot be ignored.

Very little research has focused on optimizing the combination of email completion times and the effect of interruptions on other tasks that a knowledge worker undertakes. Prior research has suggested that the best policy to reduce interruptions and overload due to emails is to respond every 45 minutes [7] [8] [9]. While their research provides useful insights, our belief is that the ideal email processing strategy will depend on the individual's work environment.

In this study, we investigate the validity and generalizability of results reported in prior relevant studies in order to find policies that might improve knowledge workers' performance measures including worker utilization & completion time for primary tasks as well as emails. Another objective of the study is to develop a heuristic chart that would help a knowledge worker to effectively handle email communication. The next section discusses prior work done in this area.

REVIEW OF RELEVENT LITERATURE

The phenomenon of information overload occurs when the requirements for timely processing of information exceeds the limited information processing capacity of a knowledge worker [4] [17]. Interruptions are often considered to be a contributor to information overload [15]. Many researchers from various disciplines have defined interruptions in different ways. The distraction theory offers a rather precise and technical definition of interruption by defining it as "an externally generated, randomly occurring, discrete event that breaks continuity of cognitive focus on a primary task"[2]. This definition suggests that discrete event simulation could potentially serve as a useful tool in modeling the interruptions as discrete events. Although research work on interruptions exists in other disciplines such as human-computer interaction (HCI) [14], management, and cognitive psychology, it is still an under researched area in the MS/OR discipline.

Jackson, et al. [7] [8] [9] conducted a few studies to understand the role of emails as interrupts in organizations. These studies suggested that emails should be processed every 45 minutes. By controlling the time frame during which interruptions are allowed to occur, the frequency of interruptions can be controlled. This leads us to believe that scheduling the hours during which emails are processed can further reduce the interruption effects of emails. Further, the Jackson study did not consider the content complexity of the primary task. Although Speier et al. [16] [17] studied the effects of interruptions when primary task had different levels of content complexities, their work did not focus on the policies that should be used to handle interruptions like emails. It was found that interruptions improved decision-making performance on simple tasks but undermined performance on complex decision tasks. Our review of more recent literature has shown that very few studies have focused on scheduling email communication. In order to reduce interruptions and information overload based on the above discussion, it seems that it is important to investigate email interruptions in simple and complex tasks. Although limiting in some sense, we parenthetically define simple tasks as those requiring less time to complete and complex tasks as those requiring more time to complete. The following section describes the research question that we investigated and the research model developed.

RESEARCH QUESTION AND MODEL DEVELOPMENT

Little research has been done to analyze the performance of a knowledge worker when both simple and complex tasks are present, simultaneously. Controlling the time frame during which interruptions are processed allows for better attention allocation. Also, according to Single-Resource theory [10], diverting resources to a secondary task (emails) frequently may decrease the performance on the primary task. This theory suggests that we split the total information processing hours per day into two categories for better allocation of a knowledge worker's attention: one, during which emails are given highest priority (email hours) and other, during which primary tasks are given highest priority (non-email hours). Thus, by segregating the time during which interrupts and interrupted tasks are processed, we can control the number of interruptions as well as the timeframe during which interruptions are allowed to occur. By adjusting the length as well as the frequency of these email hour slots, we suggest that the number of interruptions can be effectively reduced without adversely affecting the performance on primary tasks. If the emails are processed every 45 minutes according to the policy proposed by Jackson and colleagues [9], then we will end up with 8 slots of email hours for a total length of 3 hours during which emails have highest priority. In order to verify the suggestions of prior studies and to gain deeper understanding, the research question that we would explore in this study is as follows:

Is Jackson's policy (checking email every 45 minutes) the best policy for responding to emails?

Further, Jackson' work does not provide a comprehensive assessment of knowledge workers' overall effectiveness. To develop a better understanding of the impact of email interruptions on a knowledge worker's information processing effectiveness, we have to incorporate more performance measures. In this study, we have developed a new research model (described in figure 1), and extended our focus to four different performance measures. Measures used in the study include (1) percent increase in knowledge worker utilization, (2) completion time for simple tasks, (3) completion time for complex tasks, and (4) completion time for emails.

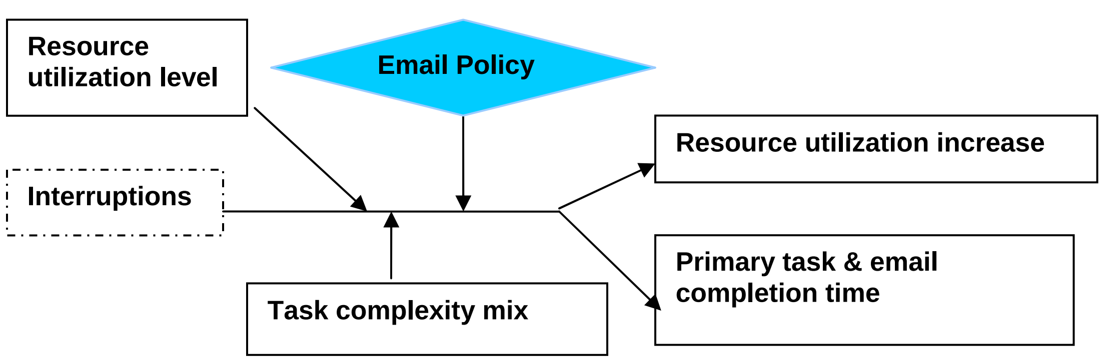

Figure 1. Research Model

Utilization is a widely used measure of overload and is defined as the probability of the operator being in a busy state [6]. We have used utilization as a measure of knowledge worker's Information Overload in this study. Resource utilization level is an indication of utilization of knowledge worker in the absence of interruptions.

Policy description

To describe the policies being compared, a discrete time frame of 3 hours is divided into fixed length intervals called time-slots. All the policies had the same total duration of email hours but differed in the number of email hour slots.

Policy type	Email hours	Notation	# of Email hour slots
Schedule	8 am to 9:30 am 3:30 pm to 5:00 pm	C2	2
Schedule	8 am to 8:45 am, 11am to 11:45am, 1 pm to 1:45 pm, 4:15 pm to 5:00 pm	C4	4
Schedule	Every 45 min	J (Jackson) or C8	8
Flow	As soon as they arrive	C	Not Applicable

Table 1 Policy table

Scenario description

Four different scenarios were studied in order to better understand the change in the performance of each policy under different work conditions. The combination of two levels of resource utilization and two levels of task complexity mix resulted in 4 different scenarios (Table 2). The levels of task complexity mix were operationalized by varying the proportion of time spent on processing complex tasks.

Scenario		Scenario Notation
Task Complexity mix	**Resource Utilization level**	
Less S, More C	Low	LS-L
More S, Less C	Low	MS-L
Less S, More C	High	LS-H
More S, Less C	High	MS-H

Table 2: Scenario table

Model implementation

Simulation models were developed using Arena 7.0 simulation software [11]. We modeled each policy type and scenario type using different parameters (please contact the authors for details about the parameters chosen). All task types followed an exponential inter-arrival distribution. 16 simulations were run for the duration of 500 days having a warm up time of 10 days. The warm-up time was determined externally by analyzing the data using Welch's method [19]. Each simulation model was run for 20 independent replications. Data was collected for all four performance measures in evaluating the four different processing policies.

STATISTICAL ANALYSIS

MANOVA was used to analyze the data collected in two different ways. First, it was used to provide an answer to the research question. Second, it was used to find mean differences among policies for each scenario so that policy ranking could be achieved. This was a necessary step to develop a heuristic chart for email response processing. Post-hoc analysis was done for all 4 scenarios and results were analyzed independently.

RESULTS & DISCUSSION

C2 and C4 were found to work relatively better than Jackson policy in all scenarios. This is in contrast with what has been proposed in earlier research. The effect of policy on completion time of simple and complex tasks across different levels of task complexity mix and resource utilization levels revealed that C4 performed better than Jackson's policy because the completion time for simple and complex tasks was relatively higher under Jackson's policy. The percentage increase in knowledge worker utilization was found to hit a minimum value under C4. This again was not consistent with earlier findings which suggest that email processing strategy as proposed by Jackson is the best policy. As expected, flow policy was found to be best for email completion time performance measure, followed by Jackson's policy.

Four separate MANOVAs were run and post-hoc analysis was done in order to identify the policy rankings for each scenario. These results and rankings have been summarized in Table 3. A detailed result and discussion section is available in a working paper [5].

Scenario	**Rank**	**Performance Measures**			
		Increase in Worker utilization	**Mean Completion time of Simple task**	**Mean Completion time of Complex task**	**Mean Completion time of email**
LS-L	**1 (Best)**	**C4**	**C2, C4, J**	**C4**	**C**
	2	C2	C	J	J
	3	J		C2	C4
	4	C		C	C2
MS-L	**1 (Best)**	**C4**	**C4**	**C4**	**C**
	2	C2	J	J	J
	3	J	C2	C	C4
	4	C	C	C2	C2
LS-H	1 **(Best)**	**C2, C4**	**C2, C4, J**	**C2, C4**	**C, C4**
	2	J	C	J	C2
	3	C		C	J
MS-H	**1 (Best)**	**C2, C4**	**C2, C4, J**	**C4**	**C**
	2	J	C	J	C4
	3	C		C2, C	J
					C2

Table 3: Heuristic chart for policies and scenarios

CONCLUSION

Simulation served as a useful tool for generating the data needed for our statistical analysis. We evaluated the validity of results of prior relevant research and proposed a heuristic chart to aid a knowledge worker better manage his or her email processing. Contrary to prior research, we found that rather than checking emails every 45 minutes [8] [9], the better policy is perhaps to process emails 4 times per day. This study has particularly important significance for those organizations where email is used extensively for business communication, such as contact centers, geographically dispersed organizations, virtual teams, and various other service industries.

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