NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

MBA PROFESSIONAL REPORT

DEADLINE TIGHTNESS AND PERFORMANCE IN OPERATIONAL AND LOGISTICS CONTEXTS

June 2016

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REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704-0188*
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.			
1. AGENCY USE ONLY ***(Leave blank)***	**2. REPORT DATE** June 2016	**3. REPORT TYPE AND DATES COVERED** MBA professional report	
4. TITLE AND SUBTITLE DEADLINE TIGHTNESS AND PERFORMANCE IN OPERATIONAL AND LOGISTICS CONTEXTS			**5. FUNDING NUMBERS**
6. AUTHOR(S) Jason E. Blanchard, Paul J. Kloepping, and Derek E. Vogt			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB Protocol number 2016.0050-DD-N.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited			**12b. DISTRIBUTION CODE**

13. ABSTRACT (maximum 200 words)

The purpose of this research is to better understand the relationships among regulatory focus (dispositional factor), inventory record accuracy (an operational context), and deadline tightness (a parameter under management control) against performance. Participant performance was measured by the amount of defects identified and the cumulative times to complete the given tasks. Two conditions placed on the participants were a high and low inventory-record accuracy and a loose or tight deadline, and prevention and promotion focused were measured on a regulatory focus scale. We analyzed, through statistical tools such as regression and a t test, the significance between performance, conditions, and regulatory focus. The anticipated outcome is to validate our assumption that tighter deadlines will lead to lower performance and that inventory record accuracy results in higher levels of performance. These findings may have practical applications for organizations such as DLA, NAVSUP, and other agencies or organizations that perform warehouse tasking when assigning or hiring individuals to perform such functions.

14. SUBJECT TERMS regulatory focus, deadlines, inventory record accuracy, throughput rate, defect rate			**15. NUMBER OF PAGES** 65
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UU

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

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DEADLINE TIGHTNESS AND PERFORMANCE IN OPERATIONAL AND LOGISTICS CONTEXTS

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Submitted in partial fulfillment of the requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION

from the

NAVAL POSTGRADUATE SCHOOL
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LIST OF ACRONYMS AND ABBREVIATIONS

COMNAVSURFOR	Commander Naval Surface Forces
DBI	demand based items
DL	deadline
DLA	Defense Logistics Agency
DLR	Depot Level Repairable
GLM	general linear models
HSD	honest significant difference
IRA	Inventory Record Accuracy
NAVSUP	Navy Supply Systems Command
RFID	radio frequency identification
SIM	select item management
SURFSUP	Surface Force Supply Procedures Manual
WQD	Word Design Questionnaire

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ACKNOWLEDGMENTS

We would like to thank our advisors for their guidance and support through this process.

We would especially like to thank our families for their patience.

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I. INTRODUCTION

A. BACKGROUND

Deadlines are ubiquitous in operations, and the setting of deadlines is a common operational decision. As described in our literature review, deadlines are thought to have a motivational effect on performance, but may also reduce quality. Based on a review of the literature on deadlines, this thesis will propose two moderators of the deadline-performance relationship: inventory record accuracy and regulatory focus. Inventory record accuracy (IRA) measures how often what percentage of the goods are accurately stored and/or recorded. Regulatory focus is a dispositional variable that is thought to be part of the human motivational processes. Both these moderators are further explained and related literature is reviewed in Chapter II.

Our thesis will be analyzing archival datasets that were gathered from an experiment at California Polytechnic State University. The experiment examined a warehouse task (order picking, a task described in more detail in Chapter III), and measured quality (defect rate) and throughput rate (work accomplished per time) as dependent variables. We will use this archival data to test the hypotheses developed below, which involve the relationships among IRA, deadline tightness, and regulatory focus, and the effect those variables have on defect rate and throughput rate.

Deadlines, IRA and regulatory focus matters to Navy Supply, as most tasks performed with order picking and inventories onboard naval ships are performed under time pressure, with imperfect inventory tracking systems, by humans who are also not perfect, and whose motivational levels may vary. The variables we are studying can have an effect on how the Navy assigns or trains individuals to perform such tasks as conducting inventories, breakouts, order picking, or storing incoming material.

B. PURPOSE OF RESEARCH

The purpose of the research is to better understand the relationships among Regulatory Focus (dispositional factor), IRA (an operational context), and Deadline Tightness (a parameter under management control). We will examine the impact that

these variables can have on performance as measured by the throughput rate and defect rate. Insights drawn from this research may be helpful in determining, for example, how tight a deadline should be, or whether to incorporate regulatory focus in the selection (hiring) criteria for certain warehouse functions.

In Navy Supply, and especially onboard naval vessels, we constantly conduct inventories, order picks, and store incoming material. When items of high value that require 100 percent IRA, the literature seems to support that it would be in our best interest to assign personnel of prevention-focused characteristics to conduct the task. Commander Naval Surface Forces Command (COMNAVSURFOR) has prescribed that, upon relief of the ship's Supply Officer inventory, validity and accuracy must be above 99 percent. The requirements are deeply entailed in the *Surface Force Supply Procedures Manual* (SURFSUP). To meet these stringent guidelines, a person who is promotion-focused may be more concerned about finishing their warehousing tasks in a timely manner and not so focused on the quality of the work; therefore, highly promotion-focused individuals may not be a correct fit for inventory related jobs. As leaders, it is critical we assign the right individuals to the right task to help mitigate errors, reduce rework and increase efficiency. This may be particularly important when assigning deadlines, which we hope to examine when we test our hypothesis.

C. RESEARCH QUESTIONS

We will develop and test specific hypotheses related to the following questions:

1. How is picking quality (in terms of defect rate) affected by deadlines, regulatory focus, and IRA?
2. How is picking productivity (in terms of cumulative pick times) affected by deadlines, regulatory focus, and inventory record accuracy?

D. ORGANIZATION OF PAPER

This thesis comprises five chapters. In Chapter II, we develop and discuss our specific hypotheses in more detail in the literature review. In Chapter III, we discuss the archival dataset and the methodology that we will use to analyze the archival datasets to test our hypotheses. Chapter IV presents the findings and discussions from analyzing the

archival data sets in testing our hypotheses. Lastly, in Chapter V, we summarize the research, look at the limitations and discuss areas we see for further research.

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II. LITERATURE REVIEW

A. BACKGROUND

Inventory record accuracy can have an effect on quality and throughput rate. A higher IRA could cause individuals conducting order picks, who consider the area in which they operate to have few discrepancies, to increase throughput when faced with a deadline because they will be less inclined to double-check items picked from the shelves.

For areas with low IRA, individuals may tend to spend more time double-checking their work for accuracy; therefore, ensuring they have the correct item could have a negative effect on throughput and a positive effect on quality.

Quality and throughput can also be affected by whether or not the person is prevention or promotion focused, as will be discussed when reviewing the literature on regulatory focus, below. People who are more prevention focused may be more inclined to double-check their work versus those who are promotion focused and more concerned with meeting the deadline.

We would like to gain a better understanding of how defect rate is affected by deadlines, regulatory focus, and IRA. To provide a measure of quality, for our hypothesis, quality will be measured by calculating defects introduced by the participants in relation to defects, which are pre-existing in the inventory.

B. DEFINITIONS

To help our readers differentiate between the various terms, we will describe some of the terminology used in this paper. This paper's primary focus is on quality, motivation and productivity, and we examine how the two moderators of deadline performance relationship: Regulatory Focus and Inventory Record Accuracy.

(1) Defect Rate

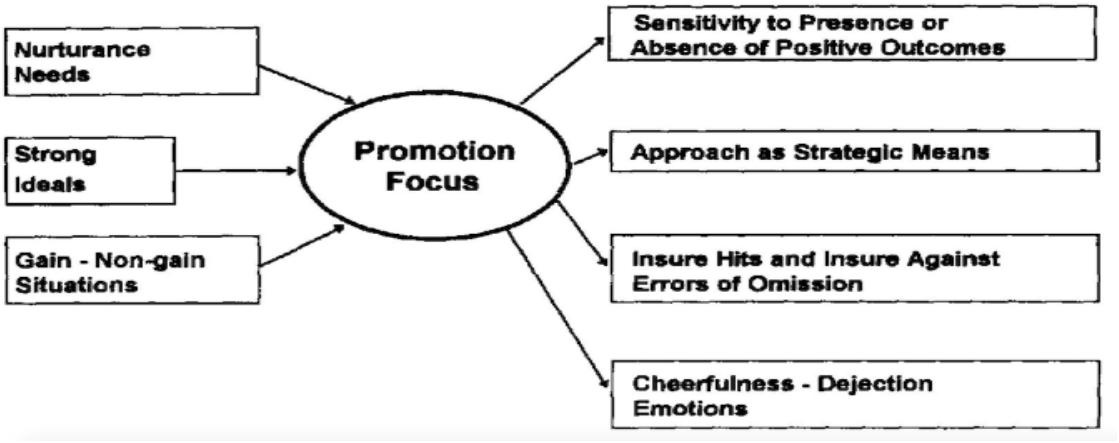
Is used as a direct measurement of quality. The defect rate represents the total amount of errors that individuals found as well as ones that were instituted by the design of the experiment to be measured by comparing defects introduced by the participants scoring high on the prevention and promotion scale.

(2) Regulatory Focus Theory

In his article titled *Beyond Pleasure and Pain*, Higgins (1997) first outlines his concept of *Regulatory Focus,* "which distinguishes self-regulations with a promotion focus (accomplishments and aspirations) from self-regulations with a prevention focus (safety and responsibilities)" (p. 1280). The theory has two distinct self-regulatory systems that suggest that individuals are either promotion or prevention focused, and that each will have different characteristics in how they approach their assigned task to achieve the outcome. The theory suggests that "*promotion-focused individuals,* emphasize achieving positive outcomes and are concerned with accomplishments, hopes, and aspirations" and "*prevention-focused individuals* emphasize avoiding negative outcomes and are oriented towards security, duties and obligations" (Beersma, Homan, Van Kleef, & De Dreu, 2013, p. 195). Based on this theory, we expect that regulatory focus will be a moderator of deadline performance, suggesting that those that are more prevention focused will tend to take more time to ensure that the picks are accurate or of higher quality as prevention focus individuals emphasis on accuracy.

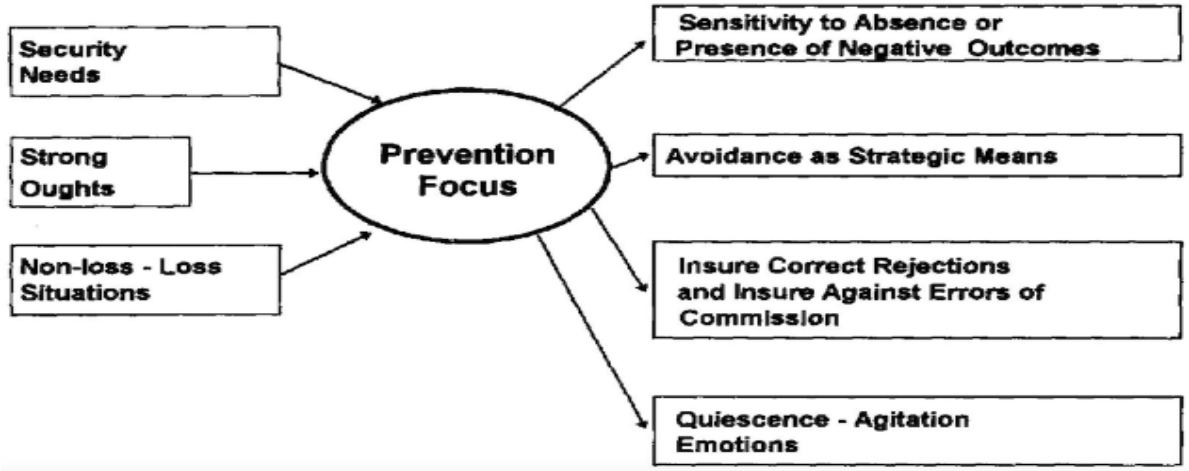
Figures 1 and 2 show the psychological characteristics that make up prevention- and promotion-focused individuals.

Figure 1. Psychological Variables with Distinct Relations to Promotion Focus



Source: Tory E. Higgins, (1997), Beyond pleasure and pain, *American Psychologist*, *52*(12), 1280–1300.

Figure 2. Psychological Variables with Distinct Relations to Prevention Focus



Source: Tory E. Higgins, (1997), Beyond pleasure and pain, *American Psychologist*, *52*(12), 1280–1300.

(3) Throughput Rate

We defined throughput rate of an entire order as 1/(cumulative time).

(4) Cumulative Time

Summed time taken by the participant to complete all orders

(5) Inventory Record Accuracy (IRA)

Defined by Rossetti and Buyurgan (2008) in their article on IRA as the total number of accurate records divided by the number of records checked times 100 to give you your IRA. This is defined, then, as how close are your actually records of your inventory to your inventory on hand. This was used in determining whether the participants were pulling from a high IRA aisle or low IRA aisle. In our research, we found that between 80 and 90 percent of all manufacturing and distribution companies around the world have low IRA, which is an inventory accuracy of below 90 percent (Rossetti & Buyurgan, 2008)

Currently, the Navy requires that Navy Supply maintain an IRA of 98% for Select Item Management (SIM) and Demand Based Items (DBI), according to the Commander Naval Surface Force Instruction P-4400 (COMNAVSURFOR P-4400). The Navy requires all surface ships to maintain an IRA equal to or higher than the top 20 percent of all civilian manufacturing and distribution companies worldwide. It also requires that certain items like Depot Level Repair (DLR) items and aviation pack-up kits maintain 100 percent IRA. The Navy requires that for these valuable items, sailors perform multiple inventory counts to ensure accuracy. Table 1 are some requirements that Commander Surface Forces Command mandates that each surface ship conduct throughout the year to ensure a high IRA.

Table 1. Mandatory Inventory Schedule for Naval Ships

RPT 142	JSI200	SCHEDULED INVENTORY BY SIM/DBI	SEMI-ANNUAL	CURRENT
RPT 142	JSI200	SCHEDULED INVENTORY BY CLASSIFIED ITEMS	ANNUAL	CURRENT
RPT 142	JSI200	SCHEDULED INVENTORY BY BULKHEAD MTD. SPARES OR RADIO ACTIVE MATERIAL	ANNUAL	CURRENT
RPT 142	JSI200	SCHEDULED INVENTORY BY DLR	ANNUAL	CURRENT
RPT 142	JSI200	SCHEDULED INVENTORY BY MAMS IAW CNSFINST 4440.1	IAW CNSF 4440.1	CURRENT
RPT 142	JSI200	SPOT INVENTORY	AS REQD	CURRENT
RPT 142	JSI200	SCHEDULED INVENTORY BY SHELF-LIFE	AS REQD	CURRENT

Source: Commander, Naval Surfaces Forces, (2008, August 25), *Surfaces forces supply procedures* (COMNAVSURFORINST P-4400.1).

(6) Order

For our research we define an order as a grouping of five individual picks.

(7) Run

We define a run as 10 orders in a run under a pre-conceived experimental condition. For example high/low IRA and tight/loose deadline conditions.

C. RESEARCH QUESTIONS

1. Defect Rate

We theorize that the number of defects found in an order is affected by deadlines, regulatory focus, and inventory record accuracy.

Quality will be lower when deadlines are tighter because the participants will feel rushed, which increases stress and decreases time available to double-check their picks for accuracy. Under tighter deadlines, we believe the participants will introduce additional defects in the picking process because they will be rushed to complete their assigned tasked in the given timeframe, based on the data observed in the article “Time Urgency: The Construct and Its Measurement” (Landy et al., 1991).

To further support our belief, we referred to two studies performed in the medical community, which cite stress and rush as a cause for errors. Increased time pressure,

including tight deadlines to perform a given task or increased workload in a specific timeframe, increased stress and results to a greater probability of error occurrence. While errors in the medical community have more severe consequences than in a warehouse, the reasons their occurrences are similar. In a study published in the *Journal of the Academy of Hospital Administration*, researchers noted that "high activity & stress environment, rushing & distraction in work … has accounted for as high as 16% of adverse events" (Reddy et al., 2009, p. 32).

In another study led by Professor Tim Dornan, researchers cited rushing to be one of many "error-provoking conditions" in hospitals, meaning when one of these conditions are present, the likelihood of errors increased. Their study concluded that "error rates were found to be highest at the busiest time of the day for prescription writing" (Dornan et al., 2009, p. 184)

During the busiest time of day, these medical professionals had to process more patients on average, per hour, than during slower times. In our study, the participants were given one of two deadlines. In the tighter deadline scenario, relates to the busiest time of the day, they had less time to process the same quantity of picks, compared to the loose deadline scenario. We believe that our hypothesis will support this research that the quality of picks has more defects in a tighter deadline condition compared to a looser deadline condition.

a. Hypothesis Ia

Quality of picks is lower/the picks have more defects in a tighter deadline condition compared to a looser deadline condition.

We believe there will be congruence in the way deadlines and prevention focus affect quality. We have already developed an argument as to why quality will suffer when deadlines are tight. Previous work done by Dr. Tory E. Higgins (1997), professor of Psychology at Columbia University, states, "Regulatory-focus theory distinguishes between the following two kinds of desired end-states: (a) aspirations and accomplishments (promotion focus) and (b) responsibilities and safety (prevention focus)" (p. 1282). The end state for the warehouse experiment will differ from person to

person, with promotion focused individuals focused on timely completion of the orders and prevention focused individuals focusing on accuracy. Crowe and Higgins (1997) also state, “A promotion focus is concerned with advancement, growth, and accomplishment, whereas a prevention focus is concerned with security, safety, and responsibility” (p. 117). In a warehouse environment prevention-focused individuals would feel a responsibility to limit errors; therefore, we believe quality will be lower under tighter deadlines if the test subject is promotion focused. Tighter deadlines will have a negative effect on accuracy and be will be reinforced by regulatory focus, with high promotion focus individuals striving to complete the given tasks on time.

The tight deadline effect may be moderated by regulatory focus, with high prevention-focus performing with a higher importance given toward accuracy, but the introduction of a tighter deadline will ultimately cause a higher ration of errors, as the individual will focus on quality, yet still want to meet the deadline. We believe that our hypothesis will support this research that when prevention focus is low and deadlines are tight, defects will be higher than when prevention focus is high and deadlines are loose.

b. Hypothesis Ib

> *When prevention focus is low and deadlines are tight, defects will be higher than when prevention focus is high and deadlines are loose.*

Figure 3 depicts our hypothesis. The best quality will occur if the test subject has higher prevention focus scores and the deadline is loose. Tighter deadlines combined with lower prevention focus scored should result in the worst-quality scenario.

Figure 3. Relationship between Quality and Prevention Focus

Quality of Picks			
		Deadline	
		Loose	Tight
Prevention Focus	Low		Worst
	High	Best	

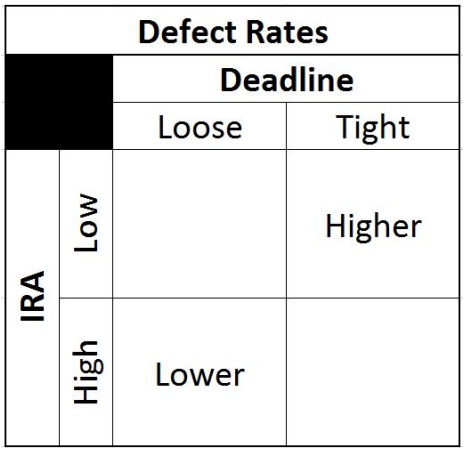
The total number of defects should be higher in areas of lower IRA, and as deadlines become tighter the number of defects will increase because there is less time allowed to pick each of the 10 items in the order. We believe that when a tighter deadline is given, additional defects are made, as the subject is rushing to complete the order. We have confidence that tighter deadlines will increase pressure to complete the given task faster, thus decreasing the likelihood or thoroughness of a double-check, when picking items from the shelves. Conversely, we theorize that quality will be higher, if subjects are told inventory accuracy is low, regardless of time pressure. The knowledge that inventory accuracy is low will force participants to perform a thorough check for accuracy when pulling each item from the shelf. We believe that our hypothesis will support our belief that when IRA is low and deadlines are tight, defect rates will be higher than when deadlines are loose and IRA is high.

c. Hypothesis Ic

When IRA is low and deadlines are tight, defect rates will be higher than when deadlines are loose and IRA is high.

Figure 4 depicts our hypothesis. The highest quality will occur if the inventory has a high IRA and deadlines are loose.

Figure 4. Relationship between IRA and Defect Rates



2. Throughput

We believe that throughput rate will be affect by the deadline as the average cumulative time will be shorter under a tight deadline condition. Research suggests that when individuals are given looser deadlines they tend to push things off to the last minute. This phenomenon is known as the *Deadline Rush*, which according to König and Kleinmann (2005) is defined as "a long time period of nearly no behavior and then a sharp increase of behavior before the deadline" (p. 33).

This is also supported by *time discounting*, which is defined in their article as "people prefer to receive a reward sooner rather than later; that is, the resent subjective value placed on a delayed reward decreases as the delay to that reward increases" (König & Kleinmann, 2005, p. 34). This suggests that people prefer to put things off if the deadline is further out and go for the more obtainable ones that are closer; therefore, suggesting that when individuals are given looser deadlines they will have higher cumulative times than those with tighter deadlines.

In König and Kleinmann's (2005) research, they looked at data that was gathered on students studying for an exam. Their research found that as the deadline got closer the more important that deadline became. The research shows that most individuals that studied for an exam pushed off the studying to the last minute. We believe that our hypothesis will show that when given a loose deadline, as those in the study had by

having 13 days before the exam, we expect that we will see the same effect on the cumulative times as those students who put off studying for an exam until the last minute. Suggesting that the participants will first start off slower and later increase their productivity as the deadline approaches given them a higher cumulative time then those given tighter deadlines. There is also research that shows that as the deadline approaches both groups and individuals will become more task-focused on meeting the deadline (Doerr, 2016). The research is focused on groups but can apply to individuals as well. The research that they conducted found that "the idea that work rates will not only increase as a deadline approaches, but that task focus increases as well (Doerr, 2016). We believe that our hypothesis will support this research with those facing the tighter deadlines will ultimately conclude with average cumulative times that are shorter under tight deadline conditions than those assigned loose deadlines.

a. Hypothesis IIa

Average cumulative times will be shorter under a tight deadline condition.

We believe that average cumulative times will decrease under tighter deadlines for those that are more promotion focused than prevention focused. We believe this effect will be moderated by regulatory focus, with higher promotion-focus associated with higher throughput or shorter average cumulative times resulting from tighter deadlines. According to Higgins (1997), "self-regulatory promotion-focus is associated with accomplishments and aspirations." His work explains that subjects that are given tighter deadlines will be more focused on finishing the task, not concerned with the quality of their throughput and will therefore have a tendency to have quicker cumulative times than those that are prevention focused. We believe that when individuals have a higher promotion focus and are given tighter deadlines, they will have higher throughput and shorter average cumulative times than those with higher prevention characteristics.

We believe that tighter deadlines for those that are more prevention focused versus promotion focused will have a harder time achieving the deadline than those that are promotion focused when faced with the tighter deadline. Earlier research has shown that "promotion-focused individuals use approach strategies and engage in risky

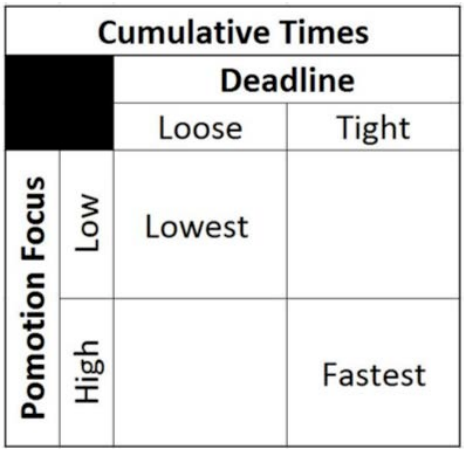
behavior, whereas prevention-focused individuals use avoidance strategies and follow rules" (Beersma et al., 2013, p. 195). Simply stating that those with a higher prevention focus would be more concerned with accuracy/quality than throughput and would be more likely to double-check their work than worried about finishing the task in a timely manner. We have faith that our hypothesis will support the literature and show the data will have a shorter average cumulative times for promotion focus individuals than those that are prevention focused.

b. Hypothesis IIb

When promotion focus is high and deadlines are tighter, cumulative times will decrease.

Figure 5 depicts our hypothesis. Lower cumulative times will occur when the test subject is promotion focused when faced with a tighter deadline.

Figure 5. Relationship between Cumulative Times and Promotion Focus



Throughput rate will be higher under tighter deadlines when individuals have knowledge of a high IRA. We believe this effect will be moderated by IRA, with high-accuracy environments having higher throughput-rates and lower cumulative times. We believe that when individuals believe that they have higher accuracy they are less likely to double -check the accuracy of the pick and will therefore have higher throughput, especially when faced with tighter deadlines. Though when looking at literature on IRA

we have found that for a facility to have a considerable high IRA they would have to be above 95% ± 5 accuracy on every item in the warehouse. In addition they have found that only 10 to 20 percent of all warehouse and distribution facility in the world actually achieve 95 percent IRA (Rossetti & Buyurgan, 2008). This suggest that there is a relative low number of companies that actually have a high IRA suggesting that even though someone states they have a high IRA the likelihood of that being true may not always be accurate.

The research suggest that even though the IRA is high there is still room for error, implying that given the tight deadlines, the participants should still check to ensure accuracy. Our hypotheses suggest that given the information they are picking material in an area that is known to have a high inventory accuracy they will be less inclined to double-check there work and will be more concerned with achieving a higher throughput rate when faced with the tighter deadline given that they perceive that the IRA is high. We believe that we will achieve a higher throughput rate and shorter average cumulative time but may also have a higher defect rate under this hypothesis.

c. Hypothesis IIc

When IRA is high and deadlines are tight, cumulative times will be lower than when IRA is low and deadlines are loose.

III. METHODOLOGY

Our study on deadline tightness and how it relates to quality and throughput rates will utilize experimental data gathered by two California Polytechnic State University graduate students, under the supervision of Dr. Tali Freed and Dr. Jelle de Vries. Although we are using their data as an archival dataset (we were not involved in data collection) we think it is important to review the protocol used in that experiment, so the reader can put our results in context. So, in this chapter we will (1) describe the protocol used by Drs. Freed and de Vries, (2) describe the measures we extracted from their archival data, and (3) describe the analyses we will conduct on those measures, to address the hypotheses developed in Chapter II.

A. EXPERIMENT SETUP

1. Participants

Participants were drawn from the students and employees of a public university in Central California. Of the 50 participants, 29 had no experience in a warehouse, 15 had experience, and the remaining six are unknown with lack of reporting or no questionnaire. Participants with warehouse experience had average job tenure of 17.78 months of experience in warehouse work with a standard deviation of 124.1 months. The standard deviation for the participant group is high because three of the participants have 420, 280 and 36 months of warehouse experience. The remaining participants have only one year or less experience with warehouse work. Without these three experienced participants, the mean would be 1.19 months with a standard deviation of 3.18 months. Twelve of the participants were female. The average age in years of the participants was 23.41 with a standard deviation of 8.87 years. Three of the participants failed to fill out the demographics portion of the questionnaires and three questionnaires are missing, leaving us with complete data on 44 of the 50 participants. Table 2 depicts the participant demographics.

Table 2. Participant Demographics

Variable	N	Percentage
Gender		
Male	32	64
Female	12	24
Unknown	6	12
Total	50	100
Age		
≤ 25	40	80
> 25	4	8
Unknown	6	12
Total	50	100
Experience		
With	15	30
Without	29	58
Unknown	6	12
Total	50	100
Deadline Condition		
Loose	50	50
Tight	50	50
Total	100	100
Inventory Record Accuracy		
High	50	50
Low	50	50
Total	100	100
Promotion Focus		
High	26	52
Low	24	48
Total	50	100
Prevention Focus		
High	26	52
Low	24	48
Total	50	100

Source: Vries, J., & Freed, T. (2014). Inventory record accuracy, deadline tightness/ task difficulty, and individual difference in predicting quality/productivity performance [Unpublished raw data].

Participation was voluntary. Modest rewards ($5 gift certificates) were given for meeting task deadlines, as described below. For confidentiality purposes, the participants were assigned a participant number and were identified only by that number. No names were to be placed on the questionnaires or order forms in the warehouse.

2. Protocol

Prior to the experiment, 50 participants were asked to fill out questionnaires used to measure dispositional factors, as described below.

The region of warehouse used in the experiment consisted of two aisles, one with high IRA and one with low IRA. The participants were given an order sheet containing five products to be picked, with a quantity of either one or two each, from one of these aisles. Each of the aisles was vertically divided into two sections (section 1 and 2). Each section had 11 bins which are divided into an upper and lower region (lower = 1, upper = 2); therefore, each aisle had a total of 44 total locations. An example of a location would be location A01.07.1, which means section 1, location 7, and level 1. Organizing the warehouse in this fashion standardized the picking process for both the high and low IRA rows. See Figure 6.

Figure 6. Aisle Layout

Source: Vries, J., & Freed, T., (2014). [Inventory record accuracy, deadline tightness/ task difficulty, and individual difference in predicting quality/ productivity performance]. Unpublished raw data.

To avoid confusion and interference, only one participant at a time was allowed to pick stock from the shelves. They were informed that one of the rows had high IRA and the other did not. The row with high IRA used RFID tagging to simulate greater accuracy. The lower IRA isle used only manual inventory procedures to monitor accuracy. Prior to each picking run the participants told whether they were in a high or low IRA aisle.

Each participant was given 10 orders that contain five items each, for a total of 50 items to be picked from the warehouse shelves. A timer was placed on the table at the end of the row and was clearly visible to the participants. Upon completion of each order the cumulative times and the individual pick times were logged by the moderator for each participant.

The participants were instructed that accuracy was critical to the experiment and that they should try to avoid making mistakes. To ensure accuracy, they were instructed to check each item picked from the associated bin with the item description and stock number on the order sheet. If the item picked from the bin did not match the description and stock number, the participants were told to leave the item and annotate the discrepancy on their order sheets. In addition, if they believed the correct item was picked from the bin, they were to place the item in their baskets and annotate the pick was completed on their order sheets prior to proceeding to the next pick.

Once the participant completed all 10 orders their total time was logged and their items checked for accuracy.

B. MEASURES

The questionnaires were used to measure the participant's motivational drivers and their sensitivity to time constraints. These questionnaires were compiled from the Landy et al. and Morgeson and Humphrey article (1991, 2006; see exhibits 1 and 2).

Inventory record accuracy as defined by Rossetti and Buyurgan (2008) as:

$$\frac{Total\ Number\ of\ Accurate\ Records}{Number\ of\ Records\ Checked}\ x\ 100\%$$

In the experiment, IRA was controlled by the placement of items as compared to the pick lists given to the participants. In the low accuracy aisles, between 76–78% of the items in the pick list were not in the indicated bin, while in the high accuracy aisles, 98% were in the indicated bin. In the low accuracy aisle there were 11 defects introduced in the inventory for the first run and 13 defects in the second run. In the high accuracy aisle there was only one defect intentionally placed in the wrong bin.

To accurately distinguish between errors induced by the participant and errors intentionally produced by the moderators, one error was subtracted from the errors in the high IRA zone. Likewise, during the first and second runs in the low IRA area, 11 and 13 errors were subtracted, respectively, from the participant's total errors of the 50 line items picked. If the participant was meticulous as well as fast in the low IRA runs, it is possible to receive a negative error score, if there were 12 errors or less in their basket on the first run or 10 or less on their second.

To measure the effects of deadline tightness, test subjects were given one of two deadlines. An eight-minute deadline which was considered "tight" or a 10 minute 30 second deadline, which was considered "loose." These times were determined in pilot studies, and set so that only about 20% of the participants would meet the 'tight' deadline, while 50% would meet the 'loose' deadline. Participants assigned a tight deadline had an average of 9.6 seconds to complete each pick, whereas those assigned loose deadlines had 12.6 seconds.

Scales for regulatory focus were included in the dispositional questionnaires the participants completed and these questionnaires were coded by us into spreadsheets. To measure the participant's level of prevention and promotion focus, the Prevention/ Promotion Questionnaire was used (Lockwood, Jordan & Kunda, 2002). The prevention focus score was obtained by the equation:

PP1+PP2+PP4+PP7+PP10+PP11+PP13+PP15 = Total Prevention Score

where each term preceded by PP is a question from the promotion/prevention scale. Likewise, the promotion focus score was obtained by the equation:

PP3+PP5+PP6+PP8+PP12+PP14+PP16+PP17+PP18 = Total Promotion Score

where each term preceded by PP is a question from the promotion/prevention scale (Lockwood, Jordan & Kunda, 2002). Medians scores for prevention and promotion focus were 45 and 63, respectively. These medians were used in the determination of a participant having a "high" or "low" prevention or promotion focus where a score above the median was deemed "high" and a score below the median deemed "low."

To measure the participant's sensitivity to time, or time urgency, we used the Time Urgency scale, which had also been completed by participants as a part of the questionnaire. The Time Urgency scale uses five principle factors, which, according to Conte, Landy Moran and Ringenbach constitute time urgency (Conte et al., 2001). These five factors are eating behaviors, competitiveness, speech patterns, general hurry and task hurry.

Eating behavior was measured by adding the scores for questions 1, 6 and 11, (6-Q16) and (6-Q21). Questions 16 and 21 are reverse-score items. Competitiveness was measured by adding the scores for questions 2, 7, 12, 17 and 22. Speech patterns were measured by adding the scores for questions 3, 8, 13, 18 and 23. General hurry was measured by adding the scores for (6-Q4), (6-Q9), 14, (6-Q19), (6-Q24) and 25. Questions 4, 9, 19 and 24 are reversed score items. Task hurry was measured by adding the scores for questions 5, 10, 15 and 20 (Conte et al., 2001).

There were two scales provided to the participant to measure promotion and prevention. The first validated scale measuring regularity focus in a work context was extracted from Wallace et al., (2009). The second scale measuring promotion and prevention was obtained from Lockwood, Jordan and Kunda. (2002). We thus had two psychometric scales measuring the factors to be used in a model testing the significance of the terms to the response variables, and decided to use only one. The selected criterion

to choose between scales was Cronbach's Alpha, a measure of the internal consistency of a scale. As stated by Panayides (2013), "heavy reliance on Cronbach's alpha has been standard practice in many validation studies."

The formula for alpha is given by:

$$\alpha = \frac{n}{n-1}\left(1 - \frac{\sum_i V_i}{V_t}\right)$$

where n is the number of items, V_t is the variance of the total scores and V_i is the variance of the item scores (Cronbach, 1951). From the Panayides article, "Nunnally (1978) recommends reliabilities of .70 or better (but not much beyond than .80) for basic research and between .90 and .95 in cases where important decisions are to be made on the basis of the test scores" (2013). Panayides reminds us to be skeptical of Cronbach Alpha scores as a universally accepted tool and that there are misconceptions related to the method. He also mentions that higher scores could be the result of a high number of items included when calculating Cronbach Alpha, he does not mention an exact number to be considered high but alludes through examples that it would be in excess of 18 items (Panayides, 2013). The scales utilized in this analysis had 9 items each; therefore, in line with the Panayides study we determined the alpha scores to be accurate and not overinflated due to excess items. This, with the higher standardized alpha scores, the promotion and prevention scales from Lockwood et al. were chosen to be most internally consistent for analysis.

C. MISSING DATA

The experiment and questionnaire data included missing values. Missing experiment data were unrecorded participant defects and unrecorded times, while in the questionnaire data the missing values were due to the participant not answering a question, and there were also missing questionnaires for three participants.

Missing values were found in the data for number of defects found by the participant in run one for five individuals and in run two for four individuals or 10% and

8%, respectively, timing data for run one had one missing value and run two had two missing values or 2% and 4%, respectively, and questionnaires missing for four of the fifty participants or 8% of the questionnaire data. In general, missing data for participant data was relatively low in the experiment. While using estimated values for missing observations is never ideal, in order to use all data for each participant a method to impute missing values was employed, the predictive mean matching (PMM) method. Landerman et al. (1997) state in their article, "The predictive mean method is a stochastic regression technique in which a missing value on a variable (v) is replaced with the value of v from a donor—a respondent whose regression-predicted score of the respondent for whom the value is missing." As all missing values being from categories within the data were numeric the PMM method was used for all data. For each instance used, the standard of number of multiple imputations was set to 5 and the seed set to 500 to not allow for randomness in seed and consistency when rerunning the script file. For each vector of defect quality and time data, missing values were replaced with the estimated values from the PMM method.

D. ANALYSIS

We will use the measures just described to investigate the hypotheses laid out in Chapter II via a series of general linear models (GLM) developed in the R ® statistical package. Because the number of observations in our dataset is so small, a full factorial model is unlikely to yield statistically significant results. However, the hypotheses do not postulate interaction (non-linear effects) per se, but merely main effects (Ia and IIa) and congruence (independent main effects working in the same direction). Thus, regardless of the statistical significance of the full factorial GLM procedures, we will conduct simple t-tests to support the postulated main effects, and post-hoc cell means comparisons, using a Tukey HSD procedure, in order to support those hypotheses that postulated congruence. We will not use an arbitrary threshold such as $p < .05$ to asses support for our hypotheses. Rather in keeping with recent recommendations we will qualify support in terms of P value and direction of effect (APA, 2016). We will discuss the limitations of this procedure in more detail when discussing our results in Chapter V.

IV. RESULTS

A. PURPOSE

The purpose of this study was to examine the effect of deadline tightness, IRA, and regulatory focus on the quality of the output and the cumulative time the task was completed by the sampled participants.

B. DESCRIPTIVE ANALYSES

The Promotion/Prevention scale from Lockwood et al. (2002) was used to measure participant Regulatory Focus. The internal consistency and reliability of the validated scale was measured by use of the Cronbach's alpha. The promotion focus subscale consisted of 9 items $(\alpha = .83)$ and prevention focus subscale consisted of 9 items $(\alpha = .82)$. See Table 3.

Table 3. Cronbach Alpha of Validated Subscales

Factor	Items	Cronbach Alpha
Regulatory Focus		
Promotion Focus	3,5,6,8,12,14,16,17,18	.83
Prevention Focus	1,2,4,7,9,10,11,13,15	.82

There were 50 observations of participant scores for regulatory focus. Prevention focus scores had a minimum score of 25, maximum of 75, median of 45, a standard deviation of 12.9, and a mean of 46. Based on a median split, 26 participants were labeled as 'high prevention focus' and 24 participants were labeled as low prevention focus. Promotion focus scores had a minimum score of 39.0, maximum of 81.0, median of 63.0, standard deviation of 9.54, and a mean of 62.1. Based on a median split, 26 participants were labeled as high promotion focus, and 24 participants were labeled them as having low promotion focus. See Table 3.

There were 100 observations of quality, measured by total number of defects (incorrect picks) found by the participant in an environment of either a tight or loose

deadline condition. Number of defects ranged from a minimum of 0 to a maximum of 15 with a median of 4.00 a standard deviation of 4.31, and mean of 5.20.

The number of incorrect records varies between the two IRA conditions. Each incorrect record will potentially result in a defective pick, unless the participant notices the inaccuracy. This raises the question as to whether or not we should 'correct' for the number of inaccuracies in some way, to account for the fact that the participants in the Low Accuracy condition faced many more potential defects. For analyses under research question one with regards to quality, there was no correction for instituted defects. However, instituted defect correction is revisited in the post-hoc analyses section.

For output of cumulative time taken to complete a run there were 100 observations under the two deadline tightness conditions of loose or tight and IRA condition of high or low. The time to complete a run by a participant had a minimum of 301.7 seconds, maximum of 1657 seconds, a median of 534 seconds, standard deviation of 166.9 seconds, and mean of 560 seconds.

C. ANALYSIS OF HYPOTHESES

In this section, we will report on the analyses conducted to investigate the hypotheses that were developed under each research question.

Research Question I—How is picking quality (in terms of defect rate) affected by deadlines, regulatory focus, and IRA?

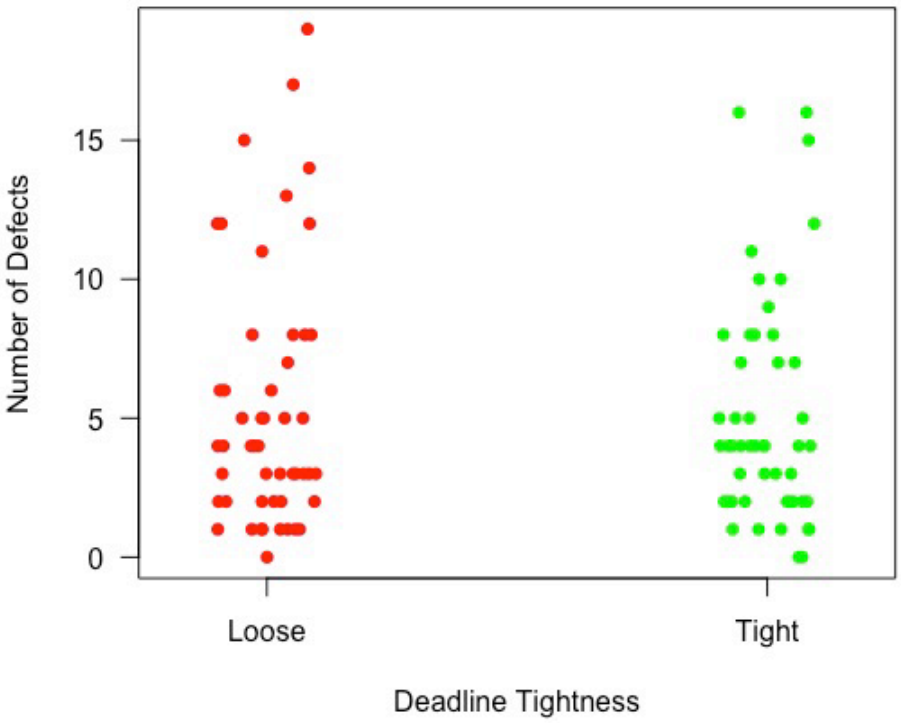
Two types of statistical analysis were utilized for the first research question including a Welch Two Sample t-test and multiple linear regression models.

Hypothesis Ia—Quality of picks is lower/ the picks have more defects in a tighter deadline condition compared to a looser deadline condition.

There was a highly significant effect of deadline on quality of picks, $t(102) = 8.53, p < .0001$, with participants in a tight deadline condition. In this case, we reject the null hypothesis that deadline tightness conditions have no effect on quality of picks, and find strong support for hypothesis Ia.

With this strong support of hypothesis Ia we also looked at a plot of data points for number of defects found by participants in each run against deadline tightness condition where we visually observe similar clustering in the 0 to 5 defect range but in the greater-than-5 defects found there was greater dispersion in the loose deadline tightness condition. See Figure 7.

Figure 7. Quality vs. Tightness Condition



Number of defects found by participants n=50 over runs n=100 of a deadline tightness condition of either loose or tight.

Hypothesis Ib—When prevention focus is low and deadlines are tight, defects will be higher than when prevention focus is high and deadlines are loose.

Multiple regression analysis was used to test if the interaction between prevention focus and deadline tightness condition significantly predicted the number of defects found by participants. The results of the regression indicated the two predictors and their interaction explained 3.3 percent of the variance, but the overall fit is not significant $(F(1,96) = .038, p = .85)$. The interaction between prevention focus and deadline

tightness condition approached significance in predicting number of defects $(\beta = -.11, p = .12)$, as did the main effect of deadline tightness $(\beta = 4.79, p = .15)$ and the main effect of prevention focus $(\beta = .076, p = .093)$. Given the lack of significance in the overall model fit and the weak significance of the interactive term, the regression does not support a hypothesis of interaction. See Table 4.

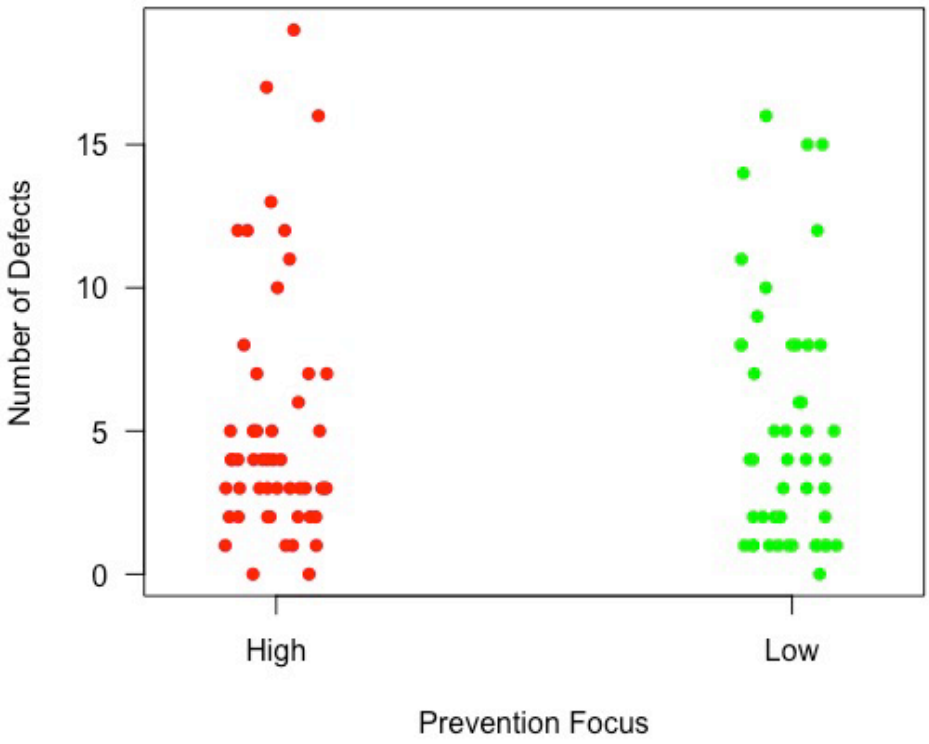
Table 4. Summary of Multiple Regression Analysis for Variables Predicting Quality with Raw Uncorrected Defect Data (N = 100)

	Hypothesis Ib			
Variable	B	SE B	β	p
Deadline Tightness (DL)	.55	3.27	4.79	.15
Prevention Focus	.23	.076	.076	.093*
DL: Prevention Focus	-.61	.068	-.105	.12
R^2		.033		
F for change in R^2		1.08		

* $p < .10$

However, as mentioned in Chapter III, the hypothesis is not predicting an effect across the range of interaction. Rather, the hypothesis is addressing a comparison between two specific cells of the experiment (low prevention focus with tight deadlines, compared to high prevention focus with loose deadlines). That is, the hypothesis posits congruence between the effects, not a broad or non-linear interaction.

Figure 8. Quality vs. Prevention Focus



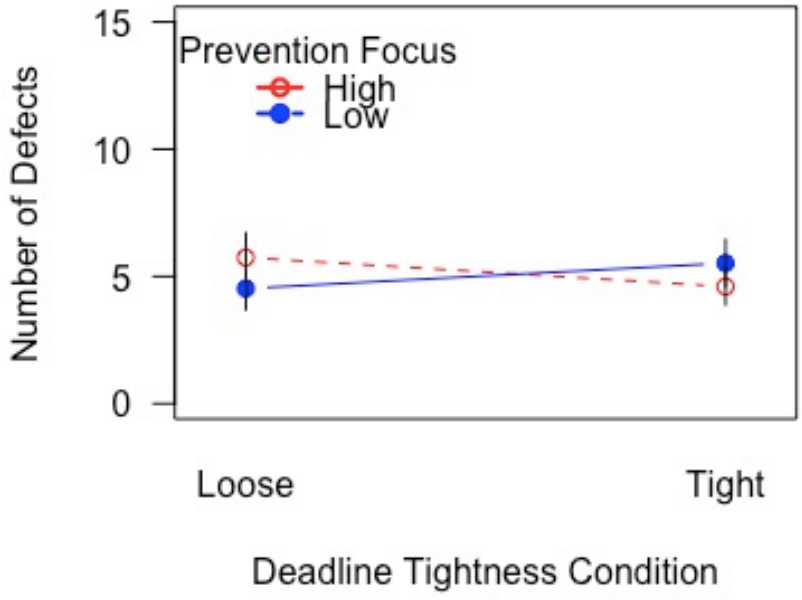
Number of defects found by participants n=50 over runs n=100 of a prevention focus of either high or low.

Though not hypothesized, the main effect of prevention focus was significant. A plot of data points for number of defects found by a participant for each run conducted against the participant either being high or low prevention focused shows clustering in the two conditions in the 0 to 5 defects found range but greater dispersion in the greater than 5 defect range. And we also notice that, as gathered from the literature in Chapter II, the fewer defects were found by participants in the high prevention focus group. See Figure 8. Note that Figure 8 is a jitter graph—within each condition (high or low) the method used to separate points that are coincident on the vertical axis is to scatter (or jitter) them randomly across the horizontal axis.

The graph indicates there may be interaction between the variables approaching statistical significance, but the interaction is not of the hypothesized form. See Figure 9.

Note that in Figure 9, the vertical line through the mean point indicates the size of the standard error.

Figure 9. Quality vs. Deadline Tightness Condition and Prevention Focus



Number of defects found by participants n=50 over runs n=100 under deadline conditions of loose or tight and prevention focus of either high or low.

Hypothesis Ic—When IRA is low and deadlines are tight, defect rates will be higher than when deadlines are loose and IRA is high.

Multiple regression analysis was used to test if the interaction between the categorical variables deadline tightness and IRA significantly predicted the number of defects found by participants. The results of the regression indicated the two predictors and their interaction explained 15.7 percent of the variance and the fit is highly significant $(R^2 = .16, F(3,96) = 5.92, p = .0009)$. It was found that the interaction between deadline tightness and IRA showed no significance in predicting the number of defects $(\beta = -1.12, p = 0.49)$, nor did the main effect of deadline tightness $(\beta = 1.24, p = .63)$ the main effect of IRA however was highly significant $(\beta = 5.00, p = .052)$. With no significance in the interactive variable we fail to reject the null hypothesis that the

interaction between deadline tightness and find no support for the hypothesis. See Table 5.

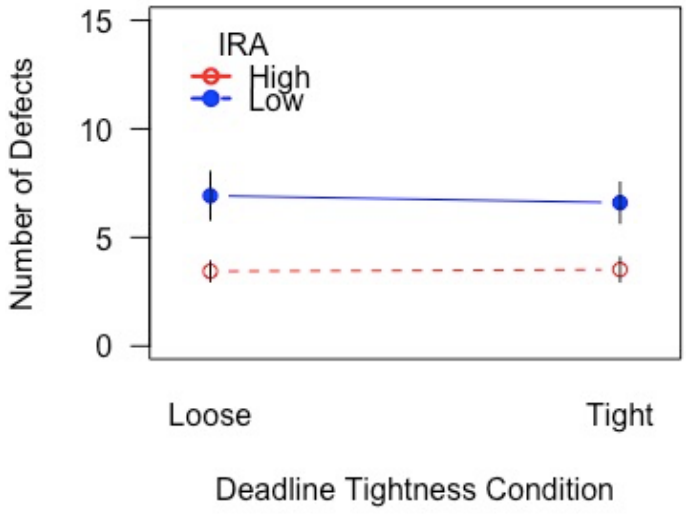
Table 5. Summary of Multiple Regression Analysis for Variables Predicting Quality with Raw Uncorrected Defect Data (N = 100)

	Hypothesis Ic			
Variable	B	SE B	β	p
Deadline Tightness (DL)	.14	2.54	1.24	.62
IRA	.58	2.54	5.0	.052*
DL:IRA	-.28	1.61	-.70	.49
R^2		.16		
F for change in R^2		5.95		

* $p < .10$

Figure 10 shows little interaction. However, we can interpret hypothesis 1c more narrowly, as postulating congruence, not broad interaction. The post-hoc Tukey HSD test of this comparison will be reported below in the section on post-hoc analyses.

Figure 10. Quality vs. Deadline Tightness Condition and Inventory Record Accuracy



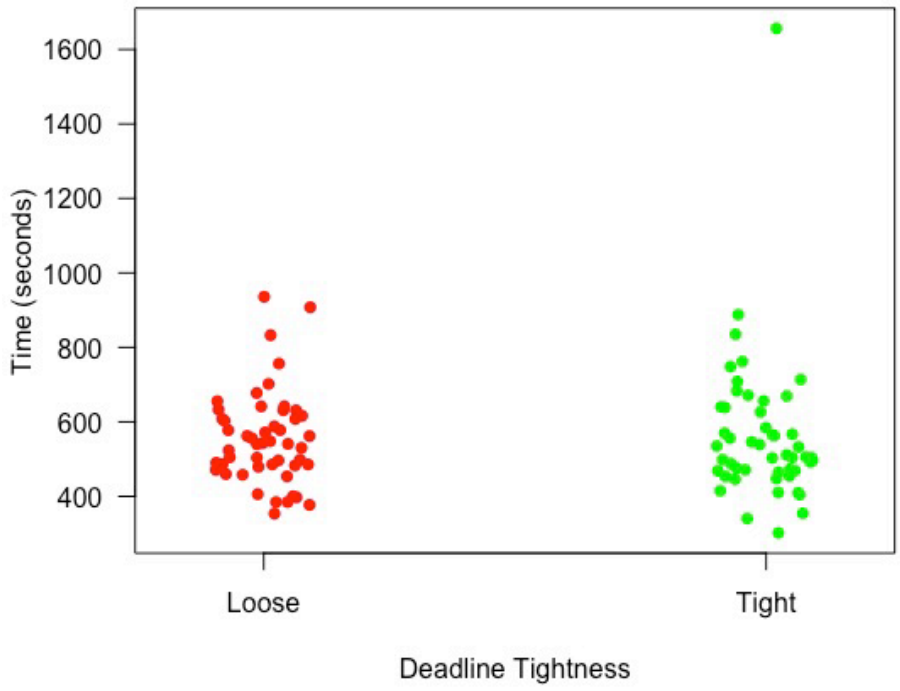
Number of defects found by participants n=50 over runs n=100 under deadline conditions of loose or tight and IRA of either high or low.

Research Question II—How is picking productivity (in terms of cumulative pick times) affected by deadlines, regulatory focus, and inventory record accuracy?

Hypothesis IIa—Average cumulative times will be shorter under a tight deadline condition.

There was a highly significant main effect of deadline tightness on cumulative time, $t(99) = -33.3$, $p < .0001$, with participants in a tight deadline condition. In this case, we reject the null hypothesis and find strong support for hypothesis IIa.

Figure 11. Time vs. Deadline Tightness Condition



Cumulative time in seconds by participants n=50 over runs n=100 of a deadline tightness condition of either loose or tight.

The plot of cumulative time taken by a participant to complete a run against deadline tightness conditions shows clustering of data points in tight condition in the lower range than in the loose range reinforcing the literature in Chapter II that those participants in the tighter deadline will take less time to complete the task. See Figure 11.

Hypothesis IIb—When promotion focus is high and deadlines are tight, cumulative times will decrease.

Multiple regression analysis was used to test if the interaction between promotion focus and deadline tightness condition significantly predicted the cumulative time the participants took to complete the task. The results of the regression indicated the two predictors and their interaction explained 6.8 percent of the variance and the overall fit was moderately significant $(R^2 = .068, F(3,96) = 2.34, p = .078)$. It was found that the interaction between promotion focus and deadline tightness showed statistical significance predicting cumulative times $(\beta = 6.92, p < .050)$. The main effect of deadline tightness is also significant $(\beta = -434, p = .054)$, providing further support for hypothesis 2a. The main effect of promotion focus $(\beta = -.19, p = .94)$ is not significant. See Table 6.

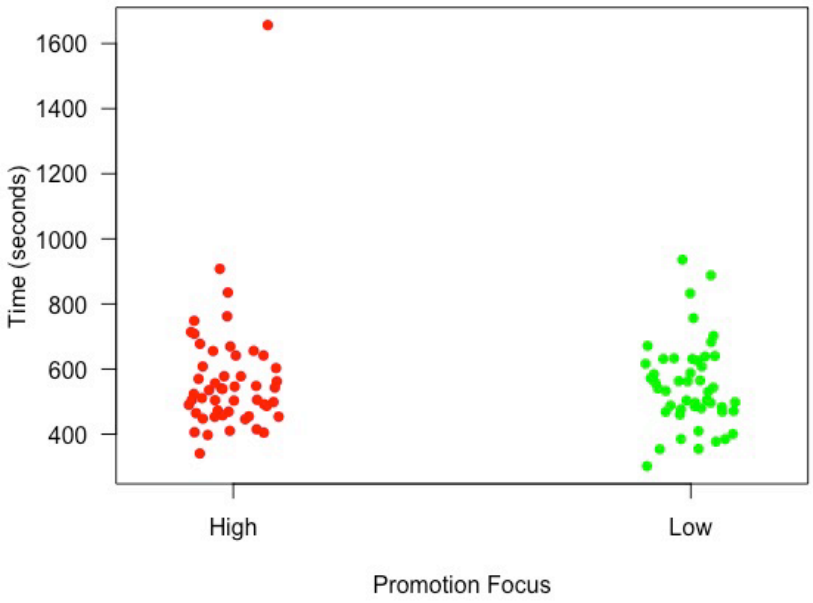
Table 6. Summary of Multiple Regression Analysis for Variables Predicting Cumulative Times (N = 100)

	Hypothesis IIb			
Variable	B	SE B	β	p
Deadline Tightness (DL)	-1.32	223	-434	.054*
Promotion Focus	-.010	2.35	-.19	.94
DL: Promotion Focus	1.39	3.49	6.92	.050*
R^2		.068		
F for change in R^2		2.34		

* $p < .10$

By plotting cumulative time the participants took to complete the task against a promotion focus of high or low there is greater dispersion for participants in the high promotion focus grouping. See Figure 12.

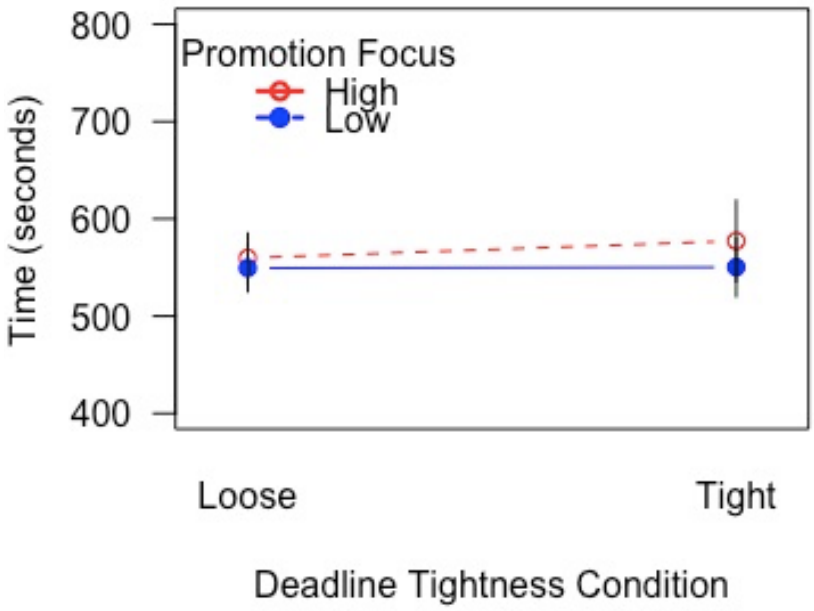
Figure 12. Time vs. Promotion Focus



Cumulative time in seconds by participants n=50 over runs n=100 of promotion focus of either high or low.

Contrary to expectation, participants with a high promotion focus took more time to complete the run than participants with a low promotion focus. Although the interaction is statically significant this is because the loose deadline condition decreased the performance gap between participants with a high promotion focus and participants with a low promotion focus. So hypothesis IIb receives no support from this data. See Figure 13.

Figure 13. Times Reported vs. Deadline Tightness Condition and Promotion Focus



Cumulative time in seconds by participants n=50 over runs n=100 under deadline conditions of loose or tight and promotion focus of either high or low.

Hypothesis IIc—When IRA is high and deadlines are tight, cumulative times will be lower than when IRA is low and deadlines are loose.

Multiple regression analysis was used to test if the interaction between deadline tightness condition and IRA significantly predicted the cumulative time for the participant to complete the task. The results of the regression indicated the two predictors and their interaction explained 19 percent of the variance and was highly significant $(R^2 = 0.19, F(3,96) = 7.37, p = .0002)$. However, it was found that the interaction between deadline tightness and IRA showed no significance on the cumulative time $(\beta = -11.8, p = .85)$, indicating no support for hypothesis IIc. The main effect of deadline tightness $(\beta = 13.5, p = .75)$ was also not significant. The main effect of IRA is highly significant $(\beta = 148, p < .001)$. See Table 7.

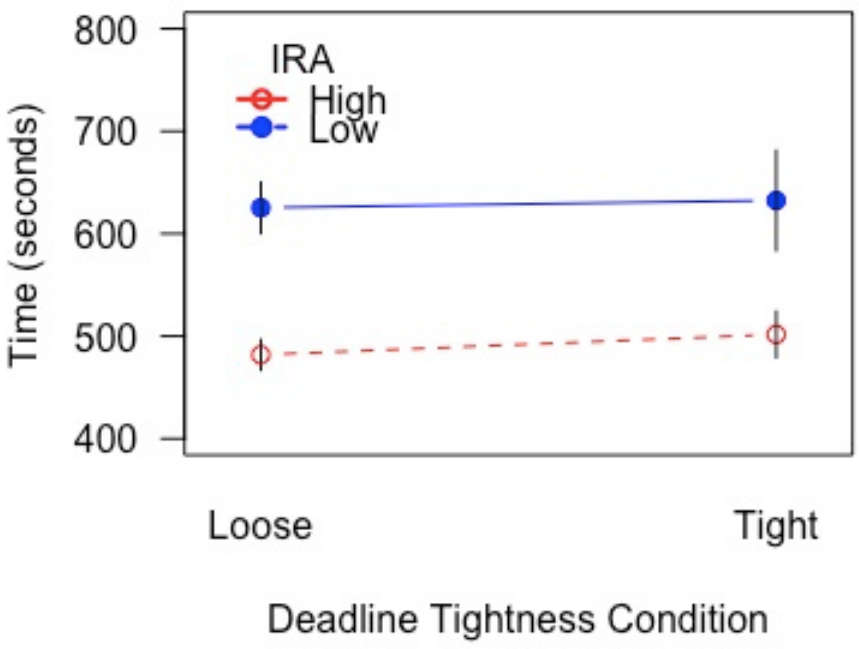
Table 7. Summary of Multiple Regression Analysis for Variables Predicting Cumulative Times (N = 100)

	Hypothesis IIc			
Variable	B	SE B	β	p
Deadline Tightness (DL)	.041	42.8	13.52	.75
IRA	.45	42.8	148	.0008*
DL:IRA	-.031	60.6	-11.8	.85
R^2		.19		
F for change in R^2		7.37		

* $p < .001$

Overall, participants in a low IRA category took more time to complete a run than participants in a high IRA category. Deadline appeared to have little effect. Overall, there is little to no interaction between the two groups. As before the hypothesized relationship is between two specific conditions that we will test in post hoc analyses. See Figure 14.

Figure 14. Times Reported vs. Deadline Tightness Condition and Inventory Record Accuracy



Cumulative time in seconds by participants n=50 over runs n=100 under deadline conditions of loose or tight and IRA of either high or low.

D. POST HOC ANALYSES

As mentioned in Chapter III and under research question I the IRA conditions involved different numbers of potential defects, implanted by those conducting the experiment. We wanted to see if this was the reason our test of hypothesis 1b failed to detect significant interaction. A post hoc analysis conducting a multiple linear regression for hypothesis Ib with number of defects corrected for differences in the IRA conditions had the following results. The results of the regression indicated the two predictors and their interaction explained 1.7 percent of the variance, but the overall fit is not significant $(F(3,96) = .017, p = .66)$. The interaction between prevention focus and deadline tightness condition showed no significance in predicting number of defects $(\beta = -.10, p = .25)$, as did the main effect of deadline tightness $(\beta = 4.68, p = .27)$ and the main effect of prevention focus $(\beta = .07, p = .26)$. Given the lack of significance in the overall model fit and the weak significance of the interactive term, the regression still does not support a hypothesis of interaction. See Table 8.

Table 8. Summary of Multiple Regression Analysis for Variables Predicting Quality with Instituted Effects (N = 100)

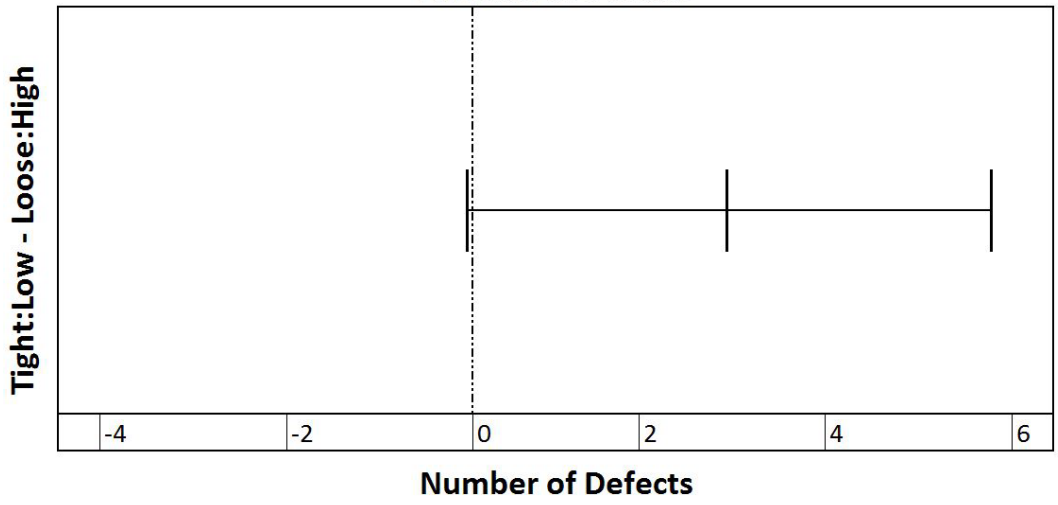
	Hypothesis Ib			
Variable	B	SE B	β	p
Deadline Tightness (DL)	.42	4.23	4.68	.27
Prevention Focus	.15	.058	.07	.26
DL: Prevention Focus	-.46	.088	-.10	.25
R^2		.017		
F for change in R^2		.54		

A post hoc analysis was conducted on hypothesis Ic and IIc as there was little support found for broad interaction in the multiple regression analyses. The post hoc analysis included a Tukey HSD test for both hypotheses. A post hoc analysis using a Tukey HSD test was not conducted for Ib or IIb since it was clear from the graphs that there was no support for the hypothesizes. See Tables 4 and 6. In each case, the Tukey HSD test compares the specific experimental cells mentioned in the hypotheses (e.g., for

hypothesis 1c, the comparison is between low IRA and tight deadlines on the one hand, and high IRA and loose deadlines on the other hand).

The Tukey HSD test compares the difference in means between all 6 pairwise conditions each for the interactive predictor variable in hypotheses Ic and IIc. For our analysis of hypothesis Ic, only one comparison was important to hypothesis Ic is a tight deadline tightness condition and low IRA to a loose deadline tightness condition and high IRA. As stated by Faraway (2015), the mean difference is significant if zero is not in the 95 percent confidence interval and also mentions that the Tukey method assumes the worst by focusing on the largest difference leading to a more exacting result. The result of the Tukey HSD test for our condition of interest in hypothesis Ic had an upper confidence level of 5.85, a lower confidence level of -.09, with a difference of 2.88, and did pass through zero (slightly) with an adjusted $p = .061$ indicating moderate statistical significance. The result of the post hoc analysis gives weak-moderate support for hypothesis Ic. See Figure 15.

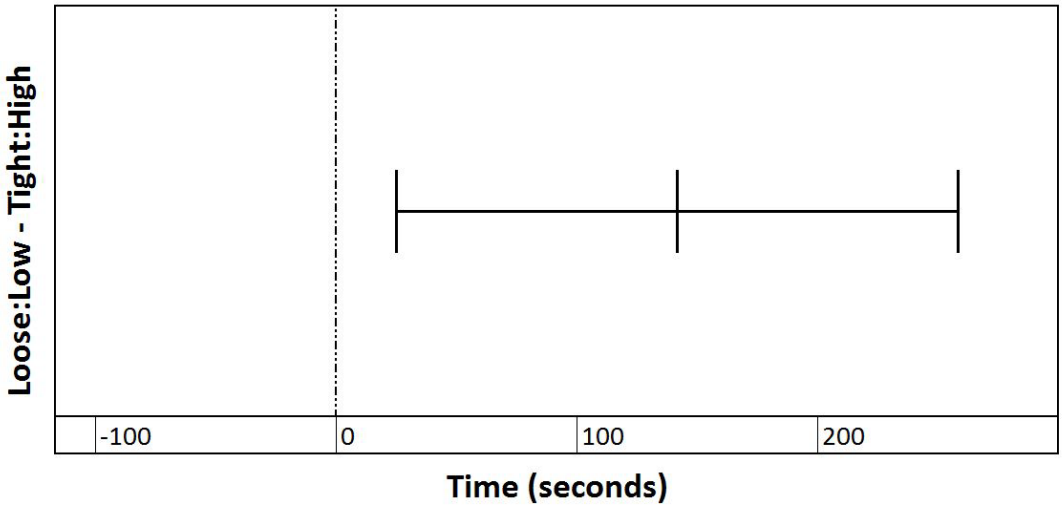
Figure 15. Tukey HSD Plot for Deadline Tightness Condition to IRA Against Number of Defects



Tukey HSD test plot depicting the mean difference between the tight deadline condition to low IRA and loose deadline tightness condition to high IRA against number of defects in the raw data not corrected for instituted defects.

The particular condition relating to hypothesis IIc is a loose deadline tightness condition and low IRA to a tight deadline tightness condition and high IRA. The result of the Tukey HSD under the concerned condition's had an upper confidence level of 246, a lower confidence level of 22.5, with a difference of 134, and the interval does not pass through zero with strong significance $p = .012$, providing support for hypothesis IIc. See Figure 16.

Figure 16. Tukey HSD Plot for Deadline Tightness Condition to IRA Against Cumulative Time



Tukey HSD test plot depicting the mean difference between the tight deadline condition to low IRA and loose deadline tightness condition to high IRA against number of defects.

E. SUMMARY

In summary, the t tests related to hypotheses Ia and IIa showed strong support.. Investigations of hypotheses Ib and IIb showed weak support for hypothesis Ib, but strong support for hypothesis IIb and investigations of hypotheses Ic and IIc, via multiple regression analyses yielded no support. However, post hoc analyses of these hypothesis with a Tukey HSD test, indicated some support for congruence of the main effects, as hypothesized.

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V. SUMMARY AND CONCLUSION

A. SUMMARY

In summary, our thesis analyzed archival datasets that were gathered from an experiment at the California Polytechnic State University. The experiment examined a warehouse task, measuring quality and cumulative time to complete a run as dependent variables. We used this archival data to test our hypotheses which involve the relationships among IRA, deadline tightness, regulatory focus, and the effect those variables have on defect rate and cumulative time to complete a run.

Our goal was to determine if there was a relationship between regulatory focus (dispositional factor), IRA (an operational context), and deadline tightness (a parameter under management control). We found four of six of our hypotheses were statistically supported in the sense that deadline tightness conditions do have an affect on the quality of the defects and the cumulative time taken to complete a run, and that those faced with tighter deadlines, as opposed to looser deadlines, will have a higher defect rate. We also found that participants in a low IRA aisle, on average, found five more defects than those in a high IRA. This might be attributed to the fact that individuals performing order picks in low or high IRA aisles were told the accuracy levels prior to the experiment.

In analyzing our hypotheses, we found the main effect of prevention focus approaches significance on the number of defects found by a participant, conducted through multiple regression analysis. In addition, we found that the main effect of promotion focus does not have statistical significance on cumulative time taken by a participant to complete a run, though it does have a significant effect when faced with a deadline.

B. DISCUSSION AND CONCLUSIONS

This paper examined several implications of deadline tightness.

As expected, we found the main effect of deadline tightness on productivity is positive. We also found the main effect of deadline tightness on quality is negative. This latter result is not surprising either but is less well known than the impact on productivity.

We examined the interaction of dispositional motivation and deadlines but found no support for our hypothesized relationships. The results indicate there may be interaction (see Figures 9 and 13) but the interactions were not statistically significant, and hence we will not interpret them here. However, future work with a larger sample size may be useful in further investigating these relationships.

Finally, we examined the interaction of IRA and deadline tightness. We found that tight deadlines exacerbate negative affect of low IRA on quality while tighter deadlines reinforces the positive affect on productivity.

It is difficult to draw strong conclusions from lab data based on a single experiment. But our findings may have practical applications for organizations such as DLA, NAVSUP, and other agency or organizations performing warehouse tasking when assigning or hiring individuals to perform such functions. For example, based on our results regulatory focus questionnaires maybe useful in the hiring selection process. In relation to deadlines, supervisors should be cautious that tighter deadlines have the potential to affect quality negatively.

C. LIMITATIONS AND EXTENSIONS

The limitations for this experiment are three-fold. The first limitation may be the environment/ setup of the experiment itself. It can be difficult to draw comparisons from those performing inventories in an experimental setting from those conducting order picks in a tactical environment or in a high dollar environment. A tactical environment can be considered similar to a tight deadline environment; however, a high dollar environment where soldiers, sailors, airmen, and marines are conducting order picks which may value in the millions, such as DLRs. Items used for this experiment were low

value assets such as, notepads and other various office supplies. Unlike in our experiment, where defects have little recourse, in high dollar environment deadlines may not matter due to the extreme repercussion for a single defect.

Secondly, another limitation may be that participants were only paid a nominal fee of $5; therefore, their level of input into the survey and experiment may not have been a true representation of their personality traits due to lack of motivation and seriousness. Further studies can be conducted using a reward scale, based on performance, to examine a relationship between reward, speed, and quality conditions.

Lastly, our sample size for this experiment was small, consisting of 50 individuals, of mostly college students with little to no warehouse or even work experience. This impacts statistically significance and our ability to estimate effect sizes. We have dealt with this in part by avoiding strict adherence to arbitrary thresholds like $p < .05$. However, to gain a better statistical understanding we would have preferred a larger sample size in which to evaluate.

A small sample size can also overweight outliers. There was one observation that seems to be an outlier; the participant, who we believe to be a full-time employee, was 721 seconds greater than the next largest observation. The removal of this assumed outlier reduces the median by 1.20 seconds and the mean by 11.0 seconds; this does not change the results to our conclusion. It can be assumed that this individual was extremely diligent in ensuring that he properly identified every item to eliminate as many defects as possible.

As previously noted, the literature on the relationship between deadline tightness and quality is sparse. Our results have added to a growing concern over the application of tight deadlines. Unlike the main effect of deadlines, the interaction with dispositional motivation we hypothesized has very little support in the literature. We built these hypotheses on expectations from the literature on the main effects. Our results suggest there may be interaction, but not of the form we suggested. Further theoretical work may be needed to explain these interactions.

We recommend that further research be conducted in an environment such as DLA or onboard ships to evaluate how factors such as inventory item value can play into deadlines and whether or not regulatory focus can have an effect on the throughput when value is introduced into the equation.

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