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Impact of interruptions in white collar working environment

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Department:

IMPACT OF INTERRUPTIONS IN WHITE COLLAR WORKING ENVIRONMENT

by

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ABSTRACT

An interruption is a randomly occurring, discrete event that breaks continuity of cognitive focuses on a primary task and typically requires immediate attention and insists on action. "White collar interruptions" are those that affect knowledge workers in professional, managerial, or administrative positions. Interruptions are often a common occurrence in the white collar workplace.

The aim of this thesis is to investigate the effect of timing of an interruption on the overall performance of white collar workers. This study also analyzes the interruption sources (i.e. externally and internally generated) along with effect of different types of interruptions on both demanding and non-demanding tasks. The data analyzed comes from time logs of daily work activities in white collar jobs and surveys. A total of 21 subjects participated in this study. The participants in the study vary in years of work experience, location, and occupation. Findings show that interruptions have a negative impact on the performance of the worker when they occur at the middle or end of the current/primary task. In addition results show that at although most of the interruptions were externally generated, internally generated interruptions were also common (around 22% of the total interruptions). The results show that most of demanding tasks that were interrupted had a negative impact on the overall performance. Suggestions for reducing the impact of white collar interruptions are also discussed.

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1. INTRODUCTION

1.1. INTERRUPTION

Interruption, is defined as

- the action of interrupting or being interrupted
- an act, utterance, or period that interrupts someone or something *(Oxford Dictionary)*

This is the definition that most people think of when they think about interruption. Cooper et. al (1993) defined interruptions as "any disturbance to the normal functioning of a process in a system and typically the cause of such disturbances is an unexpected communication event". Baddeley (1990) defined interruption as "any interference with working memory". According to Baddeley (1990), interference may be overcome by the contextual and temporal knowledge in long-term memory, reinstating the pre-interruption contents of working memory. The interruption will be disruptive when long term memory cannot provide the proper contextual or temporal information.

Corragio (1990) gave another definition of interruption that is more appropriate and related to knowledge workers. According to him, an interruption is "externally-generated, randomly occurring, discrete event that breaks continuity of cognitive focus on a primary task". An interruption typically "requires immediate attention" and "insists on action" (Covey 1989, pp. 150-152). In addition, an interruption breaks a person's attention on a primary task and forces him or her to turn his or her attention toward the interruption, if only temporarily. A primary task is the current task, which the knowledge worker is doing.

From the above definitions one can say that Corragio (1990) considered external source as a requirement to generate interruptions and that the timing of interruption cannot be controlled. Another important characteristic of interruption is that they are discrete and have a clear start and end. In summary the definition of interruption by Corragio (1990) and Covey (1989) the main characteristics of interruptions are they are discrete, externally generated, and require immediate action. This distinguishes interruptions from distractions, which may inhibit but not break worker concentration. Distracting conditions might be in the form of background noise or commotion that is part of the work environment

Other literature has shown that the source of interruptions can be either external or internal. Internal interruptions is described as mind wandering, spontaneous cognitive events, daydreams, stimulus-independent thought, and intrusive thought by past researchers (Antrobus, Singer and Greenberg, 1966; Gold and Reilly, 1985-1986; Klinger, 1977; Klos and Singer, 1981).

Spira J. et al (2005) divided interruptions into two types based on the source of interruptions. First type is active interruptions and other is passive interruptions. Active interruptions are initiated by the individual who chooses to be interrupted while passive interruptions are those which come from others and arrive via email, telephone, text message to name a few.

Fisher (1998) related internal interruptions with job satisfaction. According to her, internal interruptions from non-task related thoughts are associated with boredom and people who are portrayed as thinking about non-work concerns at work are seen as more

bored and less satisfied, especially when they think about these concerns frequently and when the concerns seem non-urgent.

This thesis will analyze the source of interruptions. We will be investigating the impact of interruption source on the overall performance of white collar workers. We will also analyze the amount and main causes of interruptions generated internally and externally.

Other than source, we will also be analyzing the impact of timing of interruption on overall performance of the white collar worker. We will analyze the effect of interruption at beginning, middle, and end of primary task. The impact of interruptions on demanding and non-demanding tasks will also be analyzed.

For the purpose of this thesis we define interruptions as "any discrete invent having either an external or internal source which diverts attention from primary task and which affects the knowledge worker mostly negatively but may have a positive effect under some circumstances". Interruptions affecting the white collar workers/knowledge workers are white collar interruptions.

1.2. WHITE COLLAR WORKERS/KNOWLEDGE WORKERS

There are number of definitions of white collar workers or knowledge workers. Some of the definitions of white collar workers available online are as follows

- Relating to people who work in offices, doing work that needs mental rather than physical effort (Cambridge online dictionary).
- Refers to employees whose job entails, largely or entirely, mental or clerical work, such as in an office. The term white collar work used to characterize non

manual workers, but now it refers to employees or professionals whose work is knowledge intensive, non-routine, and unstructured (Business dictionary).

Corragio (1990) summarizes very well and defines white collar workers/knowledge workers as those who,

- perform primarily mental and/or abstract tasks;
- focus primarily on information processing;
- use both internal and external knowledge bases;
- work on non-repetitive task;
- possess a relatively high level of formal education

Some of the examples of white collar/ knowledge workers are financial analysts, accountants, design engineers, consultants, software developers, specialized technicians, intellectuals, managers, and administrators.

1.3. MOTIVATION

White collar interruptions are an important issue in today's fast paced and technologically enhanced working environment. Todays working environment in highly demanding, competitive with high cognitive work load. White collar workers are required to multitask very often, this makes them susceptible to interruptions which affects not only their performance but also causes mental stress and effects their emotional state. White collar interruptions not only affect the workers but also the companies. It causes a significant economic loss to companies, as there is loss of productivity and decrease in quality of work due to interruptions.

Of the total workforce available in USA about 40% of them are white collar workers. A study by Basex found office distractions take up to 2.1 hours of the average day (28%) with workers taking an average of five minutes to recover from each interruption and return to their original tasks. Basex calculated the cost of interruptions in lost working hours to U.S. business is $588 billion a year.

In 2007, a group of Microsoft workers took, on average, 15 minutes to return to serious mental tasks, such as writing reports or computer code, after dealing with incoming email. They wandered off to reply to other messages or browse the Web. (*New York Times, 3/25/2007)*

Findings from the research done by TNS show that the economic downturn is putting pressure on American workers, as they:

- Required to do more work with fewer resources, 48%
- Doing the work of two people because of recession, 39%
- Difficulty taking time off from work, 47%
- Feel the need to stay connected 24/7, 30%

(TNS Research, March 2010, for InterCall)

The above facts show that interruptions in white collar working environment are harmful and a serious issue which needs attention.

2. LITERATURE REVIEW

2.1. THEORIES BEHIND MULTITASKING AND INTERRUPTION

There are number of theories that explain the concept of interruption and multitasking. In this chapter a brief overview of the concepts and theories behind interruptions is given.

2.1.1. Solingen's Theory of Interruptions. As discussed in the above chapter interruption is defined as any event or distraction that causes a person to stop his or her primary task or planned activity and respond to it. Solingen et. al. (1998) further divided interruption into three phases:

1. Occurrence: An interrupt occurrence makes a person stop his or her planned activities. For e.g. the telephone rings, an important e-mail arrives, or a manager pays a visit.
2. Handling: The knowledge worker handles the interrupt, which implies that he or she works on the interrupt until the initiator is satisfied with the result. Workers usually handle interrupts immediately after they occur, but can sometimes postpone handling them until later.
3. Recovery: The developer resumes his or her planned activities. Developers must spend some time returning to the point in their work at which they were interrupted. We refer to this as recovery time. Although this time is spent on planned activities, it is an immediate interrupt effect.

2.1.2. Multiple Resource Theory. Another theory that explains more about multitasking is Multiple Resource Theory. This theory proposes that the human operators have different pools of resources for information processing that can be used simultaneously (Wickens, 1984).

According to Wickens' multiple resource theory there is a decrease in performance of the worker if there a shortage of these different resources and it also says that humans have a limited capability for processing information. Cognitive resources are limited and a supply and demand problem occurs when the individual performs two or more tasks that require a single resource. Therefore, when there is heavy workload on a worker caused by a task using the same resource, it can cause problems and result in errors or slower task performance.

2.1.3. Attention Models. In this age of information technology and computer, industries have started paying attention to individuals most important output, time and attention (Adamsczyk et al., 2004). Interruption depends on how we switch attention between two tasks.

2.1.3.1. Selective attention theory. According to Kahneman (1973*) attention* is a process of applying oneself to some task or activity. Selective attention implies that "organisms selectively attend to some stimuli or aspects of stimulation, in preference to others". Selective attention theory suggest that individuals have a tendency to orient themselves toward, or process information from only one part of the environment with

the exclusion of other parts. For example you are chatting to people in a group, then you choose a particular individual you are interested in listening and concentrate on him while ignoring the others.

2.1.3.2. Capacity model. Kahneman's Capacity Model talks about the general limit on a person's capacity to perform mental work due to the restricted number of cognitive resources available. When two stimuli are presented at once, people perceive only one of them at a time and ignore the other. If both are perceived, the responses to them are usually made in succession rather than simultaneously (Kahneman, 1973, p. 5).

2.1.3.3. Zeigarnik effect. According to this effect, details of secondary tasks are often better recalled than the details of the primary task (Zijlstra, 2001). According to "Zeigarnik Effect" memory releases information concerning the task when it is completed, and interrupting ongoing tasks can create confusion in the storage system (Zijlstra, 2001).

2.1.3.4. Goal-activation model. Spiekermann et al. (2008) have summarized this model. According to Altman and Trafton (2002), to govern behavior, a new (or interrupting) goal must be repeatedly sampled or strengthened, a process that rapidly builds up base-level activation above that of other goals to overcome proactive interference. This base-level activation decreases once the goal is selected until eventually it dips below that of newer, more active goals. Subsequent retrieval of this goal is then aided by a process of priming. Cues in the mental or physical context boost associative activation of that goal, making it more active than other competing distracters. So to summarize in brief, an interruption suspends the primary goals, and obliges the user

to remember, or encode the primary goals. To be able to continue working on the suspended primary task after completion of the interruption task, its goals must be retrieved and activated. Rehearsal of goals may facilitate goal activation and retrieval.

PAPER

I. IMPACT OF INTERRUPTIONS IN WHITE COLLAR ENVIRONMENT

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Abstract

An interruption is a randomly occurring, discrete event that breaks continuity of cognitive focuses on a primary task and typically requires immediate attention and insists on action. "White collar interruptions" are interruptions that affect knowledge workers in professional, managerial, or administrative positions. Interruptions are often a common occurrence in the white collar workplace.

The aim of this paper is to investigate the effect of timing of an interruption on the overall performance of white collar workers. This study also analyzes the interruption sources (i.e. externally and internally generated) along with effect of different types of interruptions on both demanding and non-demanding tasks. The data analyzed comes from time logs of daily work activities in white collar jobs and surveys. A total of 21 subjects participated in this study. The participants in the study vary in years of work experience, location, and occupation. Findings show that interruptions have a negative impact on the performance of the worker when they occur at the middle or end of the

current/primary task. In addition results show that at although most of the interruptions were externally generated, internally generated interruptions were also common (around 22% of the total interruptions). The results show that most of demanding tasks that were interrupted had a negative impact on the overall performance. Suggestions for reducing the impact of white collar interruptions are also discussed.

Keywords: White Collar Workers, Interruptions, Human Factors

1. INTRODUCTION

1.1. MOTIVATION

Since the recent recession began, more and more companies are laying off and restructuring their employees in an effort to cut costs and increase profits. This has increased workload on white collar workers and they are constantly required to multitask. In such an environment with growing demand where workers have to step up and do more with less, workforce considers technology and tools as means to be more productive. On one hand, these tools and technologies are useful in increasing productivity and the capacity to multitask, at the same time these tools can cause interruptions that prevent workers from concentrating on their task and affects the quality of work (Bailey 2001, Hudson 2002).

An interruption is "an externally generated, randomly occurring, discrete event that breaks continuity of cognitive focuses on a primary task" and typically "requires immediate attention" and "insists on action" (Corragio 1990). White collar interruptions are interruptions that affect the employees performing knowledge work, such as those in professional, managerial, or administrative positions

U.S. office workers are interrupted on the job as often as 11 times an hour (González 2005), costing as much as $588 billion to U.S. business each year, according to research (Spira 2005). These statistics show how interruptions can be harmful and may cause huge loss economically to the company and mentally to the knowledge workers.

White collar workers are not only faced by interruptions through tools and technologies used for multitasking and increasing their productivity. Some other important forms of interruption are being interrupted by a colleague or self-interruption.

Previous work done in the field of interruptions affecting white collar workers focuses mainly on the effects of interruptions on performance of worker and how they can be minimized taking into consideration mostly the interruptions caused by use of technology and tools like emails, instant messaging, and phone calls. However, in the study we found that interruptions caused by other person and self-interruptions are a major portion of interruptions faced by white collar workers. This paper considers the interruptions caused by other person and self-interruptions in addition to other commonly researched interruptions while analyzing their impact on the performance of white collar workers. This paper also analyzes the source of interruption (i.e. externally or internally generated) and its impact on overall performance of white collar workers. This study also investigates the impact of interruptions on demanding and non-demanding tasks.

1.2. RELATED WORK

Most of the previous work related to interruptions suggests that most of the interruptions have negative effect on the performance of the workers (Burmistrov 1997, Perlow 1999). Interruptions also cause significant time loss especially in white collar working environments. It not only decreases performance and efficiency but also causes stress and mental load to the knowledge workers.

Interruptions although affect negatively most of the times but studies suggest that interruptions can sometimes also have a positive effect (O'Connail 1995). Studies suggest that interruptions can have positive effect in case of simple tasks giving a much needed break from monotonous task and starting again fresh (Speier 1997, Speier 1999).

Research has also been done on forms and types of interruptions affecting the white collar workers. Most common forms of interruptions affecting them are emails,

instant messaging, telephone calls, and interrupted by other person/colleague (Shamsi 2007).

Researchers have also investigated on minimizing the effects of interruptions and have suggested various tools to control interruptions. Some suggest delaying the receipt of information to avoid interruptions (Horvitz 2005). Providing with external cues to reduce the time of resumption of primary task after interruption is also another way of dealing with interruptions (Altmann 2004).

1.3. PURPOSE OF THE STUDY

The main purpose of this study is to analyze the effect of interruptions on white collar workers. Although many studies have been done to study the effect of interruptions on performance of knowledge workers most of them have been done in artificial setting (Adamczyk 2004, Eyrolle 1999, Schiffman 1992, Cutrell 2001). Some have been done in natural setting by using shadowing and observational techniques but in these techniques the workers themselves did not maintain a log, the researcher analyzed based on his observations (González 2005). In this study, the knowledge workers themselves maintained a log of their daily activities and interruptions, as they feel appropriate.

Another purpose of this research is to analyze the source of interruption. To investigate the percentage of interruptions generated externally and internally. Externally generated interruption are those generated by some external source like the phone call, email pop ups, etc. Internally generated are those generated by the worker himself or herself for example if the knowledge worker remembers something important in middle of a task then that is an internally generated interruption.

The effects of interruptions on demanding and non-demanding tasks are also studied. Based on mental load and concentration required the workers decided the demand or difficulty of task.

In addition, another important aspect of this study is to analyze the effect of timing of interruptions on the performance of the knowledge worker. Some of the researchers suggest that interruptions are least harmful when it affects in early stages of the primary task (Czerwinski 2000) while others suggest the opposite that interrupting user in early stages of tasks is harmful (Cutrell 2001, Gievska 2005). Some suggest that interruptions are harmful when a user is in middle of the task (Bailey 2000).Different types and number of interruptions faced by knowledge workers is also studied.

2. METHODOLOGY

Twenty-one participants of whom ten were females participated in our study. All participants were white collar workers of varying job types, backgrounds and locations. The participants' ages ranged from 23-50 years of age. Their roles and responsibilities also varied, some were managers, design engineers and others were administrators.

Subjects were from various cultural backgrounds, of the twenty participants fourteen were from United States while remaining seven from India. Talking more about their working environment ten participants were from academic settings. The academic participants worked in support departments and were not faculty members. The remaining eleven were from industrial organizations.

In this research, we use a survey and time log to collect the necessary information from participants. First, the participants read the cover letter and then we explain the experiment to them with help of a sample time log (Appendix A). The participants then signed a consent form and completed a survey (Appendix B and C). Then they maintained a time log of their daily activities for one complete day.

At first the workers were asked to maintain a time log for two days but after collecting data from first few subjects it was seen that the data of second day was not recorded as precisely as first day and most of the tasks were very similar to the first day. In addition, most of the workers were neither keen nor enthusiastic on maintaining the log for two days due to their busy schedule. Therefore, we use a time log for one day in this study.

Survey:

The survey consisted of two sections. The first section consisted of general information about the knowledge worker. The second section contained questions regarding interruptions, how aware they were about it and how it affected them in their daily work life. The survey consisted of 10 questions including both sections. The participants completed the survey before starting the time log to know their awareness about interruptions and it effects in general.

Time Log:

A time log (Appendix A) of daily activities helped us collect data about interruptions affecting the knowledge workers. The participants were required to maintain a time log of their daily activities for one complete day. The time log consisted of various columns starting with time and then current task, which the participants were required to categorize as demanding or non-demanding. The next column required the participants to categorize their current task as interruption or not. The following columns were about the type, timing, and effect of interruption. The participant could choose from the types of interruption provided like audio, visual, other person or list another type. Next column consisted of the timing of interruptions (Start or middle or end of the task). In the last column, participants chose the effect of interruption from the options provided such as positive, slightly positive, negative, slightly negative, and no effect.

2.1. WHY TIME LOG AND SURVEY

Although in previous studies very few empirical research methodologies are used, they are useful and effective in some research settings (Czerwinski 2004). Methods such as use of an experimental setup and other empirical methods like shadowing, observation,

videotaping have been used successfully in most of the studies (González 2005). We chose time log and a survey over other options for number of reasons. Firstly, the participant directly reports it and hence the chances were less of data being bias by an observer's perspective or presence. Secondly, the study takes place in their natural office surrounding rather than an artificial setting in research lab. We cannot create exact office settings in a lab, as we are not aware of the interruptions that may affect the knowledge worker in natural office setting. Also in artificial setting researcher controls the interruptions, their occurrences, and timings.

Shadowing and observation are also very effective methods for empirical study but they come with their disadvantages. They are expensive, labor-intensive, and difficult as well as time consuming (Holmes 2007). The presence of an observer may also affect the knowledge worker and it may make the person uncomfortable. Also not all participants are willing to share details of their work especially due to confidentiality issues.

Maintaining a time log also has its disadvantages like the data is not rich and detailed as shadowing or observation and maintaining a time log in itself may be an interruption. Despite these problems we thought that time log would give us useful and relevant data about interruptions in their natural work environment and would consider perception of the knowledge workers apart from other advantages mentioned above.

3. RESULTS AND ANALYSIS

3.1. RESULTS OVERVIEW

Most of the subjects reported around twenty tasks on average while maintaining their time log. Exhibit 1 is an example of a completed time log. The subjects also completed a survey along with the time log (Appendix A and C). Based on the results we will be analyzing various issues related to interruptions such as effect of timing of interruption on performance of the worker, different sources of interruptions, effect of interruptions on demanding and non-demanding tasks, types of interruptions faced by white collar workers.

Exhibit 1. Sample of a Completed Time Log

Task No	Time	Current Task	Demading or Not	Interruption Or Not	Interruption Type	Source of Interruption	Timing of Interruption	Effect
1	9.00 AM	Organizing Office	ND	Y	P	E	B	NO
2	9.20 AM	Checking Email	ND	N				
3	10.00AM	Paperwork	ND	N				
4	10.30 AM	Apt. with Student	ND	N				
5	11.05 AM	Paperwork	ND					
6	11.30 AM	Lunch	ND	N				
7	12:00PM	Scholarship Interview WriteUp	D	Y	S	I	M	P
8	12.40 PM	Prepare Presentation	D	Y	S	I	M	P
9	1.00 PM	Move Furniture/ Supplies to new location	ND	Y	P	E	M	NO
10	2.00 PM	Respond to emails	D	Y	P	E	M	SN
11	2.45 PM	Change onto dress uniform	D	N				
12	3.00 PM	Ensure staff prepared for commanders call	D	Y	P	E	M	NO
13	3.15 PM	Walk to Havener	ND	N				
14	3.30 PM	Give presentation	D	Y	P	E	B	NO
15	4.10 PM	Return to office	ND	N				
16	4.20 PM	Prepare for class	ND	Y	V	E	M	NO
17	4 .50 PM	Pick up pizza/soda for class	ND	N				
18	5.00 PM	Seeds of success	ND	N				
19	5.20 PM	Class dismissed/cleanup/done	ND	Y	P	E	E	SP

3.2. DATA ANALYSIS

3.2.1. Number of Interruptions. The 21 subjects recorded 145 interruptions in total. On average there are seven interruptions for each individual with a standard deviation of two. Previous research has shown that, an average US office worker faced around eleven interruptions per hour (Basex 2006). The reason behind the low number of interruptions reported in this study may be difficulty in maintaining a detailed time log of daily activities. In addition, the time logs were not consistent as some time logs gave a good and detailed overview of daily tasks and interruptions while some were very brief. Another reason for less number of interruptions may the small sample size used for this study or a tendency to not record very brief interruptions. Exhibits 2 and 3 show the number of tasks and interruptions faced and calculations for average interruptions respectively.

Exhibit 2. Number of Tasks and Interruptions

Subject No.	Number of Tasks	Number of Interruptions	Number of Non-Demanding (ND) Tasks (%)	Non-demanding Tasks Interrupted	Number of Demanding (D) Tasks (%)	Demanding Tasks Interrupted
1	19	9	13 (68%)	4	6 (32%)	5
2	16	9	13 (81%)	8	3 (19%)	1
3	24	9	16 (67%)	7	8 (33%)	2
4	29	9	26 (90%)	8	3 (10%)	1
5	15	9	11 (73%)	7	4 (27%)	2
6	20	8	12 (60%)	2	8 (40%)	6
7	19	8	11 (58%)	4	8 (42%)	4
8	25	10	9 (36%)	1	16 (64%)	9
9	19	5	6 (32%)	2	13 (68%)	3
10	22	8	2 (9%)	0	20 (91%)	8
11	21	7	6 (29%)	1	15 (71%)	6
12	20	6	8 (40%)	2	12 (60%)	4
13	21	7	7 (33%)	2	14 (67%)	5
14	22	7	8 (36%)	3	14 (64%)	4
15	19	6	3 (16%)	0	16 (84%)	6
16	20	4	3 (15%)	1	17 (85%)	3
17	19	6	7 (37%)	3	12 (63%)	2
18	19	5	4 (21%)	1	15 (79%)	4
19	18	6	4 (22%)	0	14 (78%)	6
20	18	3	3 (17%)	0	15 (83%)	3
21	17	4	2 (12%)	0	15 (88%)	4

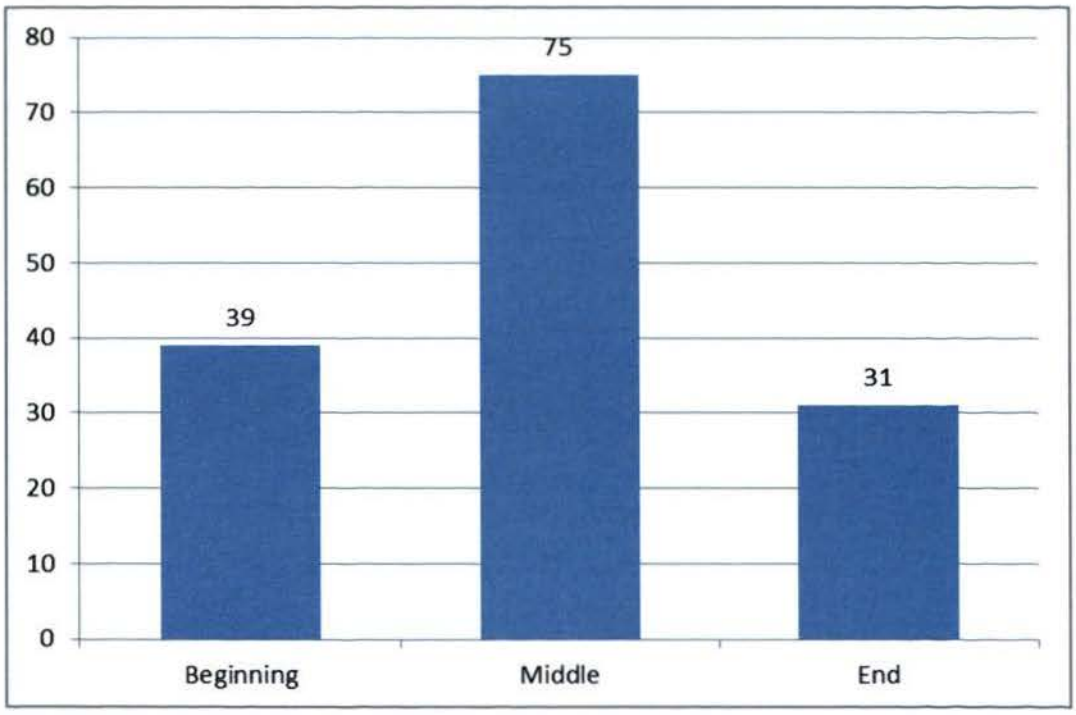
Exhibit 3. Average Interruptions

Skewness	-0.33
Mean	6.90
Std Dev	1.97
Median	7
Mode	9
Kutosis	-0.85

Exhibit 3 explains that a white collar worker on average receives up to seven interruptions with a standard deviation of two. A negatively skewed distribution implies that there are more chances for a white collar worker to get less than seven interruptions than to get more than seven interruptions.

3.2.2. Effect of Timing of Interruption. As we can see from Exhibit 4 most of the interruptions, (more than 50%) occur while a knowledge worker is in middle of the primary task. Almost 30% of interruptions occur at the beginning of a task while 20% occur at the end of primary task. Thus, interruptions mostly occurred when a knowledge worker was in the middle of primary task.

Exhibit 4. Timing of Interruptions



So for example consider a task such as preparing a report, when a knowledge worker is working on the report and is in the thick of it interruptions occur and the knowledge workers are forced to shift their attention. To analyze the effect of interruptions on performance of a knwoledge worker we will be studying the effect of interruptions based on its timing.

The effect of interruptions depending on its timing is given in Exhibit 5. A one-way Analysis of Variance (ANOVA) is applied and the effect of timing of interruption on the performance of the knowledge workers is analyzed. The effect on performance of knowledge workers when the interruptions affect at the beginning, middle, and end of primary task is discussed.

Exhibit 5. Number of Interruptions and Its Effect Based on Timing of Interruption

Beginning	Middle	End
39	75	31

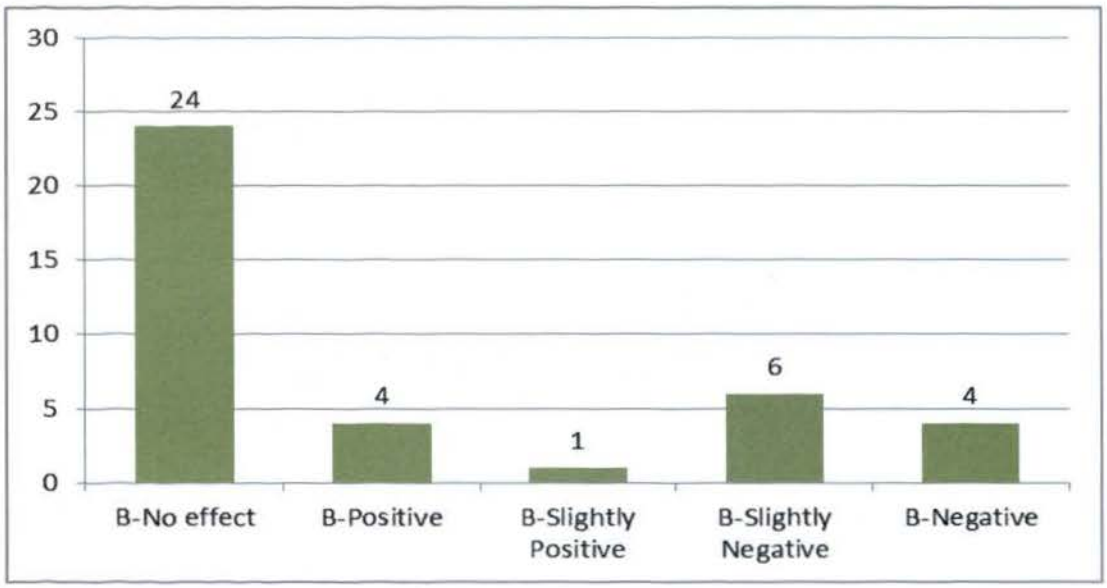
B-NO	B-SP	B-P	B-SN	B-N	Total
24	1	4	6	4	39
M-NO	M-SP	M-P	M-SN	M-N	
18	11	5	34	7	75
E-NO	E-SP	E-P	E-SN	E-N	
4	5	0	9	13	31

Relation between different timings of interruption (B-beginning, M-middle and E-end) and its effect on performance i.e. NO-no effect, P-positive, and N-negative is studied. We have combined the slightly negative and negative effects into negative as the overall effect on the performance is negative.Similarly we have combined the positive effects.

3.2.2.1. Interruptions at beginning of the primary task. As we can see from Exhibit 6 interruptions occurring at beginning of the primary task generally do not have much impact on the performance of knowledge workers. Most of the participants felt that interruptions were not that harmful when they occur at the beginning of the task. The reason may be that users find it easy to switch attention between tasks easily as they have just begun with the task. This result is consistent with previous research suggesting that interruptions are least harmful at the beginning of primary task (Czerwinski 2000).

For analyzing the effect of interruption at the beginnning of the task we applied one way ANOVA. We have tried to analyze the relation between means of effect on performance i.e. NO-no effect, P-positive (Slightly positive and positive combined) and N-negative (Slightly negative and negative combined).

Exhibit 6. Effect of Interruptions Occurring at the Beginning of the Task



For comparing the three categories we assumed a null hypothesis and alternative hypothesis.

C1 = BN (Beginning-Negative)

C2 = BP (Beginning-Positive)

C3 = BNO (Beginning-No Effect)

Null Hypothesis: Mean of BN=Mean of BP = Mean of BNO

Alternative Hypothesis: At least one is different

P-value =0.006 < 0.1(Significance level of test) so we reject null hypothesis and conclude that at least one mean is different. The result shows that C3 is different from both C1 and C2. We can say that the mean of BNO is different from means of BP and BN. In addition, from Exhibit 6 we can say that interruptions affecting at the beginning of primary task has no effect on performance of worker. The possible explanation for this may be, knowledge workers can easily switch their attention early in the task, before the user has become deeply engaged in the task goal. So we can say that, users can tend to

the interruptiong task at the beginning instead of avoiding or delaying as they do not have much impact on the performance.

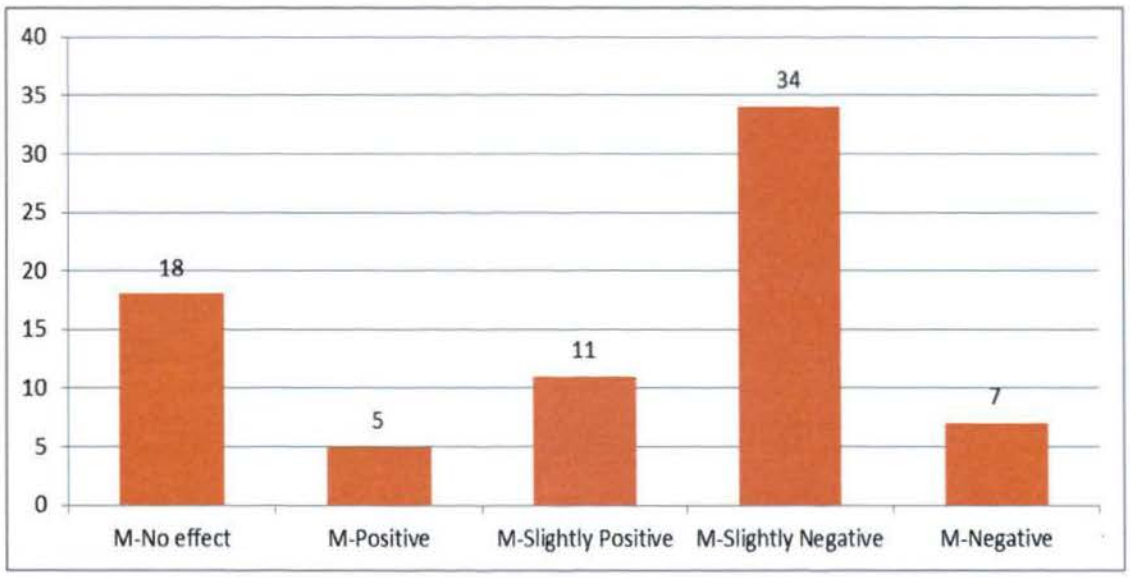
Exhibit 7. Effects of Interruptions at the Beginning

	Beginning		
	B-N	B-P	B-NO
1	0	0	2
2	0	1	1
3	2	1	2
4	0	2	5
5	1	0	2
6	1	0	2
7	0	0	3
8	0	1	2
9	0	0	1
10	0	0	0
11	0	0	2
12	1	0	0
13	1	1	0
14	0	0	0
15	1	0	0
16	1	0	0
17	1	0	0
18	0	0	0
19	1	0	0
20	0	0	0
21	0	0	0
Total	10	6	22

3.2.2.2. Interruptions at middle of primary task. As we can see from the chart in Exhibit 8 interruptions occurring at the middle of the primary task tend to have a slightly negative effect on the performance, meaning it may be difficult for a knowledge worker to getting interrupted in middle of a task and then resume again with the primary task. Almost fifty percent of white collar workers thought the effect of interruption was slightly on the negative side when it occurred at middle of a primary task. This result is in

line with previous research done which says interruptions are most harmful when a worker is in middle of a task (Bailey 2000).

Exhibit 8. Effect of Interruption at Middle of Primary Task



For analyzing the effect of interruption at the middle of the task we applied one way ANOVA.We have tried to analyze the relation between the effects on performance i.e. NO-no effect, P-positive (Slightly positive and positive combined) and N-negative (Slightly negative and negative combined) when interruptions occur at middle of task.

Exhibit 9. Effect of Interruptions at the Middle

	Middle		
	M-N	M-P	M-NO
1	1	2	3
2	2	1	3
3	1	1	0
4	0	0	0
5	3	1	0
6	0	0	3
7	3	0	0
8	1	2	2
9	2	0	1
10	4	0	1
11	2	2	0
12	1	2	1
13	2	1	0
14	4	1	0
15	2	2	0
16	1	1	0
17	3	0	1
18	2	1	1
19	1	1	1
20	2	0	0
21	2	0	1
Total	39	18	18

For comparing the three categories we assumed a null hypothesis and alternative hypothesis.

C1 = MN (Middle-Negative)

C2 = MP (Middle-Positive)

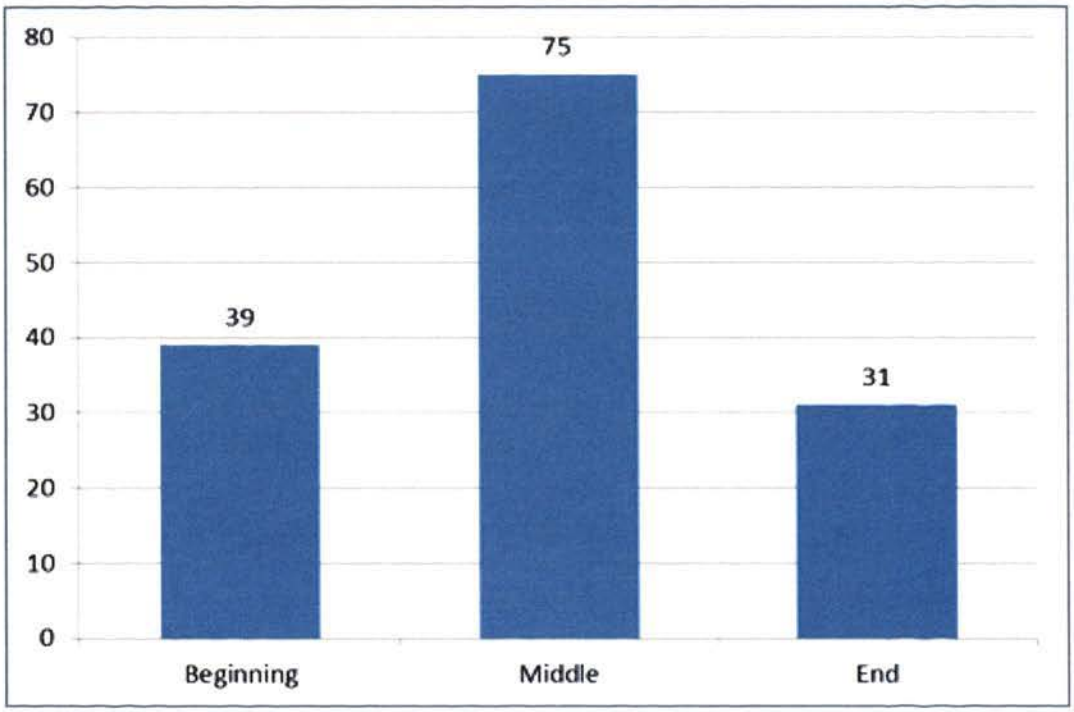
C3 = MNO (Middle-No effect)

Null Hypothesis: Mean of MN=Mean of MP = Mean of MNO

Alternative Hypothesis: At least one is different

One can see means of MP and MNO are same, but both are different from MN.P-value $0.011 < 0.1$ so we reject the null hypothesis.

Exhibit 10. Timing of Interruption

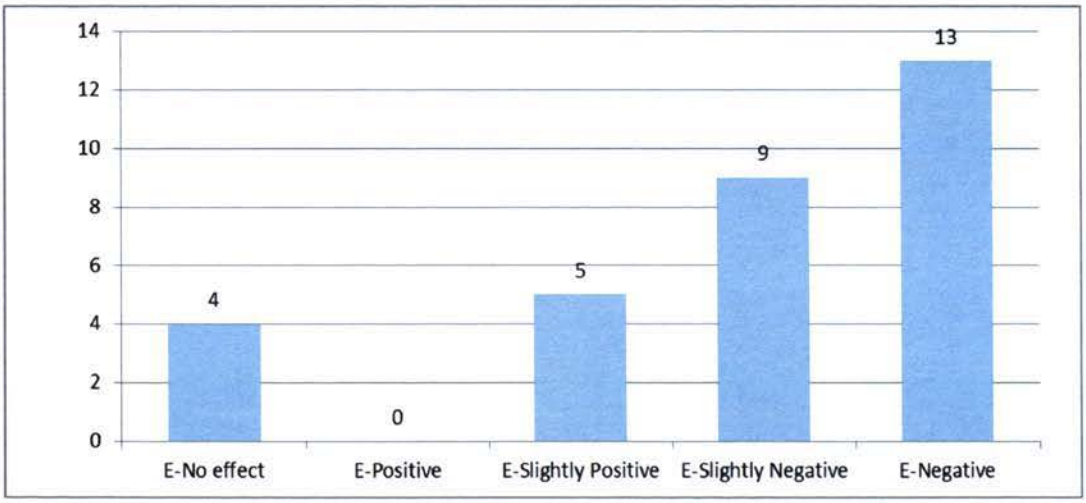


From Exhibit 8 and one-way anova analysis we can say that the mean of MN is different from means of MNO and MP and interruptions occurring at middle seem to have slight negative impact on the overall performance. Also the number of interruptions (Exhibit 10) occurring at middle are maximum so the overall effect of interruptions will be on the negative side. So from above results we can say that interruptions have a slightly negative impact on the performance when the knowledge worker is in middle of a primary task.

3.2.2.3. Interruptions at end of the primary task. As seen from Exhibit 11, it can be said that interruptions occurring at the end of the primary task tend to have a strong negative effect on the perfromance of the worker. Almost half of the participants thought interruptions occurring at the end definitely affected their performance negatively. While

thirty percent of the participants thought to have at least some negative effect. This result supports previous research that an interruption point placed at the end of a subtask led to longer resumption times, partially because of the effort to decide on what to do next, but moreover because of the existing relationships between subsequent subtasks (Gievska 2005). No participant thought that interruptions occurring at the end had a positive effect on their performance.

Exhibit 11. Effect of Interruptions Occurring at the End of Primary Task



Now the relation between the effects of interruption occurring at the end of task were anlayzed using ANOVA. In this study we have combined the two effects "slightly negative" and "negative" into one as the overall effect is on the negative side and similarly for positive effect. Exhibit 12 shows the number of interruptions which affects the performance of the knowledge workers at end of the primary task.

Exhibit 12. Effect of Interruptions at End

	End		
	E-N	E-P	E-NO
1	0	1	0
2	1	0	0
3	2	0	1
4	2	0	0
5	1	0	0
6	2	0	0
7	1	0	0
8	0	0	2
9	1	0	0
10	3	0	0
11	1	0	0
12	1	0	0
13	2	0	0
14	2	0	0
15	1	0	0
16	1	0	0
17	0	1	0
18	0	0	1
19	1	1	0
20	0	1	0
21	0	1	0
Total	22	5	4

For comparing the three categories we assumed a null hypothesis and alternative hypothesis.

C1 = EN (End-Negative)

C2 = EP (End-Positive)

C3 = ENO (End-No effect)

Null Hypothesis: Mean of EN=Mean of EP = Mean of ENO

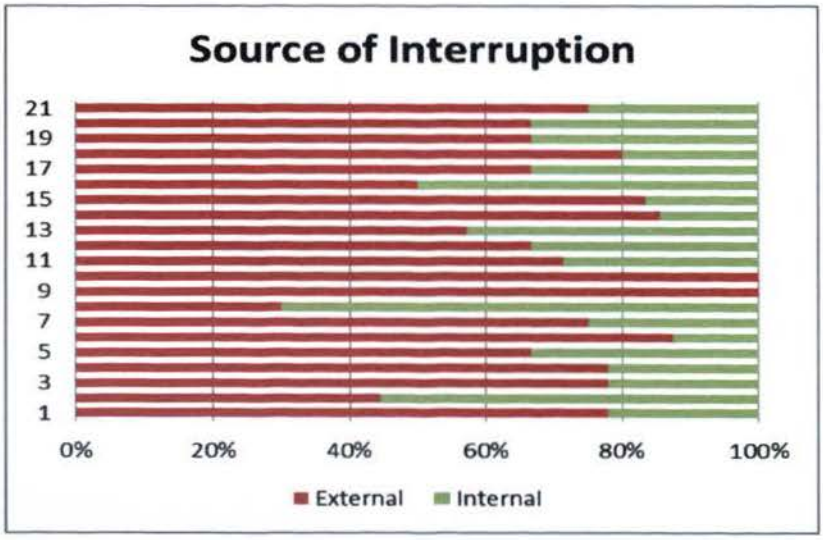
Alternative Hypothesis: At least one is different

It can be seen that means of EP and ENO are almost same, but both are different from EN.P-value 0.011 < 0.1 so we reject the null hypothesis.

From results obtained by applying one-way anova, we can say that means of EP and ENO are almost same while EN is different. It can be seen from the chart in Exhibit 11 that interruptions occurring at the end tend to have a strong negative effect on the performance of the knowledge worker. As we can see from the results twenty two interruptions had a strong negative and nine had slightly negative effect out of a total of thirty one interruptions that occurred at the end.So the overall effect is negative when interruptions occur at the end of primary task.

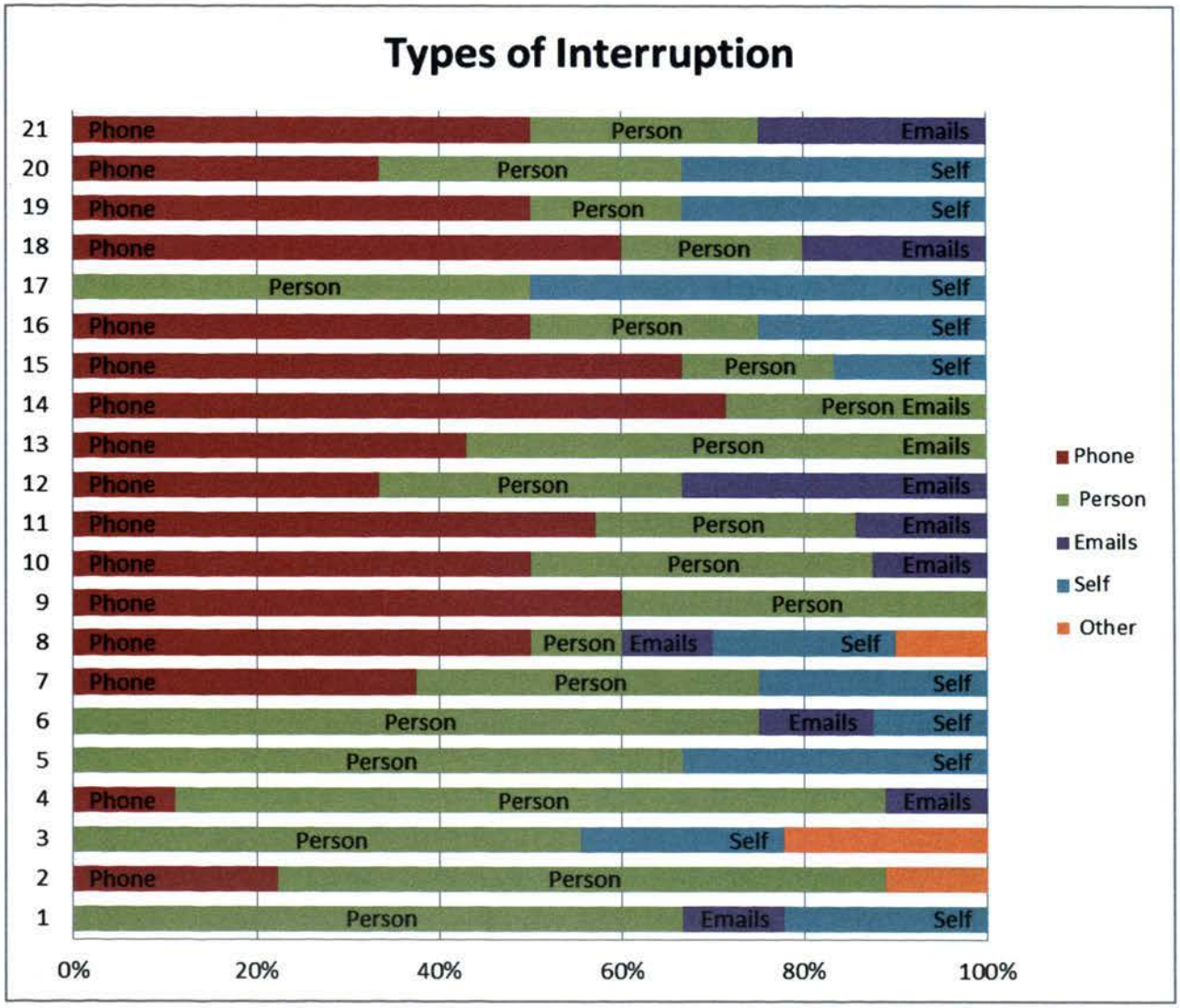
3.2.3. Source of interruptions. We can see from Exhibit 13 that most of the interruptions have an external source. Almost 80% of the interruptions generated have an external source. Although most of the interruptions are generated externally, internal source also contribute up to 22% of the interruptions generated. As shown in the chart below the source for more than 75% of the interruptions are classified as "External".

Exhibit 13. Source of Interruption



After studying the data, we can see that making phone calls and visits were major types of internal interruptions (Together they comprised about 50% of the internal interruptions). Therefore, by controlling the internally generated interruptions one can reduce the effect of interruptions significantly. Some other types of interruptions were email and instant messaging as seen in the exhibit.

Exhibit 14. Types of Interruptions



Another interesting observation from Exhibit 14 is that few of the subjects have no interruptions due to telephone calls. When investigated we found that two of them had secretaries to answers their calls so were not interrupted by phone calls, while other three were part of a design team in India and they had only one phone for the team. They had access to phone only through their team manager so were not affected by it.

After a thorough examination of the source of the interruption and its impact on the performance, results show that when an interruption is an "External" interruption more than 65% of times, it affected negatively on the performance of the person and the effect was positive in less than 6% of the total externally interrupted tasks. Hence, an externally generated interruption will most likely impact performance of the worker negatively.

3.2.4. Demanding and Non-Demanding Tasks. On an average, a member identified twenty different tasks that he/she does in his/her office hours where he/she is getting disturbed on every third task, as there are on average of seven interruptions per person. The data shows that almost 60% of the demanding tasks are interrupted and identified as have their performance affected.

One can see from the Exhibit 2 that there are fifty-six non-demanding tasks, followed by interruptions. Around thirty of these non-demanding tasks are followed by "other person" interruption type. Only four interruptions had some positive effect while more than 60% of interruptions had a negative impact.

Therefore, we can say that even if a person is doing a non-demanding task he/she mostly considers himself/herself interrupted if there is an external person involved in the interruption.

3.2.5. Expected vs. Unexpected. The results from the survey indicate that most of the knowledge workers did not consider interruption to be having a negative impact on the performance.

From the survey, we can see that most of the participants thought interruptions might affect their performance when asked to choose between positive negative and no effect. Around 50% of the participants guessed that interruption might have some impact on their performance, eleven of twenty-one participants said that interruptions might affect their performance and remaining said it might affect positively or have no effect.

When participants were asked if interruptions were a significant issue to them, more than half (11) of total participants said interruptions did not affect their performance and was not a significant issue. They considered it as a part of their job, expected interruptions, and said they were prepared for it. This is an interesting fact as the results from the time log say that interruptions affect the knowledge workers negatively but most of white collar workers did not consider interruptions harmful

CONCLUSION

We carried out an empirical study on white collar interruption with the help of time logs and surveys to analyze the effect of timing and source of interruptions on overall performance of white collar workers. We presented the results of the study and provided an analysis of the effect interruptions on white collar workers.

The findings from our study suggest that interruptions are more harmful if they affect at latter part of primary task which supports previous research findings (Gievska 2005). For example, suppose a design engineer is studying a difficult blue print and is in the middle or end of it when a colleague knocks on the door, then the impact of the interruption will be negative, as the knowledge worker will have to go over it again from the start to understand where he/she had left. This affects the knowledge worker negatively.

Our study also suggests that interruptions occurring at the beginning of the task tend to have no effect on the knowledge worker, which agrees with previous findings (Czerwinski 2000). Again considering above example suppose that the design engineer has just opened the blueprint and started reading it when his or her phone rings, in this situation it will be easy for him or her to get back to the primary task as he or she had just stated it before getting interrupted.

So our suggestion for white collar workers is when interruptions occur in the later portion of the primary task it is best to delay or ignore the interruption to help prevent negative effect on overall performance of the knowledge worker.

Another finding of our study is that when a demanding task is interrupted it generally tends to have a negative impact on the performance of the knowledge worker. Also another interesting finding even when a non-demanding task is interrupted by "other person" more than 50% of the non-demanding tasks showed to have a negative effect even though the task is non-demanding. Therefore, another suggestion for white collar workers is to set a particular time for visitors which will help in reducing the negative impact of interruption by "other person".

Our results also analyzed the sources of interruptions and its effects. Our study showed that majority of the interruptions (around 80%) had an external source. We also found that 22% of the interruptions were generated internally. Our findings also showed that most of the internal interruptions were due to phone calls.

Also another reason for internal interruptions previous researchers have suggested is that boredom and job satisfaction but the time log mostly suggested that remembrance of some important task or urgent phone call were mostly the reasons behind internal interruptions. Therefore, by preventing internal interruptions we can reduce the effect of interruptions significantly.

Another important finding from the survey it that most of the knowledge workers were not aware of the negative effects interruptions. The survey results show that most of the workers said of being aware of interruptions but did not think it affected them in any way. Only after filling the time log the negative effect of interruptions was understood. Therefore, another way of reducing the impact of interruptions is by creating awareness about their negative effects and also learning more about techniques to reduce its effect.

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APPENDIX A

SAMPLE TIME LOG

Task No.	Time	Current Task (CT) D: Demanding Or ND: non Demanding	Is it an Interruption (Y/N) (Y-Yes N-NO) *If "yes" then only fill in the next columns marked by the arrow*	Interruption type (A/V/P/S/O) (A - Audio, V - Visual, P - Other person, S - Self O - Other) Mention other type in space provided.	Source of Interruption (E/I) (E-External Source Or I-Internal Source)	Timing of interruption (B/E/M) (B - Beginning M- Middle E - At the end of Primary/Current task)	Effect of Interruption (P/SP/N/SN/NE) (P - Positive SP- Slightly Positive NO - No Effect SN- Slightly Negative N - Negative)
1.	8.00	CT: Reading Email D / **ND**	Y/**N**	A / V / P / S / O O:	E / I	B / M / E	P / SP / NO/ SN /N
2.	8.14	CT: Phone rings **D** / ND	**Y**/N	**A** / V / P / S / O O:	**E** / I	B / **M** / E	P / SP / NO/ **SN** /N
3.	8.21	CT: Call Bob D / **ND**	Y/**N**	A / V / P / S / O O:	E / I	B / M / E	P / SP / NO/ SN /N
4.	8.45	CT: Finish Email **D** / ND	**Y**/N	A / V / P / **S** / O O:	E / **I**	B / M / **E**	P / **SP** / NO/ SN /N
5.	8.57		Y/**N**	A / V / P / S / O O:	E / I	B / M / E	P / SP / NO/ SN /N

Instructions to fill the time log:

1. **Task Number**: Write the task numbers in the order as they are completed (1,2,3,4.....). For Eg. If you are reading an email and this is the first task of the day then fill "1" in the column of "Task no". Then you are interrupted by a phone so "talking on phone" is your next task. i.e. task no 2 and so on.

2. **Task Time:** Enter the start time of the task in this column. For eg. If you start reading email at 8.15am note down that time in the task time column. If you are interrupted by phone at 8.23am note it in the task time column. When the interrupting task of talking on phone is done and you start reading email again at 8.30am note it down in the task time column and task will be "Continuation of task 1".

3. **Current task:** It is the task you are currently doing. For eg. Reading emails, talking on the phone, Proofreading etc.

   Demanding or Non-Demanding task: Demanding tasks are those which require full attention and any distraction causes difficulty in continuing the task. For eg: Addition of numbers: when we are doing addition of a list of numbers any distraction will cause us to forget the number and we are required to start again. While on the other hand if we are surfing the net distraction will not be that harmful.

4. **Interruption:** The task other than the primary task. For eg: You were proofreading and you get a telephone call which distracts your attention from proofreading, then "talking on telephone" becomes an interruption while proofreading is your primary task. When you resume proofreading it will again be your primary task until you are done with it or decide to leave it for other time.

5. **Interruption type:**

   What is the type of interruptions that you are currently dealing with?

   Audio: Telephone call, an announcement etc.

   Visual: Email notifications, IM etc

   Other person: Interrupted by other person/colleague

   Self: Interrupted by self. For eg. While doing a task you remember other important task and you leave first task to complete the second task. Another example may be we get lost

in thoughts or think about something and find it difficult to comeback and complete the primary task then the type of interruption is self.

Other: Please mention any other type in the space provided.

6. **Source of Interruption:**

   Was it generated by you or was it generated externally. For eg: You are working on a task and a colleague comes to discuss some issue then the source of interruption is "external", while on the other hand if you decide to stop an call someone then the source of interruption is "self".

7. **Timing of interruption:** When did the interruption occur in regard with the primary task. For eg. Suppose you have ***just started*** proofreading and an interruption (Like telephone) occurs then you will write **"S" for start** in the column of timing of interruption.

8. **Effect of Interruption:** How did the interruption affect your performance? For eg : if you are doing a monotonous task then a break might refresh you and your performance might improve while on the other hand interruption might be harmful if you are in the middle of a cognitively challenging task.

APPENDIX B

CONSENT FORM

Missouri University of Science & Technology

Engineering Management & Systems Engineering Department

Consent Form

Title of the project: White Collar Interruptions

Project Supervisor: Dr. Susan Murray

Student Researcher: Zafar Khan

Purpose of the Project:

To analyze the disruptive effects from interruptions on the performance of knowledge workers

If you participate, you will be asked to:

1. Maintain a time log
2. Complete surveys

Time required for participation:

1. You would require maintaining a time log for a minimum of two days
2. Completing the survey should not require more than 5 to 10 minutes

Risks:

There are no foreseeable physical, psychological or social risks from the tasks.

Benefits/Compensation:

A small thank you gift of a Missouri S&T portfolio and pen (or similar items) will be given.

How confidentiality will be maintained:

Subjects will be assigned a number. All data will be recorded and analyzed using these assigned numbers.

Voluntary Participation:

Participation in this experiment is completely voluntary. If you decide not to participate there will not be any negative consequences. Please be aware that of you decide to participate, you may stop participating at any time and you may decide not to answer any specific question.

By signing this form I am attesting that I have read and understand the information above and I freely give my consent to participate.

Printed Name of Research Subject:

Signature:

Date:

APPENDIX C

SURVEY FORM

WHITE COLLAR INTERRUPTION STUDY

Thank you for your willingness to help with my research study. Please complete this survey and return it with your time logs. Your information will be kept confidential. If you have questions, please feel free to contact me at zak253@mst.edu or my advisor Dr. Murray (murray@mst.edu or 573-341-4038).

– Zafar Khan

General Information:

Name: _____

Job Title: _____

Typical Working hours: _____

Gender:

Male _____ Female _____

Age:

20-29 _____ 30-39 _____ 40-49 _____ 50-59 _____ 60 and above _____

Primary Working Location:

Office _____ Home _____ "On the Road" _____

Other_____ (Please Explain)

_____

Experimental Survey:

How aware are you of the types and frequency of daily interruptions?

_____ Very Aware _____ Aware _____ Somewhat Aware

_____ Slightly Aware _____ Not aware at all

How frequently you face interruptions?

_____ Very Frequently _____ Frequently _____ Sometimes

_____ Rarely _____ Very Rarely or Not All

What is your estimate of number of interruptions you face daily?

_____ 0-10 _____ 11-20 _____ 21-30 _____ 31-40 _____ 41-50

_____ 51-60 _____ 61-70 _____ 71-80 _____ 81-90 _____ More than 90

How is your performance affected by interruptions typically?

_____ Positively _____ Slightly Positively _____ No Effect

_____ Slightly Negatively _____ Negatively

What is your most common form of interruption (for example telephone calls, another person, email…)?

Are interruptions a significant issue for you? Why or why not?

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