

**EFFECTS OF MULTIPLE ADJUSTMENTS IN SUPPLY
CHAIN FORECASTING ON FORECAST ACCURACY**

Banusha Aruchunarasa

208025X

Degree of Master of Science

Department of Transport and Logistics Management

University of Moratuwa

Sri Lanka

December 2021

EFFECTS OF MULTIPLE ADJUSTMENTS IN SUPPLY CHAIN FORECASTING ON FORECAST ACCURACY

Banusha Aruchunarasa

208025X

Thesis/Dissertation submitted in partial fulfillment of the requirements for the degree
of Master of Science in Supply Chain Optimization

Department of Transport and Logistics Management

University of Moratuwa

Sri Lanka

December 2021

DECLARATION OF ORIGINALITY

I declare that this is my own work, and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or institute of higher learning and to the best of my knowledge and belief, it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to the University of Moratuwa the non-exclusive right to reproduce and distribute my thesis/dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: ***UOM Verified Signature***

Date: 19/03/2022

STATEMENT OF THE SUPERVISOR

The above candidate has carried out research for the Degree of Master of Science under my supervision.

Name of the supervisor: Dr. H.N. Perera

Signature of the Supervisor:  ***UOM Verified Signature*** Date: 19th March 2022

ABSTRACT

Behavioral supply chain management is a subdiscipline within behavioral operations management that is growing rapidly. Judgmental adjustments of forecasts are considered part of this domain given the salience of forecasts to the smooth functioning of a supply chain. System-generated forecasts are frequently modified in the industry by forecasting professionals for numerous purposes. Accurate forecasts are significant to supply chain management and efficient organizational planning. Multiple adjustments occur when forecasts are subjected to more than one adjusted in its life cycle. Multiple adjustments are one of the key forecasting issues which impact forecast accuracy. Despite this, multiple adjustments to forecasts remain a not well-addressed research gap in academia. There are very few preliminary studies that investigate multiple adjustments to forecasts. Thus, to investigate the effect of multiple adjustments to forecasts to enhance forecast accuracy in the SC, the researcher employed a laboratory experiment with four different treatments to measure the forecasters' behavior specifically on multiple adjustments to forecasts. 194 undergraduate and MBA students were recruited as participants for the experiment.

In the Control Group, forecasts with first adjustments were observed while other treatments investigate how the participants would perform when they do subsequent adjustments with different levels of information availability. The authors found that multiple adjustments to forecasts significantly improve forecast accuracy. This expands the knowledge of multiple adjustments to forecasts to industry and academic professionals. Moreover, the provision of relevant information related to the previous adjustment allows the forecasters to perform better. The authors suggest the industries to increase information visibility among supply chain partners to have accurate forecasts and subsequent results in supply chain optimization. The results emphasize the importance of industry exposure and understanding the practical situations for a forecaster to improve his/her decision-making regarding judgmental adjustments. This study stresses the supply chain management-related degree programs to provide industry exposure to students to understand the practical implications of forecasting and other supply chain issues. Further works in this avenue, such as developing a forecasting model by integrating multiple adjustments and investigating the impact of the black-box effect in multiple adjustments are encouraged.

Keywords:

Forecasting, Judgmental adjustments, Multiple Adjustments, Laboratory Experiment, Behavioral Supply Chain Management

ACKNOWLEDGEMENT

In the first place, I intend to convey my heartfelt gratitude to Dr. Niles Perera, my post-graduate research supervisor. I have been privileged to get supervised by a supervisor like him who directed me from the very start of my MSc to the end. Further, I am thankful for his knowledge, motivation, guidance, and commitment throughout the degree program. I am sincerely grateful to my external advisor Prof. Dilek Onkal of Northumbria University, United Kingdom for her guidance, motivation, and support in the methodology development of my research study.

I intend to express my gratitude to the post-graduate research coordinator of the Department of Transport and Logistics Management Dr. T. Sivakumar for his guidance and support for the progress reviews at each step of the degree program. My profound gratitude should go to Senior Prof. Amal S. Kumarage, Former Head and Founder of the Department of Transport and Logistics Management of University of Moratuwa, and the current Head of the Department, Prof. A.A.D.A.J. Perera for providing me the opportunity to follow the degree program.

Further, I would like to thank Dr. A.I.T. Gamage and Mr. H.H.H.R. Chamara for their support and guidance throughout the experimental design and data collection for the research study. I am also thankful to the undergraduate and post-graduate students of the Department of Transport and Logistics Management and SLIIT Academy for their participation in the experiment. I wish to appreciatively acknowledge the Senate Research Grant No. SRC/LT/2020/20 of the University of Moratuwa, Sri Lanka for funding my research.

I would also like to thank all the academic and non-academic staff of the Department of Transport and Logistics Management for their support. Finally, I am truly grateful to my family, friends, and team members of the Center for Supply Chain, Operations and Logistics Optimization (SCOLO) for their advice, encouragement, and emotional support throughout the research study.

TABLE OF CONTENTS

DECLARATION OF ORIGINALITY	i
STATEMENT OF THE SUPERVISOR	ii
ABSTRACT	iii
ACKNOWLEDGEMENT	iv
TABLE OF CONTENTS	v
LIST OF FIGURES	vii
LIST OF TABLES	viii
LIST OF EQUATIONS	viii
LIST OF ABBREVIATIONS	ix
1. INTRODUCTION	1
2. LITERATURE REVIEW	4
2.1. Behavioral operations in Supply Chain Management	4
2.2. Forecasting	5
2.2.1. Judgmental Forecasting	7
2.2.2. Human adjustments in Forecasting	8
2.2.3. Multiple adjustments in Forecasting	10
2.3. Research Hypothesis Development	11
3. METHODOLOGY	13
3.1 Research Approaches	13
3.2 Laboratory experiment	14
3.3 Attributes of Laboratory experiments	15
3.3.1 Effective experimental design	15
3.3.2 Context	17
3.3.3 Subject pool	17
3.3.4 Incentives	19
3.3.5 Infrastructure and logistics	19
3.4 Experimental Design	19
3.5 Mechanics of the experiment	21
3.5.1 Task description	22
3.5.2 Basic Information	23
3.5.3 Plan	23
3.5.4 Feedback panel	27
3.6 Method and Procedure of experiment	28
3.7 Course credit selection for treatments	30

3.7.1	Random assignment of treatments	30
3.8	Sample	32
4	DATA ANALYSIS	34
4.1	Forecast accuracy improvement and multiple adjustments	35
4.2	Impact of Information sharing in multiple adjustments	39
4.2.1	Forecast Value Addition	40
4.3	Impact of Industry exposure in forecast accuracy	42
4.4	Size and Direction of the adjustments	46
4.5	Feedback Analysis	47
4.5.1	Prior knowledge on multiple adjustments	47
4.5.2	Importance placed on system-generated forecast	48
4.5.3	Importance placed on the forecast with the First adjustment	49
4.5.4	Importance placed on historical information	50
4.5.5	Level of trust on the system	51
5	DISCUSSION	52
5.1	Multiple adjustments and forecast accuracy	52
5.2	Forecast accuracy improvement through information sharing	53
5.3	Impact of industry exposure on forecast accuracy of multiple adjustments	53
5.4	Additional findings of the study	54
6	CONCLUSION	57
	REFERENCES	60

LIST OF FIGURES

Figure 2-1: Year-wise distribution of research papers	4
Figure 3-1 - Task description panel	22
Figure 3-2 - Cover story of the experiment	22
Figure 3-3 - Basic information panel	23
Figure 3-4 - Countdown clock in plan panel	24
Figure 3-5 - Historical information - Control Group	24
Figure 3-6 - Plan tab (Control Group)	26
Figure 3-7 - Plan tab (Treatment 1)	27
Figure 3-8 - Plan tab (Treatment 2)	27
Figure 3-9 - Plan tab (Treatment 3)	27
Figure 3-10 - Feedback panel	28
Figure 3-11 - Sequence of the experiment	29
Figure 3-12 - Landing page of fence link	31
Figure 3-13 - Redirection to treatment	31
Figure 3-14 - Random assignment of treatment	31
Figure 3-15 - Gender	32
Figure 3-16 - Subject group	32
Figure 3-17 - Age distribution	33
Figure 4-1 - Sample size of treatments	34
Figure 4-2 - QQ normal plots - H1	36
Figure 4-3 - Violin plot of MAPE by Treatment	38
Figure 4-4 - Violin Plot Groups	45
Figure 4-5 - Awareness of multiple adjustments	48
Figure 4-6 - Importance placed on the System-generated Forecast	48
Figure 4-7 - Importance placed on Forecast with the first adjustment	49
Figure 4-8 - Importance placed on Historical information	50
Figure 4-9 - Trust on System	51

LIST OF TABLES

Table 3.1 - MAPE of each SKU in data set	21
Table 3.2 - Difference between treatments	25
Table 3.3 - Details of marks	30
Table 3.4 - Average marks of students	30
Table 4.1 - Summary of Observations	35
Table 4.2 - R output of Shapiro Wilk test	36
Table 4.3- Dunn (1964)'s test- H1	37
Table 4.4 - Dunn (1964)'s test H2	40
Table 4.5 - FVA comparison	41
Table 4.6 - Summary of Observations in Groups	42
Table 4.7 - Shapiro Wilk test - Groups	43
Table 4.8 - Bartlett test H3	44
Table 4.9 -R output of Kruskal-Wallis's test H3	44
Table 4.10 - Summary of forecast adjustments	46
Table 6.1 - Findings of the Study	58

LIST OF EQUATIONS

Equation 3-1 - Marks calculation	30
Equation 4-1 - MAPE calculation	34
Equation 4-2 - FVA calculation	41
Equation 4-3 - Forecast Adjustment	46

LIST OF ABBREVIATIONS

ANOVA – Analysis of Variance

BSCM – Behavioral Supply Chain Management

BSC – Behavioral Supply Chain

CG – Control Group

FSS – Forecast Support System

FBA – Forecast by Analogy

FVA – Forecast Value Addition

MAPE – Mean Absolute Percentage Error

MBA – Master of Business Administration

MRP – Material Resource Planning

RBF – Rules Based Forecasting

SC – Supply Chain

SCM – Supply Chain Management

SD – Standard Deviation

SKU – Stock Keeping Unit

SLIIT – Sri Lanka Institute of Information Technology

SRC – Senate Research Committee

UK – United Kingdom

QQ – Quantile – Quantile plot