DESIGN FOR A SUSTAINABLE E-COMMERCE SYSTEM -- INCORPORATING HUMAN FACTORS INTO DISTRIBUTION OF MEDICAL MATERIALS AND FAST-MOVING CUSTOMER GOODS IN INVENTORY CONTROL

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By

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ABSTRACT

The rise of e-commerce has revolutionized the way we shop with significant benefits in terms of convenience and accessibility. However, the most crucial operational management responsibilities required in an ecommerce supply chain business focusing on the distribution of medical materials and fast-moving consumer goods, are procurement, inventory control, order processing, logistics and last mile distribution. A typical ecommerce business faces problems like careless data entry from employees, returns and customer complaints, customer acquisition and retention, high labor cost and high operational cost. These lead to an increase in late delivery of orders to customer and often resulted to customer orders returned, loss of sales, customers dissatisfaction, and low profit. This thesis investigated an ecommerce business that distributed fast moving consumer goods (FMCG) and medical materials (MM) to their online customers. This research discusses the impact of HF such as job skill, job satisfaction, job rotation, and job fatigue, on workers' job performance in an ecommerce operation system that focuses on distribution of MM and fast-moving consumer goods. First, surveys were created with the intention of identifying the HF mentioned and quantifying their influence on the system work performance. The data were examined for validity, reliability, and correlation using statistical analysis techniques. The study hypotheses were as follows: (1) There is no significant impact of (HF), including job skills, job satisfaction, job rotation, and job fatigue, on job performance within the modern B2B e-commerce model of companies ABC and XYZ. (2) There is no significant impact of (HF) on the levels of job satisfaction, job fatigue, and job rotation among warehouse workers within the modern B2B e-commerce model of companies ABC and XYZ. (3) The combined influence of job skills, job satisfaction, job rotation, and job fatigue does not significantly impact the determination of job performance among workers in the B2B e-commerce of companies ABC and XYZ. To test these

hypotheses, an experiment was created and carried out. The findings demonstrated an inconsequential significance between job skills, job satisfaction, job rotation, and job fatigue on job performance of the warehouse system. When making decisions in a real-world industrial context, these findings are anticipated to improve an ecommerce operation. The significant contributions of this thesis are summarized. First, this thesis work has increased the present understanding of HF and their significance in e-commerce operation, specifically in relation to the distribution of FMCG and MM, which will help the management of any ecommerce business make decisions in the fields of operations and supply chain management. Second, in starting an ecommerce business, this work has also shown that HF should be considered while investing in e-commerce business in terms of organizational goals and profit making.

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DEDICATION

To God Almighty, the Alpha and Omega, the Beginning and the End, and the Ancient of Days.

I humbly dedicate this work, with profound gratitude and reverence to God, my Creator and Sustainer. You are the source of all wisdom, inspiration, and strength. In your divine presence, I find purpose, meaning, and the boundless love that fills my heart.

In awe of your majesty, I acknowledge that every breath I take, every step I make, and every achievement I attain are only possible through your grace. You have guided me through the depths of darkness, and your light has illuminated my path, revealing the wonders of your creation.

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LIST OF ABBREVIATIONS

FMCG	Fast moving consumer goods
E-COMMERCE	Electronic commerce
B2B	Business to business
B2C	Business to customer
C2C	Customer to customer
HF	Human factors
C2B	Customer to business
JR	Job rotation
JS	Job shop
DC	Distribution Centre
SC	Supply chain
SKU	Stock keeping unit
GRN	Good receipt note
PO	Purchase order
OPU	Order processing unit
E2E	End to end
CAPEX	Capital expenses
MOM	Month on month
MHT	Material handling tool
MM	Medical materials
ANOVA	Analysis of variance
REB	Research ethics board
DTC	Direct to customer
SPSS	Statistical Package for Social Science
SME	Small manufacturing enterprise
SS	Service system
WSE	Work schedule error

CHAPTER 1

INTRODUCTION

1.1 Background and Motivation

Electronic commerce (E-commerce) is the buying and selling of goods and services, or the transmission of funds or data, over an electronic network, primarily the internet Tsagkias et al., (2020). According to figure 1.1, ecommerce business transactions occur either as business-to-business (B2B) (Pedeliento et al., 2016), business-to-consumer (B2C) (Zhang et al., 2011), consumer-to-consumer (C2C) (Peltier et al., 2020), or consumer-to-business (C2B) (Merchant and Mar 2012) . E-commerce is the business model of conducting transactions over the internet, which has been digitized to facilitate transactions between organizations and individuals. Ecommerce includes the process of product distribution, sale, purchase, marketing, and service through electronic system interface. Ecommerce encompasses a comprehensive ecosystem that extends beyond sourcing goods from manufacturers and suppliers. It intricately involves logistics, warehousing, retail partners, and most importantly, the end customers. In the E-commerce domain, there are other system process known as supply chain system (Wang et al., 2018). Supply chain (SC) is the management of the flow of goods amongst businesses, procurement, distribution center (DC), and logistics (Vakulenko et al., 2019; Ogbeyemi et al., 2023). SC includes the procurement of different stock keeping unit (SKUs) (Langley et al., 2021), through inbounding of the products, inventory storage, order processing (i.e., pick and pack), distribution to last-mile locations, and finally, the last-mile delivery to the customer (i.e., end-user). According to Luo et al. (2023), Ecommerce system is defined as the design, organizing, implementing, influencing, and observing of SC activities with the goal of increasing profit, increasing quality, increasing productivity, building a competitive infrastructure, leveraging worldwide fulfillment, synchronizing supply with

demand, measuring performance globally and to meet customer satisfaction. The technology[1] used in this Ecommerce system is veritably important and influences every business activist in running a business as consumer buying habits shift from traditional brick-and-mortar shopping to online shopping (Tsagkias et al., 2020). With the use of various technological tool in Ecommerce business processes, more service systems have been able to provide quality and on-time services to their customers. Despite the use of sophisticated tools, customer satisfaction has become and continued to be a critical issue in the success of every business system, including the traditional business method (i.e., Mortar and Brick business model) (Murphy, 2022) or cyber shopping stores.

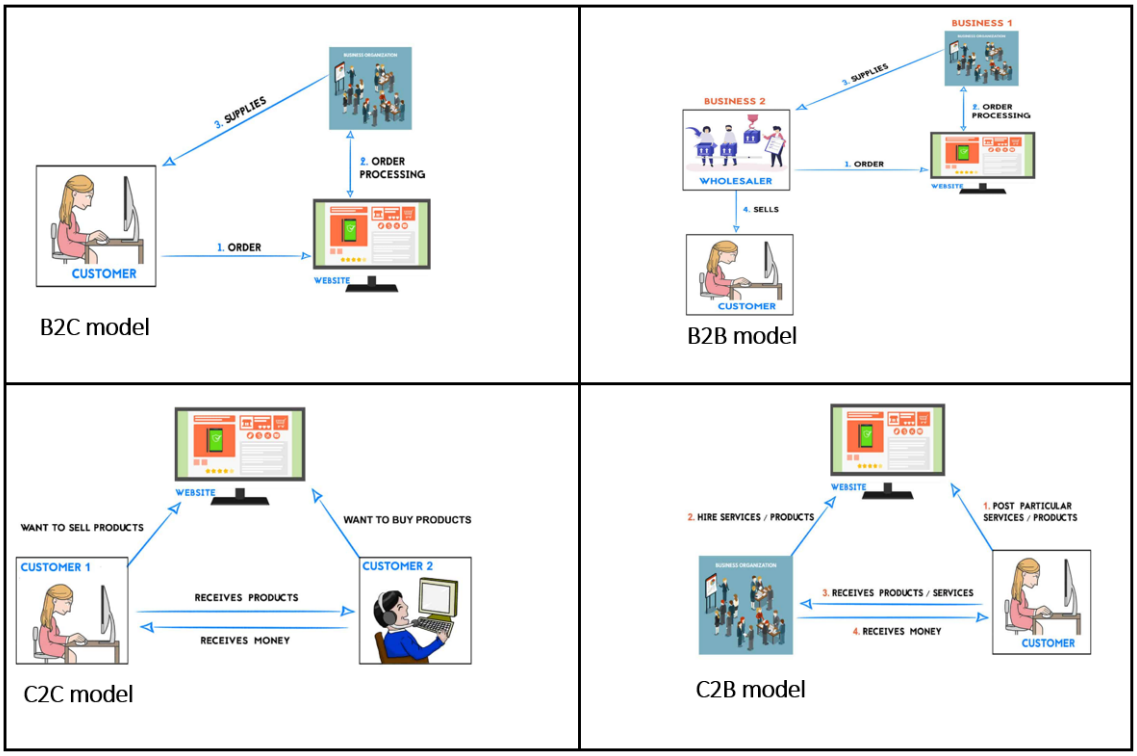
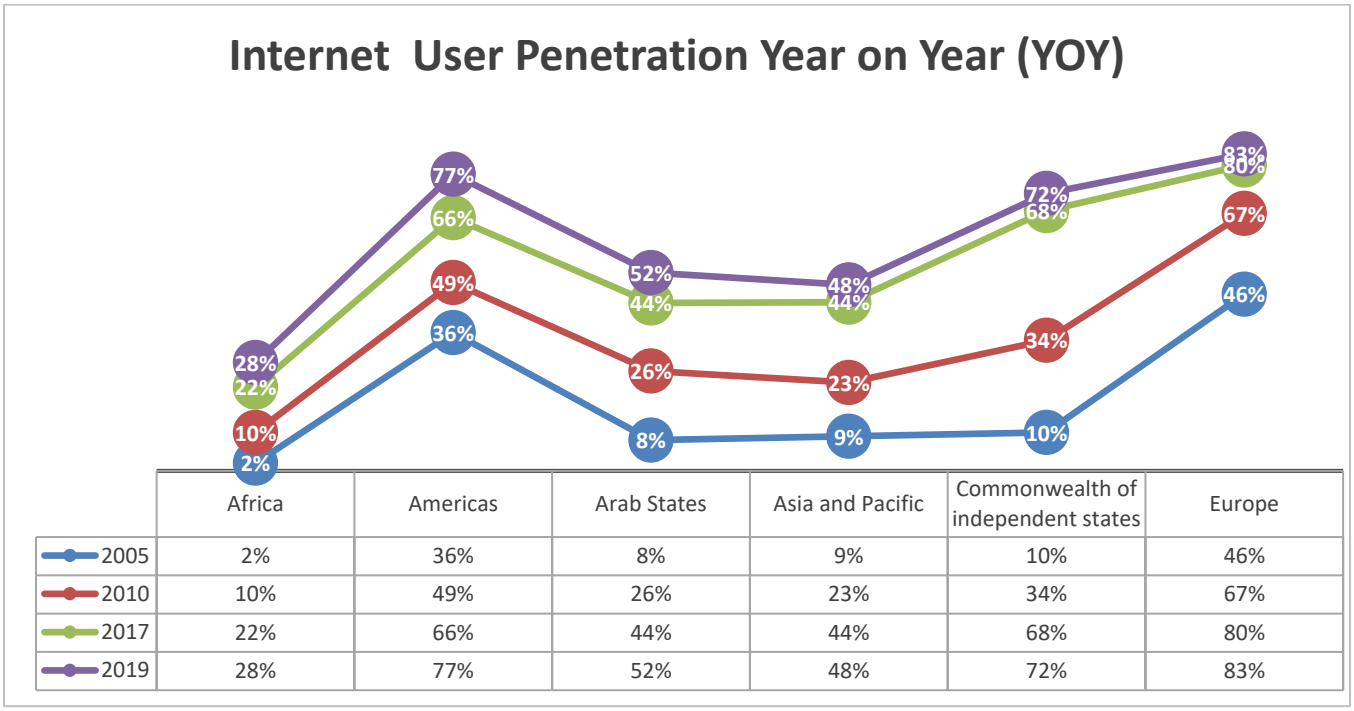


Figure 1.1. Type of ecommerce model (adapted from Arslan, 2022)

[1] Technology here is the ERP, website, and mobile application.

According to Rahman and Han (2011), a study was performed to analyze how consumers are moving toward online shopping, also data from “Statista and Internet World Stats” shows the estimated total number of internet users in 2020 to be between 4.3 billion to 5 billion active users (see Figure 1.2). Figure 1.2 shows the analysis of how users in the continent use the internet on a year-to-year basis. According to ITU (2021) online users report, African users were only 2% of the population in 2005 while in 2010, 2017, and 2019, the number of users increased to 10%, 21.8%, and 28.2% respectively. In the United States of America, E-commerce users were only 36% of the population in 2005, however, in 2010, 2017, and 2019, the users increased to 49%, 65.9%, and 77.2% respectively. In the Arab state, the users were only 8% of the population in 2005, however, in 2010, 2017, and 2019, the users increased to 26%, 43.7%, and 51.6%. For Asians in 2005, the users were only 9% of the population, and in 2010, 2017, and 2019 the users increased to 23%, 43.9%, and 48.4% respectively. Also, for the commonwealth states, the users were only 10% of the population recorded in 2005. In 2010, 2017, and 2019, the users increased to 34%, 67.7%, and 72.2% respectively. The Europeans records shows that online users were only 46% of the population in 2005, and in 2010, 2017, and 2019, the number of users increased to 67%, 79.6%, and 82.5% respectively. According to the statistical record mentioned, it is worth mentioning that there is a progressive increase in the use of the internet across the globe which shows that customers are beginning to trust the internet usage, but the core question is that why do Africa in general has the lowest percentage of internet users when it comes to E-commerce? To address this question is also part of this research motivation. Furthermore, the analysis done by ITU shows that both corporate organization and individuals internet usage trend has a profound impact on how they run their businesses. Connolly et al., (1998) With the platform-independent technology and global reach, the Internet is allowing companies to open new distribution channels,

establish communities of buyers and sellers, increase revenues, and boost the bottom line.



	Africa	Americas	Arab States	Asia and Pacific	Commonwealth of independent states	Europe
2005	2%	36%	8%	9%	10%	46%
2010	10%	49%	26%	23%	34%	67%
2017	22%	66%	44%	44%	68%	80%
2019	28%	77%	52%	48%	72%	83%

Figure 1.2. Internet Penetration 2019

Generally, most service systems work towards delivering optimal satisfaction to their client (for definition of a service system, (see Zhang et al., 2019). Although there are many factors that affect customer satisfaction, such as service quality, and some human factors (HF) to mention a few. Service quality is used to measure the quality of service that would be rendered to the user to know if they are satisfied or not when using the service (i.e., E-commerce platform) (Ogbeyemi et al., 2023). Other factors that determine customer satisfaction are customer value, customer experience, user experience, brand image, price, productivity, HF, and trust (Parker, 2015). HF is defined as "the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles,data and methods to design in order to optimize human well-being and overall system performance" (IEA Council, 2014). According to this definition, human consideration is assumed to be one of the

important factors to be considered in a system (Ogbeyemi, 2019). In addition, HF is considered to minimize the rate of human errors made by humans during the operational process like picking, packing, and shipping, and to increase the performance of warehouse operations (Perera et al., 2019). These factors are assumed to contribute to customer satisfaction. In this thesis, the motivation is to work towards incorporating some of these HF into distribution system that specializes on medical materials, fast moving consumer goods (FMCG) and inventory control through a statistical approach to address the issues faced by service systems, such as ecommerce, logistics and distribution system. This approach will be used to investigate further the effect of some HF and their impact on system performance, customer satisfaction, effectiveness, and profitability of the business management system.

1.2 Overview and Background of the Study for ABC and XYZ

In this thesis, I will consider two B2B service systems (SS) called **ABC and XYZ** to illustrate the study. The identification of ABC and XYZ would be undisclosed due to privacy and security act surrounding ABC and XYZ (Power et al., 2021). **ABC** is a SS known for B2B E-commerce activities in West Africa and ABC focuses on delivery of MM and FMCG (Farmer, 2013), via online purchase. While XYZ is also a SS known for ecommerce activities in west Africa and focuses on delivery of different categories of items including MM. This study illustrates the challenges faced by ABC and XYZ, and how it should be addressed. The primary focus of this study will be on ABC, as both SS companies have similar operations. Additionally, the inclusion of XYZ is intended to facilitate a comparison of the challenges faced by both companies and to validate the hypothesis and findings. Throughout the past decade, the E-commerce landscape in West Africa has witnessed the emergence of various companies. However, it is noteworthy that among these companies, ABC stands out as the only E-commerce company that has exclusively

concentrated on the distribution of FMCG and MM. However, ABC was established during Covid 19 pandemic to help the retailers in the procurement of FMCG and MM since they are in high demand during this period. According to ABC, they have adopted a well-known distribution model called Hub and spoke model (Loriaux, 2018) to reduce the delivery timeline for better customers satisfaction. Figure 1.3 shows the end to end (E2E) process flow of company **ABC.** In the Figure, **region A** shows how the procurement team liaises with the vendor to purchase the products and send them to the warehouse via the supplier, the inbound team receives the products by ensuring that the purchase order (PO) matches the products supplied and the receiving team raised a good receipt note (GRN) for inventory accuracy and financial reporting. **In region C**, the inventory team puts away the received products into their respective location (Racks and pallets). **In region B**, when customer places order from the website, the order processing unit (OPU) team picks and packs the assigned shipment ordered by the customer. **In region E**, shipments are transferred to the logistic team while loading into vans for onward delivery to customers (last-mile delivery). **In region D**, if the customer rejects any product due to any reason, refunds or replacement takes place and the product is returned to the warehouse. This paper is motivated by the aim to address the challenges encountered by the E-commerce companies ABC and XYZ. It places a significant emphasis on the impact of HF on job performance and seeks to compare the results of the analysis conducted for both companies, facilitating informed decision-making

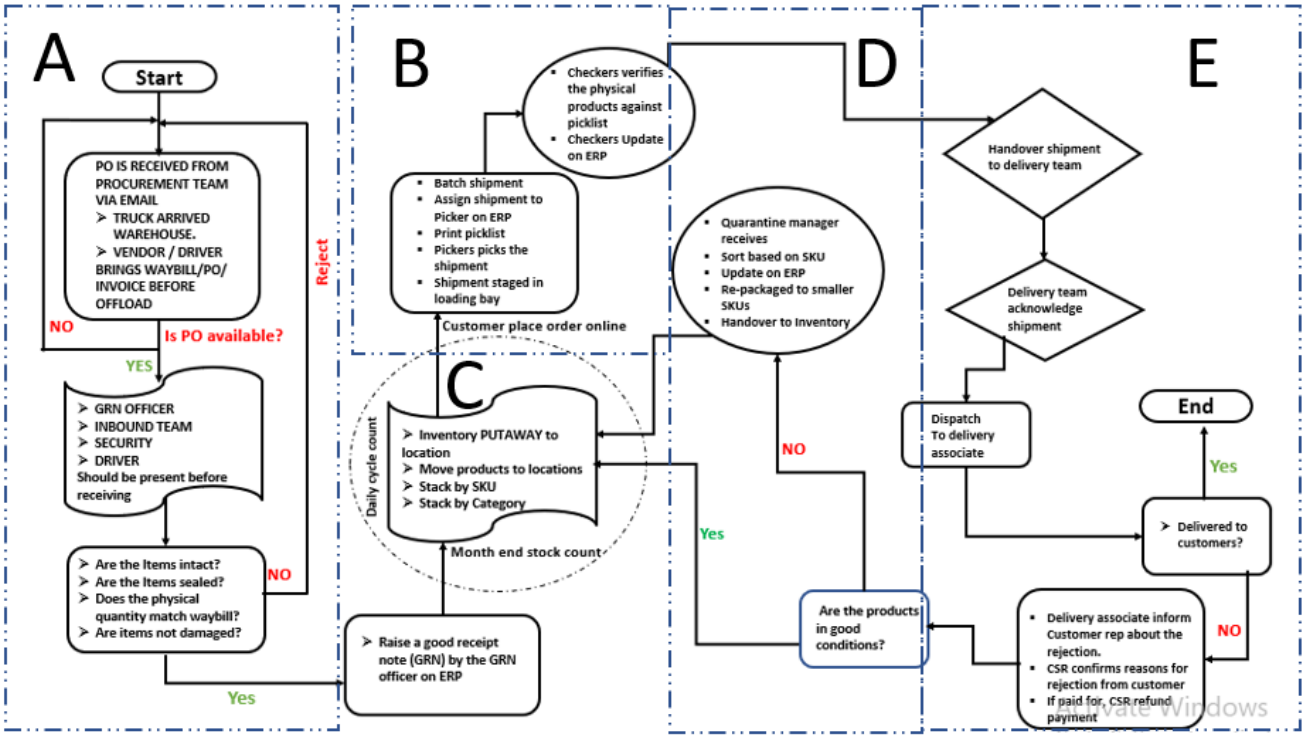


Figure 1.3. The End to End (E2E) Workflow of ABC

1.3 Problem Description

The impact of HF in the ecommerce models of both ABC and XYZ cannot be underestimated. HF plays a critical role in shaping various aspects of these models, from the design of user interfaces and order fulfillment processes to ensuring smooth interactions between workers and automation systems. A well-implemented HF approach ensures that the user experience is intuitive, efficient, and error-resistant, ultimately contributing to customer satisfaction and operational excellence. By considering ergonomic principles, cognitive load, and user-centered design, both companies can optimize their ecommerce processes, enhance user engagement, and minimize errors that can lead to customer dissatisfaction and increased costs. The sustainability of the B2B ecommerce models of ABC and XYZ hinges on their ability to balance profitability and customer satisfaction. Efficient and user-friendly platforms that result from effective HF integration enhance customers'

ease of use, leading to increased satisfaction and loyalty. Moreover, the integration of HF principles can streamline operational processes, reducing errors and enhancing productivity, which in turn influences profitability. For both ABC and XYZ, sustainable growth involves aligning their ecommerce strategies with HF best practices to achieve a harmonious equilibrium between profitability and customer satisfaction The introduction of ABC's operations in West Africa during the Covid-19 pandemic, without considering factors like HF, overhead costs, and capital expenditures, has reverberated across its workforce dynamics. As the company expands, the growing overhead costs coupled with the need for high productivity have led to a challenging dilemma. The company faces a delicate balance between maintaining a productive workforce and optimizing profitability. Downsizing, although aimed at cost optimization, raises concerns about reduced job satisfaction, increased job fatigue, and disrupted job rotation. This can lead to diminished operational efficiency, affecting order processing, last-mile delivery, and, consequently, customer satisfaction. It becomes evident that the interconnectedness between workforce dynamics, operational efficiency, and customer satisfaction underscores the critical importance of holistic decision-making guided by HF principles. In conclusion, the nexus between HF, sustainability, and workforce dynamics is essential for both ABC and XYZ to navigate the complexities of the ecommerce landscape. An adept incorporation of HF practices can pave the way for optimized ecommerce processes, enhanced profitability, and improved customer satisfaction, while strategic decisions concerning workforce dynamics must be grounded in a balanced understanding of HF, operational efficiency, and overall business goals.

Table 1.1. Warehouse overhead cost adapted from ABC

Warehouse Overhead Cost				
Role	Available staff	Monthly salary	Total Overhead cost (Naira)	Total Overhead cost (CAD)
Fulfilment center Head	1	450,000.00	450,000.00	1,363.64
Managers	7	200,000.00	1,400,000.00	4,242.42
Supervisor	45	70,000.00	3,150,000.00	9,545.45
Inventory checkers	10	60,000.00	600,000.00	1,818.18
Pickers	50	40,000.00	2,000,000.00	6,060.61
Loaders	150	30,000.00	4,500,000.00	13,636.36
Security	30	40,000.00	1,200,000.00	3,636.36
Admin/ cleaning	10	30,000.00	300,000.00	909.09
			13,600,000.00	41,212.12

Table 1.2. Warehouse Operational Cost from ABC

Warehouse operational Cost for one location				
Cost center	No of location	Operational cost	Total cost (Naira)	Total cost (CAD)
Utilities	1	220,000.00	220,000.00	666.67
Running on Generator	1	3,200,000.00	3,200,000.00	9,696.97
Internet	1	320,000.00	320,000.00	969.70
Rent	1	2,900,000.00	2,900,000.00	8,787.88
Monthly logistics Cost	1	33,000,104.12	33,000,104.12	100,000.32
			39,640,104.12	120,121.53

Table 1.3. Monthly order delivered from ABC

Monthly Order delivered				
Month	Monthly order delivered	Monthly Order delivered (Naira)	Monthly Order delivered (CAD)	Monthly Profit (CAD) @5% margin
May	4,876	170,811,315.00	517,610.05	25,880.50
June	6,536	267,854,865.00	811,681.41	40,584.07
July	8,211	330,269,019.00	1,000,815.21	50,040.76
August	8,819	357,947,447.00	1,084,689.23	54,234.46
September	11,656	467,385,838.00	1,416,320.72	70,816.04
October	12,089	546,700,000.00	1,656,666.67	82,833.33
		2,140,968,484.00	6,487,783.28	324,389.16

Table 1.1, 1.2 and 1.3 shows the monthly net salary for the workers, the operational running cost and value of orders delivered to the customer on month to month (MOM) basis. Looking at the analysis, in the month of May, June, July August, September, and October. The value of successful delivery was 517,610.05CAD, 811,681.41CAD, 1,000,815.21CAD, 1,041,6320.72CAD, 1,416,320.72CAD, and 1,656,666.67CAD, respectively. This show that there was increase in sales on month to month, yet the company was unable to make profit due to the high operational running cost. From Table 1.2, the operational cost was very high from May to October which implies that the revenue generated is below the expected budget. Furthermore, if the company wants to improve their productivity and performance, it means that the projected revenue would have to increase by 40% to 48%. For this increase to be achieved that means HF need to be considered and the CAPEX need to be adjusted. To illustrate the line plot from Tables 1.1, 1.2, and 1.3, a line graph was employed to visually depict the comparisons among order value, monthly profit, and operating

costs for each month. Initially, the data was structured into a table, with columns dedicated to the months (spanning from May to October), order value, monthly profit, and operating costs. Microsoft Excel was selected as the software for crafting the line chart. Highlighting the data corresponding to the months (May through October) and their respective values for order value, monthly profit, and operating costs. Inserting a line chart into the spreadsheet, which facilitates the simultaneous comparison of three data series (order value, monthly profit, and operating costs) for each month. Labeling the X-axis with the months (e.g., May, June, July) and the Y-axis with their corresponding values (order value, profit, and cost). Entering the data into the chart as three separate data series: order value, monthly profit, and operating cost. This approach allows for a clear visual representation of how these variables fluctuate across the six months According to figure 1.4, The data includes operating costs, monthly order delivered (revenue), and monthly profit calculated at a 5% profit margin. Operating Cost: This represents the cost incurred by the company to run its operations. Monthly Order Delivered (Revenue): This represents the total revenue generated by the company from delivering orders. Monthly Profit (CAD) @5% Margin: This represents the monthly profit calculated by applying a 5% profit margin to the revenue. comparing the monthly profit with the operating cost for each month. Which indicate that if the monthly profit is higher than the operating cost, it indicates a profit. For May: Profit (25,880.50 CAD) < Operating Cost (120,121.53 CAD) - loss. For June: Profit (40,584.07 CAD) < Operating Cost (120,121.53 CAD) - loss. For July: Profit (50,040.76 CAD) < Operating Cost (120,121.53 CAD) - loss. For August: Profit (54,234.46 CAD) < Operating Cost (120,121.53 CAD) - loss. For September: Profit (70,816.04 CAD) < Operating Cost (120,121.53 CAD) - loss. For October: Profit (82,833.33 CAD) < Operating Cost (120,121.53 CAD) - loss. Based on this analysis, the company is running at loss in each of the months from May to October, as the monthly profit is

below the operating cost for each month. Figure 1.5 shows a forecast of how the company would break-even if the performance is increased by 48%. Figure 1.5 shows that the company is making profit when monthly profit increase by 48%. Monthly Order Delivered (CAD): This line representing the trend in monthly orders delivered. It shows that there is an increase in orders over the months. Monthly Profit (CAD): This line represents the trend in monthly profits. It displays the profits across the months. Monthly Profit (CAD) with a 48% performance increase: This line shows how profits change after a 48% performance increase. indicating increased profits due to the performance improvement. Comparing Profit and Orders: The graph allow viewers to observe the relationship between monthly orders and monthly profits. If profits increase as orders increase, there may be a positive correlation. Impact of Performance Increase: The introduction of "Monthly Profit (CAD) with a 48% performance increase" will help evaluate the effectiveness of the performance improvement strategy. If this line is consistently above the original profit line, it indicates a positive impact on profitability due to the performance enhancement. This line graph will provide a clear visual representation of how monthly orders, profits, and the impact of a performance increase evolve over time, aiding in data interpretation and decision-making. The best way out of this operational issue would be to adjust the cost of running the operation, and to consider HF in other to attain sustainability, and efficiency of the operation. However, HF would be a critical factor to be considered while adjusting the running cost so as not to cause downtime on operation. In addition to financial analysis, it's essential to recognize the influence of HF on the company's performance. HF include aspects related to the employees, such as their skills, motivation, and job satisfaction. These factors play a significant role in determining the company's overall effectiveness and profitability. By examining HF alongside financial data, companies can gain a holistic understanding of the company's performance drivers. For instance, a highly motivated and skilled workforce may contribute to increased productivity, leading to higher monthly order deliveries

and ultimately improved profitability. Conversely, factors like employee fatigue or low job satisfaction may negatively impact performance. Therefore, this analysis not only considers financial metrics but also acknowledges the importance of HF.

in shaping the company's success. According to ABC operation, most of the work processes are done manually because of some limitations in the provision of material handling tools (MHT), absenteeism and sudden resignation of skilled workers. All this behavior causes shortages in manpower which does not allow proper capacity planning to achieve the goals for the business. Also, it was observed that the late delivery was because of HF. Reflecting on the challenges within the company, a significant portion of these concerns stems from human errors. These errors have subsequently contributed to a rise in customer-initiated order rejections and, consequently, delayed deliveries to their valued clients. This also indicates that, to maximize the total performance and efficiency of the ecommerce system, the effect of HF among the workers needs to be investigated towards improving the performance of the system.

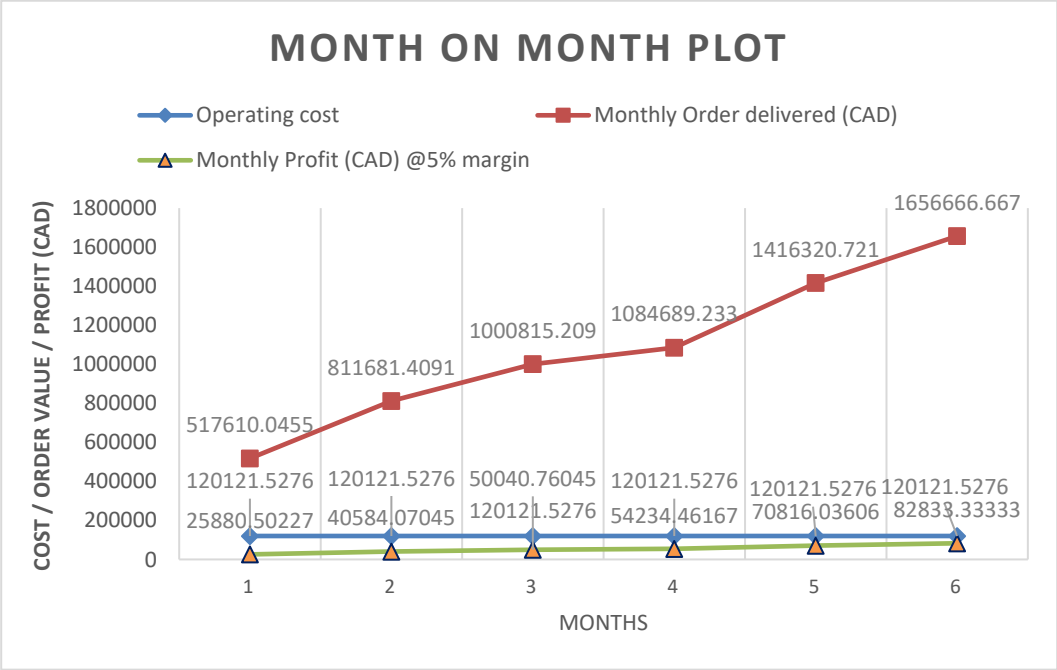


Figure 1.4. The chart of company ABC running at lost.

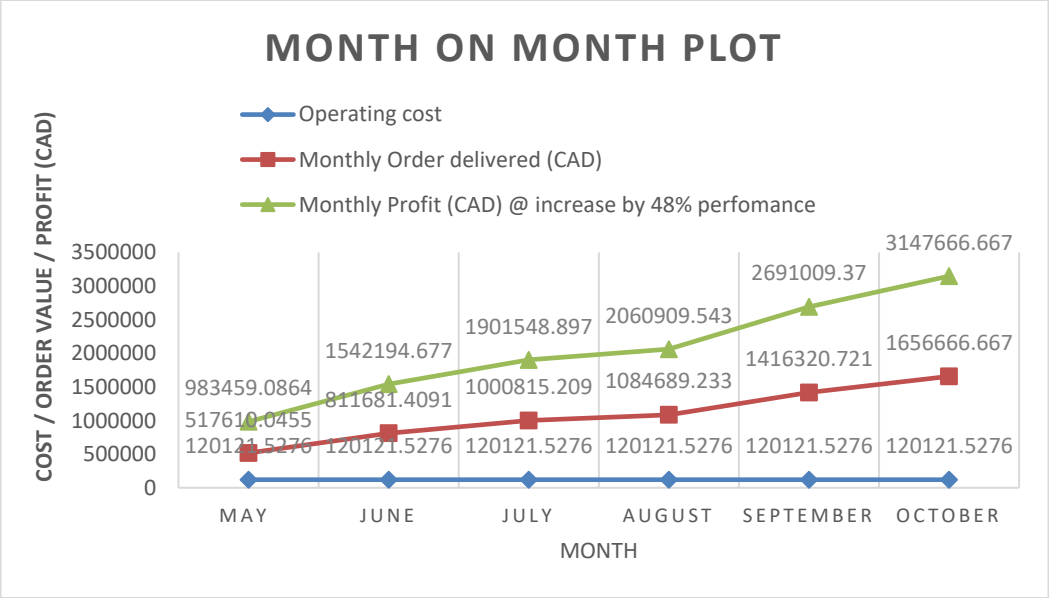


Figure 1.5. The chart of the revenue increased at 48% performance.

1.4 Research Questions

Several ecommerce models are widely used by so many companies since post pandemic covid 19, however, there are several questions about the model, which are to be addressed in this research. This study aimed to examine and investigate how the effect of HF amongst the warehouse workers influence job performance. To achieve this goal, the following questions were raised.

- Question 1: What is the significant impact of HF, including job skills, job satisfaction, job rotation, and job fatigue, on influencing job performance within the modern B2B e-commerce model of companies ABC and XYZ?
- Question 2: What is the significance impact of HF in understanding the levels of job satisfaction, job fatigue, and job rotation among warehouse workers within the modern B2B e-commerce model of companies ABC and XYZ
- Question 3: What is the combine contribution of each of the independent variables including job skills, job satisfaction, job rotation and job fatigue to the determination of the

dependent variable (i.e., job performance) of the workers within the modern B2B e-commerce model of companies ABC and XYZ

To answer these questions, this thesis embarked on quantitative research to address the questions at hand. Through careful design and execution, by identifying and exploring HF, by investigating their significance with the job performance of warehouse workers within the operational settings of both B2B ecommerce company ABC and XYZ. The research methodology encompassed an array of statistical tools, including linear regression, Pearson correlation, and two-way ANOVA, employed to ascertain significance. This statistical analysis facilitated the lighting of significance between HF and job performance of the B2B ecommerce systems. The analysis was accurately conducted utilizing the Statistical Package for Social Science (SPSS) software, serving as a robust framework for evaluating the individual and combined data. Furthermore, the hypotheses emerged progressively from the research questions, paving the way for an efficient investigation. These hypotheses were systematically tested and validated, aligning with the main objective of the study. Hypothesis One: There is no statistically significant impact of job skills, job satisfaction, job fatigue, and job rotation on job performance within the modern B2B e-commerce model of companies ABC and XYZ, and there is a significant impact of HF job skills, job satisfaction, job rotation, and job fatigue on job performance within the modern B2B e-commerce model of companies ABC and XYZ. Hypothesis Two: There is no statistically significant impact on the levels of job satisfaction, job skills, job fatigue, and job rotation among warehouse workers within the modern B2B e-commerce model of companies ABC and XYZ, and there is a significant impact on the levels of job skills, job satisfaction, job fatigue, and job rotation among warehouse workers within the modern B2B e-commerce model of companies ABC and XYZ. Hypothesis Three: The combined influence of job skills, job satisfaction, job rotation, and job fatigue does not

significantly impact the determination of job performance among workers in the B2B e-commerce of companies ABC and XYZ, and the combined influence of job skills, job satisfaction, job rotation, and job fatigue significantly affect the determination of job performance among workers in the modern B2B e-commerce model of companies ABC and XYZ. The research questions and hypotheses intertwine quantitative exploration with a careful examination of the significance between job skills, job satisfaction, job fatigue, and job rotation and job performance.

1.5 Organization of the Thesis

This thesis is divided into five chapters, each serving a specific purpose in advancing the research. Chapter 1 encompasses the introduction, research motivation, background of the study, problem description, and research questions. It sets the foundation for the study by providing a comprehensive overview of the research context. In Chapter 2, the literature review section offers a concise summary of the existing body of knowledge relevant to the research topic. It presents a thorough examination of prior works and studies that are directly related to the subject matter, contributing to a deeper understanding of the research area. Chapter 3 focuses on the research methodology, outlining the chosen approach and presenting a statistical mathematical model that illustrates the significance observed between the variables under investigation. Additionally, it details the study design and describes the techniques employed for data collection. Chapter 4 delves into the analysis and interpretation of the collected data. It encompasses various statistical analyses, including tests for reliability, normality, hypothesis testing, and descriptive statistics. The chapter presents the results derived from the statistical model and engages in a comprehensive discussion of their implications and conclusions. Lastly, in Chapter 5, the findings from the results analysis are presented along with recommendations based on the research contributions. This chapter serves as a platform to share practical insights derived from the study's outcomes.

Furthermore, it suggests potential contributions for future research (i.e., providing a valuable guide for further exploration in the field of distribution system).

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter offers a thorough explanation of the background necessary to comprehend the proposed study as well as a review of the literature pertinent to the proposed research. Section 2.2 and Section 2.3 give an overview of the research on the impact of the challenges on ecommerce model and ecommerce distribution model, respectively. Section 2.4 will cover the subject of HF and its significance with job performance. Section 2.5 discusses the statistical analysis and its application. Section 2.6 presents a conclusion of the chapter regarding the need and urgency of the proposed research. The field of HF has gained prominence in recent years as organizations strive to optimize various facets of their operations. This chapter presents a comprehensive review of relevant literature on the significance of HF, specifically job satisfaction, job fatigue, job rotation, and job skills, in influencing job performance within the e-commerce industry. HF in E-commerce; The e-commerce industry has witnessed exponential growth, revolutionizing the way business is conducted globally. As technology continues to shape this industry, the role of HF becomes increasingly crucial. Several studies have explored the relationship between HF and job performance within e-commerce settings. Lu and Lin, (2018) highlighted the impact of stress on performance effectiveness, a concept that resonates with the e-commerce sector, where workers often encounter high-pressure situations. Job Satisfaction has been recognized as a key determinant of job performance. Bowling, et al., (2015). Employee contentment and motivation have been shown to positively correlate with enhanced performance. In the context of e-commerce, job satisfaction is vital due to the highly dynamic and competitive nature of the industry. Employees who derive satisfaction from their work may exhibit greater commitment and productivity (Harter et al., 2002).

Job Fatigue and Performance Job fatigue, often linked to factors such as long hours and repetitive tasks, can negatively affect job performance. It can lead to reduced concentration, increased errors, and decreased overall productivity (Lyubykh et al., 2022). In e-commerce, where workers may face demanding schedules and workloads, the influence of job fatigue on job performance warrants examination. Job Rotation and Performance Job rotation has been proposed as a strategy to enhance job performance (Ravenhill and Liu, 1997). It can provide workers with a broader skill set and reduce monotony. However, the extent to which job rotation positively affects job performance in e-commerce, characterized by specialized tasks and roles, remains a subject of inquiry. Job Skills and Performance The importance of job skills in job performance is evident in various industries, including e-commerce. Skilled workers are often more adaptable and effective in handling complex tasks (Salas et al., 2012). The concept of job rotation, typically used to broaden skill sets and reduce monotony, presents intriguing questions in B2B ecommerce. Recent studies, such as the research by Hernandez and Charles (2020), delve into the effectiveness of job rotation in the context of specialized roles within ecommerce companies. Their findings reveal that strategic job rotation can enhance job performance, but the extent of this impact warrants further exploration in the case study.

2.2 Impact of the challenges on ecommerce model

2.2.1 Impact of the challenges on customer and organizational goal

This section discusses the existing literature pertaining to the challenges faced by E-commerce, understanding the impact of the challenges on customer behaviour (customer goal), impact on organisational profit (business goal), and the solutions to the problems. According to Tsagkias et al. (2020), their research explained certain challenges, such as the impact of regulatory and business restrictions on E-commerce business, which was used to govern which goods can be

displayed to customers. For example, hunting knives cannot be sold to customers online in the UK, alcohol and some drugs cannot be sold online in some places in the US and only adults can view or buy certain products. Though, most E-commerce sites have business technique at the time of checkout to regulate whether a product can be purchased and shipped to a given customer. However, showing products that cannot be purchased by customer provides an unsatisfying experience. According to Jennifer (2022), the challenges discussed in her research are (a) cybersecurity; in the case of a cyberattack, an E-commerce business cannot afford to have downtime in operations and sales, because every transaction is a marginal financial success that the business depends on. (b) competition: the E-commerce space has become so saturated that standing out from other E-commerce businesses is challenging, distinguishing your business from your competitors is crucial to standing out and attracting new customers for your business. (c) order fulfilment is the backbone of E-commerce fulfilment, late delivery and wrong products may generate from this challenge if this issue is not well addressed. (d) inventory visibility: when the stocks are not visible physically or on the website the customer tends to visit other E-commerce platform which reduces the sale for the business. Huria (2019) discusses selected challenges for facilitation and logistics for E-commerce. The key challenges include (a) an undeveloped legal enabling location: regulations that enable E-commerce are critical legal infrastructures that must be in place for E-commerce transaction to exist. (b) the need to improve national quality infrastructure: E-commerce consumers demand product traceability, and conformity to international standards helps reassure them that products are efficient and safe, when this is not in place customers tend to move to other competitors. (c) poor incorporation of postal services with border agencies; (d) the necessity to improve in-flight connectivity; though E-commerce delivery before the last mile uses a combination of the various transport methods (ship, air, and land). The

position of air freight cannot be overstated for cross boarder shipment. (e) the poor scope of logistics and postal distribution in isolated areas; inaccessible areas in developing countries frequently lack entree to crucial logistics facilities, infrastructure, and delivery systems, which disturbs their ability to benefit from E-commerce. Nguyen et al. (2021), further discusses that the customer satisfaction with last-mile delivery of goods in the E-commerce industry has been influenced by many factors, including tangibility, reliability, safety, empathy, responsiveness, and perceived value. Tangibility is reflected in elements that customers can feel directly, such as facilities, medical equipment, machines, personnel, and communication materials. Reliability reflects its reputation and accuracy in implementing and delivering the services promised to its customers. Responsiveness is reflected in our ability to perform, our ability to provide service quickly, our ability to be ready to respond to needs, and our ability to resolve customer complaints. Safety is reflected in factors that give customers confidence and peace of mind when using the services. This includes staff communication skills, motivation, and expertise. Empathy reflects the care and attention of the staff to ensure that customers feel welcome and comfortable with their services. Bingi et al, (2000) emphasized on four major issues facing the E-commerce industries, which are economic, technological, social, and legal. It was also discussed that the factors are broadly applicable to both business to business (B2B) and business to consumer (B2C) and understanding the effect of the factors on E-commerce performance as seen in Figure 2.1.

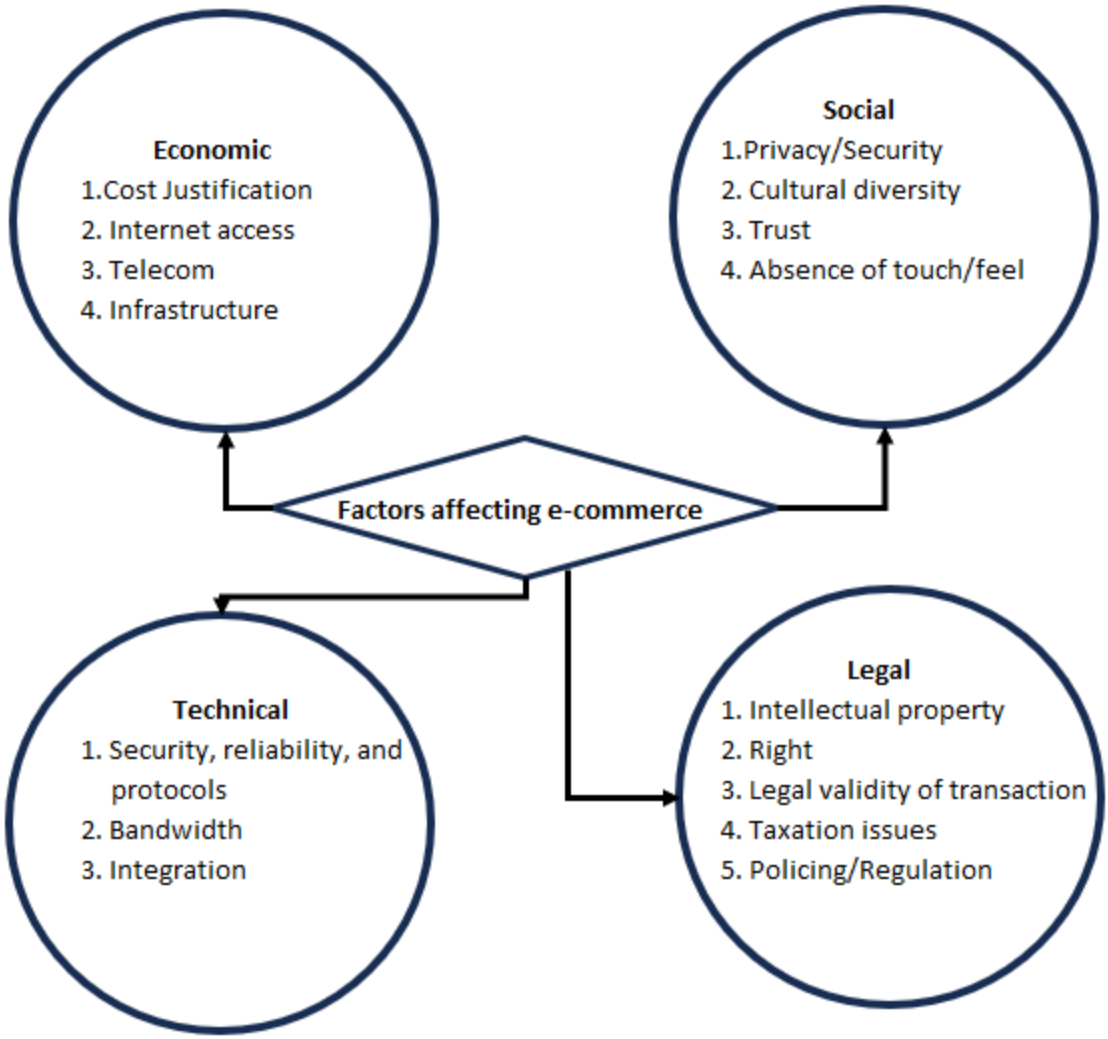


Figure 2.1. Factors affecting ecommerce (adapted from Bingi et al, (2000)**.**

In the work of Rahman and Han (2011)**,** an analysis was carried out to authenticate the factors affecting customer satisfaction in the E-commerce industries. The factors that were analyzed are network speed of response, the website image of integrity, payment security, feedback, community interaction, and return. Confidentiality of personal information, product description, shopping convenience, product quality, product prices, time saving, and operating procedures are few other

factors to be considered too. Table 2.2 shows the analysis of the survey carried out for an online merchant. This indicates that the percentage of satisfied customers outweighs those who are dissatisfied.

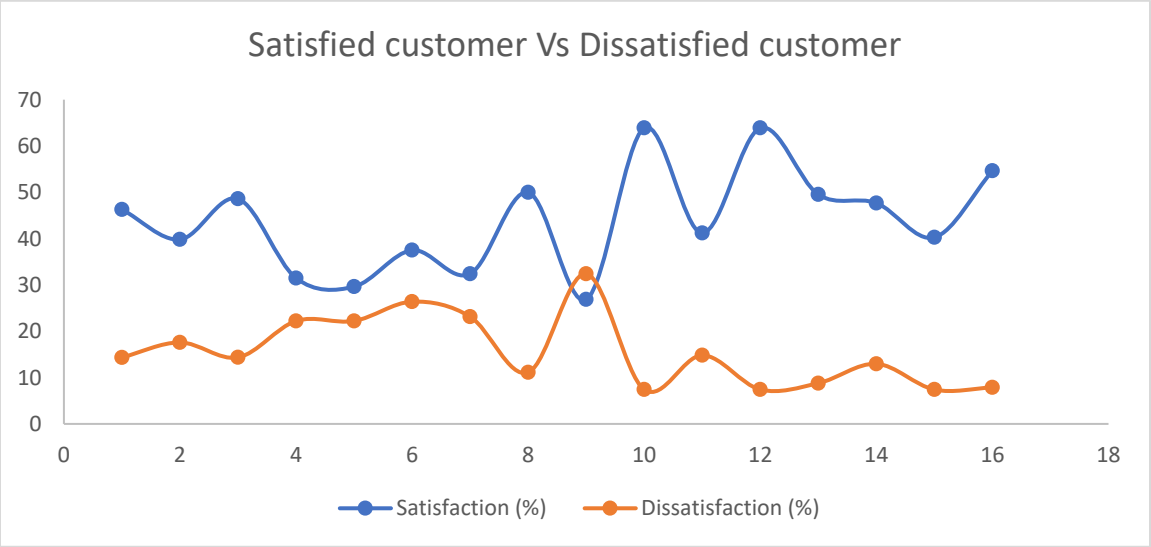


Figure 2.2. Graphical representation of customer satisfaction and dissatisfaction

Table 2.2 Customer satisfaction and dissatisfaction adapted from (Rahman & Han, 2011)

Factor	Satisfaction (%)	Dissatisfaction (%)
The network speed of response	46.3	14.35
The website image of integrity	39.82	17.59
Payment Security	48.6	14.36
Interaction	31.48	22.22
Feedback channels	29.63	22.22
Returns	37.5	26.39
Confidentiality of personal information	32.41	23.15
Operational process	50	11.11
Shopping convenience	26.86	32.41
Save time	63.89	7.41
Product Description	41.21	14.82
Product price	63.89	7.42
Product Quality	49.53	8.79
Transaction security	47.68	12.97
Personalized	40.27	7.41
Product category	54.63	7.87

E-commerce industries encounter additional challenges, including the use of labor-intensive inventory tracking methods across various software and spreadsheets. This approach proves time-consuming, redundant, and vulnerable to errors, ultimately resulting in delayed deliveries and reduced warehouse productivity. If the inventory management controls system at the warehouse is

labor-intensive and involves several steps, such as receiving and put away, picking, packing, and shipping. Such challenges can result in shipments being incomplete, inaccurate, or delayed. It can also lead to inventory losses due to factors such as wastage, damage, or theft. Additionally, inaccurate data and limited visibility further compound these issues. These challenges lack attention despite the use of sophisticated management tools to perform all these tasks. Despite the above literatures, there is still a gap in the literature when considering HF. The majority of previous studies tend to overlook the influence of HF when addressing challenges within the E-commerce system. Often, these studies center their focus on system processes and technology, inadvertently neglecting the significant impact that human actions can exert on the entirety of the E-commerce system. In this research, contributions from some of this literature will be used to address the issues, which will incorporate HF such as performance of workers, fatigue, satisfaction, and rotation, as constraints to be considered.

2.3 Ecommerce distribution model

Models for Distribution: Another crucial component of e-commerce networks is distribution, which guarantees the prompt and effective delivery of goods to customers. The hub-and-spoke model, direct-to-consumer, drop-shipping, and the cross-docking model are examples of distribution models that have been created to maximize product delivery in e-commerce systems. (Zhang et al., 2018; Jiang et al., 2017). These models don't account for the effects of HF on distribution because they are founded on logistical and transportation principles.

2.3.1 Hub and Spoke

This model involves using a central distribution hub, where products are received, sorted, and then shipped out to smaller distribution centers, which then distribute the products to customers (An et al., 2015). This model is efficient for large-scale distribution, as it allows for bulk shipments to a

central location before being dispersed to smaller locations.

2.3.2 Direct-to-Consumer (DTC)

Direct-to-Consumer (DTC): In this business model, the e-commerce business sells goods directly to the final customer without using any middlemen (Filipova, 2016). Due to its ability to give businesses better control over the things they offer and the consumer experience, this model is growing in popularity.

2.3.3 Cross-Docking

Cross-Docking: In this method, goods are moved straight from arriving trucks to departing ones without being kept in a warehouse (Van Belle et al., 2012). This concept decreases the amount of time items spend in storage and the costs related to warehousing, making it effective for products with short shelf lives.

2.3.4 Drop-Shipping

Drop-Shipping: In this business model, an online retailer does not maintain any inventory but instead collaborates with suppliers or wholesalers who send the goods to clients directly (Busari et al., 2021). This concept works well for businesses who wish to offer a wide variety of goods without having to invest in inventory and storage space.

2.3.5 Omni-Channel

Omni-Channel: This model involves offering multiple distribution channels to customers, such as in-store pick-up, home delivery, or shipping to a store location (Cai & Lo, 2020). This model provides customers with more options and flexibility in how they receive their products and can increase customer loyalty and satisfaction.

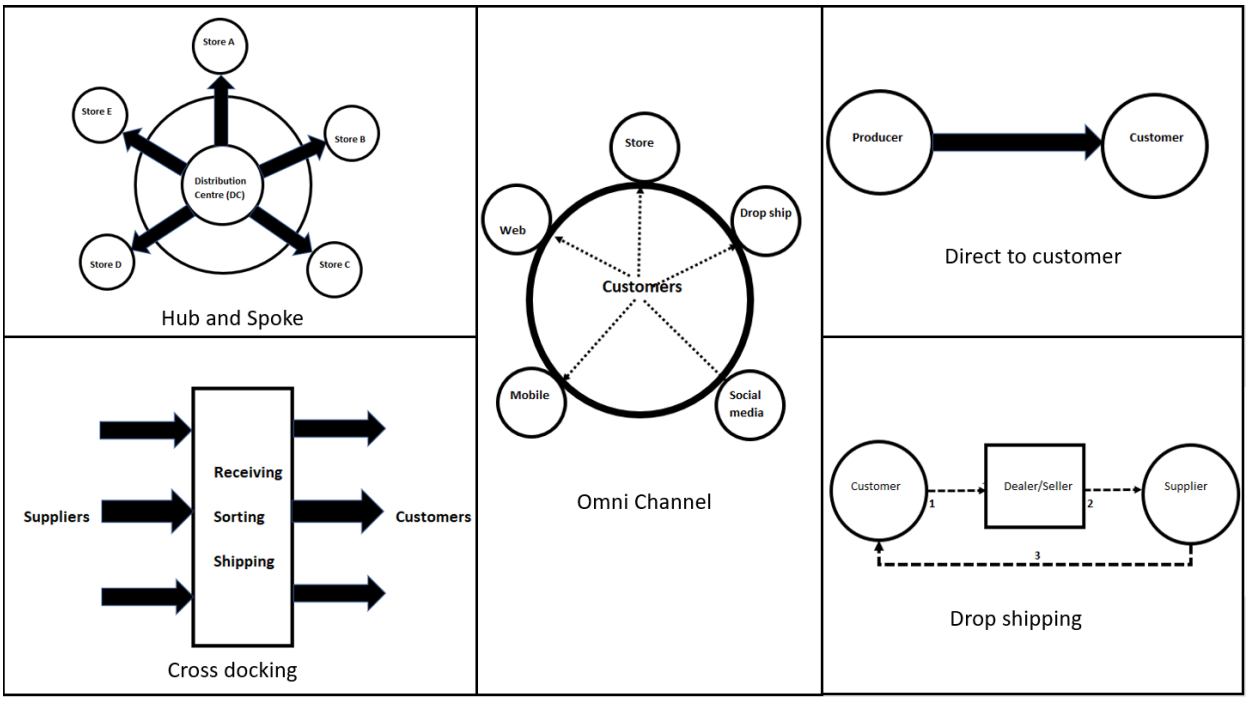


Figure 2.3. Types of distribution models.

2.4 Human Factors

According to the scientific study, HF is commonly referred to as ergonomics that focuses on how people interact with tools, settings, and machines and how these interactions can be adjusted to enhance wellbeing, safety, and performance (Jurčević et al., 2017). It involves understanding human abilities, limitations, and behaviors, and then designing environments, systems, and products that align harmoniously with these aspects. A cross-disciplinary domain, HF draws insights and methodologies from anthropology, engineering, psychology, medicine, and other disciplines (Ogbeyemi et al., 2020). Its application spans diverse sectors such as manufacturing, consumer goods, healthcare, aviation, and transportation. The goals of HF encompass error reduction, efficiency enhancement, heightened user satisfaction, and the mitigation of potential risks or injuries. Essential realms within HF research encompass human error and reliability, workplace design, anthropometry (exploring human body dimensions and proportions), as well as user

interface design and human-machine interaction.

2.4.1 Relationship between job skills and job performance in ecommerce

Job skills and job performance are closely related concepts in the workplace. Job skills refer to the specific abilities and knowledge that are necessary to perform a particular job or task effectively. These skills may include technical skills such as proficiency in computer software, mechanical skills such as the ability to operate machinery, or soft skills such as communication and problem-solving. On the other hand, job performance refers to how well an employee performs in their job. This can be measured by their ability to meet or exceed expectations, achieve targets, produce high-quality work, and contribute positively to their team or organization. Job performance in B2B e-commerce is more than completing tasks; it is about contributing positively to the organization's mission and fostering success in a highly competitive arena. The markers of job performance include meeting or surpassing set targets, producing high-quality work, and enhancing team dynamics (Jackson et al., 2020). Employees who excel in these areas are indispensable assets in the B2B e-commerce landscape. Hunter and Hunter's (1984), shows the relationship between job skills and job performance as a straightforward process, which is possessing the necessary job skills essential for performing well on the job. However, simply having the required job skills is not enough to guarantee excellent job performance (Sarmiento et al., 2007). An individual's job performance also depends on HF such as motivation, attitude, work ethic, and ability to work well with others. Any service system will likely have efficiency and increased performance as one of its primary goals. The performance of the job or system is equivalent to that of the individual worker. Worker performance is understood to be a complicated entity linked to other individualized characteristics, such as skills and job satisfaction, which are both considered to be essential components of worker performance. The completion of a task within the required

completion time by a worker on the warehouse floor is referred to as job performance in this study.

2.4.2 Relationship between job satisfaction and job performance in ecommerce

Job satisfaction is particularly important for both system performance and worker performance. According to Vroom's (1964) definition, "human relations might be described as an attempt to increase productivity by satisfying the needs of employees," there is a presumption that there is a correlation between job satisfaction and job performance. Experts in the field of job design for manufacturers and retailers have conducted several studies on how the two variables relate to one another. The most important of them all is the semi-quantitative review on job performance and job satisfaction conducted by Judge et al. (2001). In addition, Sarmiento et al. (2007) discovered that several research on job satisfaction and job performance did not directly correlate with one another but rather had some confounding variables (Michael et al, 2005). In addition, several limiting factors, such as the environment, MHT usage, or operational procedures, can prevent increased satisfaction from always translating into higher work performance.

2.4.3 Relationship between job rotation and job performance in ecommerce

Job rotation among employees on the warehouse floor is a crucial component to consider in a service system. It is also anticipated that its deployment will improve work performance. Job rotation refers to the practice of moving employees between different positions or departments within an organization, with the aim of broadening their experience and skill set. Emerging evidence indicates that job rotation could potentially yield favorable outcomes for job performance; however, the magnitude of its effects is contingent upon various influencing factors. According to Song et al, (2010), Job rotation also has been used to sustain and upgrade the various latent skills and experience of workers who have been on the job for long. One potential benefit of job rotation is that it can help employees develop a more comprehensive understanding of the organization, as

well as a broader range of skills and knowledge. This can in turn lead to greater job satisfaction and motivation, as well as improved performance. However, there are also potential downsides to job rotation. For example, frequent changes in responsibilities can be stressful for some employees and may lead to decreased job satisfaction and performance. Additionally, some employees may struggle to adapt to new roles or work environments, which could also impact their performance. Ultimately, the impact of job rotation on job performance will depend on a range of factors, including the specific job roles involved, the duration and frequency of rotations, and the individual employees and their personal preferences and abilities. Organizations that are considering implementing job rotation as a strategy should carefully consider these factors and monitor the impact on job performance over time. Additionally, job rotation supports businesses in maintaining their maximum output, should they decide to lay off staff members owing to a decline in client demand for jobs. As a result, job rotation among the younger workers is crucial in order to replace the older workers when it is time for them to retire. Furthermore, research indicates that a mathematical programming model that incorporates job rotation in a production system can be used to quantify worker boredom and skill fluctuations (Azizi et al., 2010). Implementing job rotation among employees can also lower the risk of mental stress and physical disorders, which will ultimately improve workplace performance. Job rotation was investigated among employees of an ecommerce system that operates with various roles in its online operations. According to the work of (Oparanma and Nwaeke, 2015), a job rotation schedule was created using a statistical method and was recommended for usage by employees to reduce workload across a variety of task schedules and lower the risk of "work-related musculoskeletal disorder." According to reports, job rotation has a favorable impact on employees' satisfaction (Kaymaz, 2010). A one-way statistical analysis of variance (ANOVA) was also employed in a related study to assess the

relevance of job rotation among workers and their movement between workstations. The outcome demonstrates that job rotation has a considerable positive impact on service system and worker satisfaction (Jeon et al., 2016). Although there's an argument that job rotation may yield favorable impacts on job performance, there are also limitations to this practice that should be considered. One limitation of job rotation is that it may lead to decreased productivity as employees are learning new tasks and becoming familiar with new work environments (Dineen et al., 2013). Additionally, job rotation may result in a loss of specialized skills and knowledge that employees have developed in their previous roles (Barrick et al., 2015). Another potential limitation is that employees may become dissatisfied with job rotation if they feel that they are not being given enough time to master their new roles or if they feel that they are being moved around without a clear purpose or career path (Campion et al., 1994).

2.4.4 Relationship between job fatigue and job performance in ecommerce

Another crucial aspect to consider is the impact of worker fatigue. However, when the influence is strong, a system's overall performance is put in danger. Workers' fatigue in a service system is caused by task overload, which can lead to worker injury (Jaber and Neumann, 2010). In this thesis, physical tiredness during work is referred to as job fatigue. Therefore, it is imperative that employees control their tiredness. Even though worker tiredness is unavoidable, it needs to be continuously considered during the shift planning and capacity planning. Job fatigue can have a negative impact on job performance. When an individual is experiencing fatigue, they may struggle to concentrate, feel unmotivated, and have difficulty completing tasks efficiently. This can result in lower productivity, mistakes, and a decrease in overall job performance. There are several factors that can contribute to job fatigue, including long work hours, high job demands, lack of control over work tasks, and a poor work-life balance. Employers can help reduce job

fatigue by implementing strategies such as providing flexible work arrangements, encouraging breaks throughout the day, and promoting a healthy work-life balance. On an individual level, there are also strategies that employees can use to manage job fatigue and improve job performance. These may include taking breaks when needed, prioritizing tasks, setting realistic goals, and practicing good sleep hygiene. Overall, managing job fatigue is crucial for maintaining job performance and preventing burnout. Employers and individuals should work together to identify and address factors that contribute to job fatigue and develop strategies to promote well-being and productivity in the workplace. In addition, research by (Oparanma & Nwaeke, 2015) have been able to investigate some factors that led to an increase in work schedule error (WSE) among workers. The research shows that physical fatigue among other HF is significantly related to WSE and can reduce job performance. Jansen et al (2003) describe the rate at which fatigue found among workers during work scheduling can affect workers shifting patterns. One limitation of job fatigue is that it can lead to decreased job satisfaction and increased turnover intentions (Riggio, 2013). This can be especially true for employees who experience chronic fatigue, as they may feel that their work demands are not manageable and may seek other employment opportunities. Additionally, job fatigue can result in increased errors and accidents on the job, as employees may be less alert and less able to make good decisions (Williamson et al., 2011). Another potential limitation of job fatigue is that it can lead to negative health outcomes, such as cardiovascular disease, depression, and anxiety (Lindström et al., 2014). These health outcomes can have long-term effects on employees' job performance, as they may need to take time off work to recover or may be less able to perform their job duties due to physical or mental health issues.

2.5 Statistical Analysis, Power Analysis, and Its Application

One of the methods frequently employed in the fields of HF or ergonomics is statistical analysis,

notably to assess for correlation and create predictions between variables using various statistical tests. Incorporating statistical analysis requires a meticulous consideration of data types, assessments, and variables, akin to those employed in the collection and evaluation of survey data. Aspects such as coding, ranking, scoring, as well as validity, reliability, and other pertinent factors must be thoughtfully accounted for to ensure accurate application. Given the assertion, there are two categories of statistical analysis methods: inferential analysis and descriptive analysis. Descriptive statistics are used to summarize and describe the data collected from a sample or population, including measures of central tendency (mean, median, and mode) and variability (range, standard deviation, and variance) (Creswell, 2014). Descriptive analysis is useful in providing an overview of the data and identifying patterns or trends that may be present. This can be helpful in identifying areas for further study or exploration. However, descriptive analysis alone may not be sufficient in drawing conclusions or making predictions about a larger population. Inferential analysis, on the other hand, involves making predictions or generalizations about a larger population based on a sample of data. This involves the use of statistical tests, such as t-tests and ANOVA, to determine whether there are significant differences or correlation between variables (Creswell, 2014). Both inferential and descriptive analysis have their advantages and limitations, and the choice of method depends on the research question, data type, and study design. It is important to carefully consider the appropriate statistical methods to use in research to ensure accurate and reliable results. This thesis focuses on descriptive analysis using several research methodologies. Most often, both quantitative and qualitative methods are used in research to collect data and analyze it (Venkatesh and Brown, 2013). The methodology used for this thesis, however, was quantitative (Nelson and Evans 2014). To ascertain the correlation and impact of HF considered as factors with the performance of the system, this method is utilized to analyze

numerical data gathered through the survey questionnaire. The Statistical Package for Social Science (SPSS) software has also been widely used to collate and analyze data in the field of HF or ergonomics. SPSS can be used to interact statistical analysis (IBM SPSS, Inc., 2017).

2.6 Conclusion of Literature Review

The review of literature on HF (i.e., job satisfaction, job skills, job rotation and job fatigue) and its relationship in ecommerce system performance showed the possibilities that these HF could lead to further disruption if not investigated during decision-making towards inventory control in warehousing. The impact and relationship of the HF stated in this study were reviewed in this Chapter. Furthermore, the review shows that the various HF mentioned in this study may have a relationship with the system performance of a warehouse, which might be applicable to ABC and XYZ. It was also reviewed that, in e-commerce, little or no combined HF have been considered in e-commerce. Hence, the proposed research questions as defined in the previous chapter are required to be explore in this study as the research gap. Also, this research gap motivated the study. Therefore, the findings from this thesis are expected to help warehouse and inventory manager to understand the impact of HF and how important and significant they are in e-commerce system performance.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The main purpose of Chapter 3 is to provide a detailed description of the methodology used in the study to identify HF among workers in the warehouse of ABC and XYZ. The chapter begins by outlining the research hypotheses, which provide the foundation for the study. Next, the research design and sampling technique are discussed, providing insight into the approach taken to collect data from the target population. This is followed by a discussion of the data collection methods and procedures used in the study, including the development of the questionnaire and pilot testing. In Section 3.6, the analytical technique adopted by the researcher is presented, which includes the statistical tests used to analyze the data collected from the questionnaire. Additionally, the chapter provides details on the ethics approval obtained from the Behavioral Research Ethics Board, which ensures that the study adheres to ethical guidelines. Finally, the chapter concludes with a summary of the main points covered, highlighting the key features of the research methodology adopted in the study. Overall, Chapter 3 provides a comprehensive overview of the methods used to collect and analyze data in the study, providing readers with a clear understanding of the research design and approach taken.

3.2 Research Hypothesis

One of the crucial research instruments that supports any investigation-based research is the research hypothesis (Kothari, 2002). The primary research objective of this study was to observe and discover the statistical significance between human variables and job performance among warehouse workers in a service system. Based on the research questions, hypotheses were formed and evaluated to ensure that this significance existed. Following a presumption that HF might be

a factor in the problems mentioned in Section 1.3, To ensure the validity and reliability of the hypotheses, a thorough literature review was conducted to identify relevant theories and empirical evidence to support them. The hypotheses were also evaluated in the field of HF to ensure their relevance and appropriateness for the study. Hence, the following three hypotheses were developed:

Hypothesis One:

Ho: There is no statistically significant impact of HF job skills, job satisfaction, job rotation, and job fatigue on job performance within the modern B2B e-commerce model of companies ABC and XYZ.

Hi: There is a statistically significant impact of HF job skills, job satisfaction, job rotation, and job fatigue, on job performance within the modern B2B e-commerce model of companies ABC and XYZ.

Hypothesis Two:

Ho: There is no statistically significant impact of HF which encompass job satisfaction, job fatigue, and job rotation on the level of job performance among warehouse workers within the modern B2B e-commerce model of companies ABC and XYZ

Hi: There is statistically significant impact of HF which encompass job satisfaction, job fatigue, and job rotation on the level of job performance among warehouse workers within the modern B2B e-commerce model of companies ABC and XYZ.

Hypothesis Three:

Ho: The combined influence of job skills, job satisfaction, job rotation, and job fatigue does not significantly impact the determination of job performance among workers in the B2B e-commerce

of companies ABC and XYZ.

Hi: The combined influence of job skills, job satisfaction, job rotation, and job fatigue significantly affect the determination of job performance among workers in the modern B2B e-commerce model of companies ABC and XYZ.

3.2 Research Design and Sampling Technique

Research design: The plan or strategy that outlines how the study will be conducted to achieve the research objectives (Creswell, 2014). In this study, a cross-sectional survey design was used to investigate the statistical significance between HF and job performance among workers in an ecommerce system. This design was chosen because it is appropriate for collecting data from a large population and allows for one-time data collection.

Sampling Technique: The target population for this study was all workers in an ecommerce system in west Africa. The sample size was determined using Krejcie and Morgan's (1970) sample size determination table. The sample size calculated was 40, and a stratified random sampling technique was used to select the participants.

In the first stage, the sample frame was developed by obtaining a list of ecommerce systems in the region. In the second stage, the ecommerce systems were stratified based on their size, and a proportional sampling technique was used to select the participants from each section. In the third stage, the participants were selected randomly from each section using a simple random sampling technique.

3.2 Method of Data Collection

According to Chen and Li (2019), a study of the effect of HF on job performance in e-commerce logistics was conducted using surveys as the primary data collection method. However, there are several methods of data collection that can be used to study the effect of HF on job performance among workers in an e-commerce system. Some of the commonly used methods are:

Surveys: Surveys are a popular method of data collection that involves collecting responses from a sample of participants using a set of standardized questions. Surveys can be administered online or in person and can be used to collect both quantitative and qualitative data.

Interviews: Interviews involve collecting data through one-on-one conversations with participants. Interviews can be structured, semi-structured, or unstructured and can be conducted in person or over the phone.

Observations: Observations involve collecting data by observing participants in their natural environment, observations can be structured or unstructured, and can be conducted in person or remotely.

Case studies: Case studies involve collecting data by analyzing a specific case or group of cases. Case studies can involve both qualitative and quantitative data and can be conducted through interviews, surveys, and observations.

Experimentation: Experimentation as a method of data collection in a survey can be especially useful when trying to establish causal correlation, test hypotheses, and understand the impact of specific interventions or treatments. However, it may not always be feasible or ethical to manipulate variables in certain survey settings, and practical considerations such as sample size, ethical constraints, and external validity must be considered when designing and conducting

survey experiments.

3.2.1 Data Collection

The data used for the purpose of this study is a self-administered survey questionnaire distributed among the target population. The items included in the questionnaire are all related to job skills, job satisfaction, job rotation, and job fatigue (Appendix B).

3.2.2 Procedure for Data Collection

In this study, a questionnaire (see Appendix B) was used to collect data on job skills, job satisfaction, job rotation, and job fatigue among the warehouse workers. Prior to the administration of the questionnaire, each respondent was informed about the study through a recruitment letter (see Appendix C) and a participant consent form (see Appendix A) was provided. The respondents were given the option to read the questionnaire and indicate their interest in participating. The study procedure was also explained to them, and their consent was obtained. The respondents were allowed to take the questionnaire home to ensure accurate responses without any time constraints. A total of 40 questionnaires were distributed between two companies, ABC and XYZ, and the responses were collected over a 3–4-week period. The questionnaire used was closed-ended, which provided specific and limited response options for each question. The questionnaire was chosen as the best option for this study due to its convenience in reaching out to the workers and easy collection of information on HF. The data on job performance were acquired from the warehouse supervisors. In the context of this study, it is essential to address a crucial distinction in data collection regarding job performance and job skills. While job skills are assessed at the individual level, it is important to note that job performance is evaluated at the individual level through the supervisors. This distinction is a deliberate choice made to ensure that the assessment of job performance aligns with the

operational structure of the organizations under study, namely, ABC and XYZ. By evaluating job performance, we aim to capture a holistic view of the workforce's effectiveness within these organizations, accounting for the collaborative nature of their operations. This approach allows us to explore the impact of HF, such as job skills, job satisfaction, job rotation, and job fatigue, not only at the individual level but also how they collectively influence the performance of entire organization.

3.3 Design of the Questionnaire

To ensure a clear and proper understanding of the research instrument, a questionnaire should be designed in a well-structured format with texts that are relevant to the respondents, as stated by Statistics Canada (2009). For this study on the effect of HF on job performance among workers in an ecommerce system, the questionnaire was designed based on the experiences of workers in an ecommerce system in west Africa. Participants in this study were methodically chosen based on a wide array of characteristics, spanning demographics and critical job-related details. This careful selection process was designed to build a comprehensive profile of the sample, taking into account participants' age, gender, specific roles within their respective department, their years of professional experience, and their educational backgrounds among the supervisors. It's important to note that while this detailed participant profile wasn't explicitly included in the questionnaire, it played a vital role in shaping the study's comprehensive approach to data collection and analysis. The questionnaire was used as the primary data collection for HF such as job skills, job satisfaction, job rotation, job fatigue and job performance, which were further categorized into dependent and independent variables. To perform linear regression, discrete values were collected using a 5-point Likert scale with values [1 – 5], such that a response of 1 meant 'strongly disagree', 2 meant 'disagree', 3 meant 'neither agree nor disagree', 4 meant 'agree',

and 5 meant 'strongly agree, and this scale will be treated as a continuous variable (Johnson and Creech, 1983; Norman, 2010; Sullivan and Artino, 2013). The questionnaire comprised of 45 items, which are divided into five sections for clarity to the respondents, and each section consisted of several questions as shown in Table 3.1. The complete questionnaire can be found in its entirety in Appendix B.

Table 3.1. Questionnaire structure.

Variables	Research Questions	No of Questions
Independent variable (1): job skills	There is no statistical significance observed between job skills andthe job performance of the workers.	15
Independent variable (2): job satisfaction	There is no statistical significance observed between job satisfaction and job performance of the workers.	9
Independent variable (3): job rotation	There is no statistical significance observed between job rotationand the job performance of the workers.	5
Independent variable (4): job fatigue	There is no statistical significance observed between job fatigueand the job performance of the workers.	6
Dependent variable: job performance	There is no statistical significance of individual contribution for each independent variables to the determination of job performance of the workers.	10

3.5.1 The Conceptual Framework Model

The conceptual framework model for the effect of HF on job performance among workers in an

ecommerce system involves the correlation between independent variables, including job skills, job satisfaction, job rotation, and job fatigue, and the dependent variable, which is job performance. This framework was developed based on previous research that suggests that HF plays a critical role in determining job performance among workers in various industries (Cascio and Aguinis, 2008; Kehoe and Wright, 2013). The framework posits that job skills are a critical independent variable that can significantly impact job performance. Workers with higher levels of job skills are more likely to perform better in their jobs, leading to increased productivity and efficiency. Similarly, job satisfaction is also a crucial independent variable that can significantly impact job performance. Workers who are satisfied with their jobs are more likely to be motivated and committed to their work, leading to increased productivity and job performance (Spector, 1997). Job rotation is another independent variable that can impact job performance. It involves the periodic movement of workers from one job to another, which can help to reduce boredom and monotony and increase motivation and job satisfaction. This, in turn, can lead to improved job performance and productivity (Berger, 2013). Finally, job fatigue is also an independent variable that can impact job performance. Workers who experience fatigue are more likely to experience burnout, reduced motivation, and decreased productivity, all of which can negatively impact job performance (Bridger, 2009). Overall, the conceptual framework model suggests that job skills, job satisfaction, job rotation, and job fatigue are critical independent variables that can impact job performance among workers in a service system. By understanding this correlation, organizations can develop strategies to improve job performance and productivity among their workers.

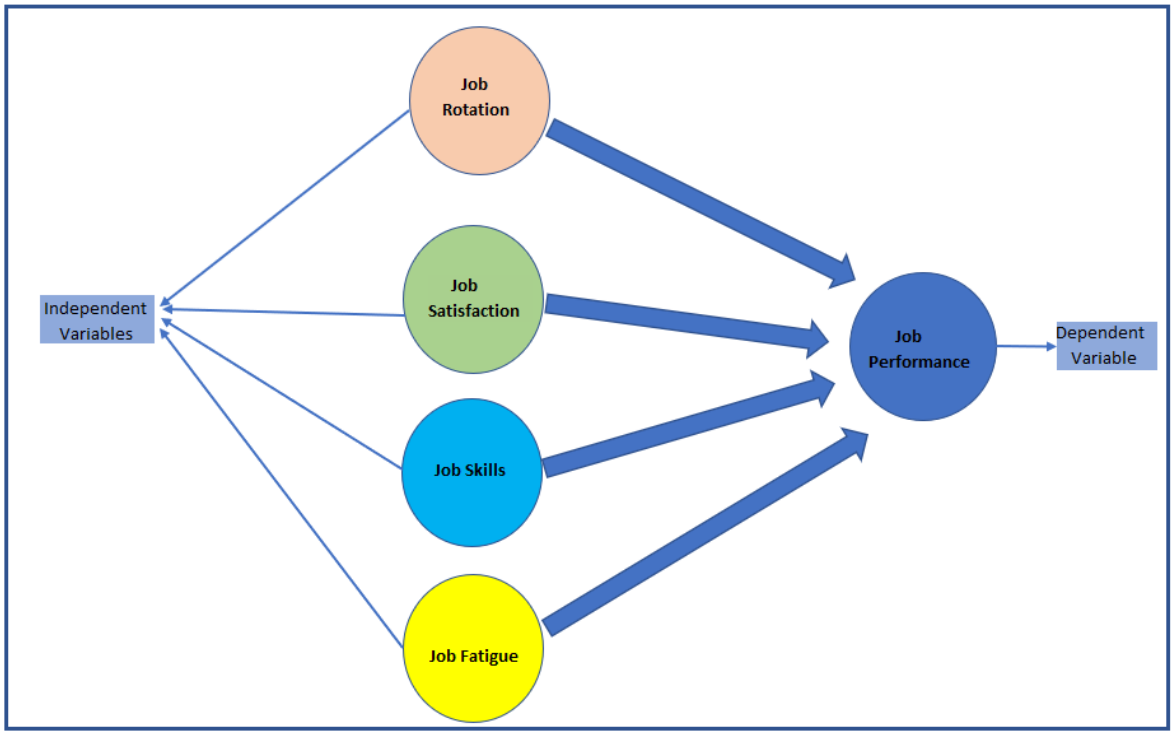


Figure 3.1. The correlation between HF among workers and job performance.

3.6 Statistical Modeling

In statistical modeling, a dependent variable is modeled as a function of one or more independent variables (job skills, job satisfaction, job rotation, job fatigue), with the goal of understanding how changes in the independent variables affect the dependent variable (job performance). The mathematical correlation between the independent and dependent variables can be expressed using various statistical techniques, such as regression analysis, time-series analysis, and multivariate analysis. Fig 3.1 is expressed mathematically as shown below in Equation (3.2)

Let,

- JSk: represents job skills, as an independent variable $X1$;
- JSa: represents job satisfaction, as an independent variable $X2$;
- JRo: represents job rotation, as an independent variable $X3$;

- JFa: represents job fatigue, as an independent variable $X4$;
- $JPerf$: represents job performance, as a dependent variable Y.

According to a standard linear regression mathematical model (Oh, 2013),

$$Y = \beta 0 + \beta 1X \quad (3.1)$$

Equation (3.1) represents the regression equation. This equation is used to analyze the significance[2] of the relationship between the independent variables and dependent variable. Nonetheless, the linear regression model will be used to statistically analyze the responses between the variables and is expressed as seen in Equation (3.2).

$$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \cdots \cdots \cdots \beta nXn + \varepsilon \quad (3.2)$$

If, $Y = \beta 0 + \beta 1X$

Then, $JPerf = f\ (JSk, JSa, JRo, JFa)$

Therefore,

$$JPerf = \beta 0 + \beta 1\ JSk + \beta 2\ JSa + \beta 3\ JRo + \beta 4\ JFa + \varepsilon \quad (3.3)$$

where,

- $\beta 0$: Intercept of job performance;
- $\beta 1$: Coefficient of job skills;
- $\beta 2$: Coefficient of job satisfaction;
- $\beta 3$: Coefficient of job rotation;
- $\beta 4$: Coefficient of job fatigue; and
- ε: Error.

[2] The significance in this context is refers to the strength and direction (correlation) of the relationship between the variables considered in Equation 3.1.

3.6.1 Data Analysis Technique

Data analysis techniques depend on the nature of the data, research questions, and research design. In the case of this study, the data collected from the questionnaire were analyzed using various statistical techniques such as descriptive statistics, correlation analysis, and regression analysis. Descriptive statistics were used to summarize and describe the characteristics of the data. This involved calculating measures of central tendency (such as mean, median, and mode) and measures of variability (such as standard deviation and range). Correlation analysis was conducted to examine the correlation between the independent and dependent variables. This involved calculating the Pearson correlation coefficient and testing for significance using a two-tailed t-test. Regression analysis was used to test the hypotheses and determine the extent to which the independent variables HF predict the dependent variable (job performance). Specifically, linear regression analysis was conducted to examine the statistical significance between job performance and the independent variables (job skills, job satisfaction, job rotation, and job fatigue). All statistical analyses were conducted using statistical software such as SPSS. The results of the analyses were reported using tables, graphs, and charts.

3.6.2 Model Validity

To ensure the validity of the conceptual framework model developed in this study, various steps were taken. First, a thorough review of relevant literature was conducted to ensure that the model was grounded in established theories and empirical evidence. Second, the model was subjected to pilot testing to assess its practical applicability and identify any potential issues. Third, reliability and validity tests were performed on the collected data to ensure the consistency and accuracy of the measurements. Finally, statistical techniques such as correlation analysis, regression analysis,

and factor analysis were used to test the significance among variables and evaluate the model's predictive power. Through these steps, the validity of the conceptual framework model was strengthened, and the findings of the study can be considered reliable and generalizable to the population of interest.

3.6.3 Ethical Approach

In research involving humans, it is essential to adhere to the appropriate scientific and ethical standards to safeguard and respect the participants. The Behavioral Research Ethics Board (Beh-REB) of the University of Saskatchewan mandates that studies that explore HF in any organization for research purposes require REB review. Hence, before administering the research survey, the researcher must undergo an REB review to assess potential risks to research participants and determine how to minimize them with potential benefits (Tri-Council Policy Statement, 2014). Before starting the study, the research participants were provided with a consent form that explained the research description, study purpose, participation options, researcher and REB contact information, and the reassurance that they could withdraw from the study at any time (Appendix A). These procedures were necessary to ensure that the ethical requirements of the research questions, as stated in Chapter 3 and Appendices D and E, were met.

3.7 Conclusion

The study examined the impact of HF on job performance among workers in an ecommerce system with focus on distribution of MM and FMCG. The research design used was a quantitative approach, and the sampling technique adopted was convenient sampling. Data was collected using a structured questionnaire that was divided into five sections and administered to 20 workers in two different ecommerce systems. The data was analyzed using descriptive statistics, correlation, regression analysis, and ANOVA. The correlations suggest that there is positive correlation among

these variables, indicating that higher levels of job skills, job satisfaction, and job rotation, along with lower levels of job fatigue, are linked to improved job performance. However, it is noteworthy that not all independent variables demonstrated statistical significance in their individual effects on job performance. This suggests that while there are positive associations, not all variables have a significant impact on job performance based on the analysis findings. Consequently, the results imply that a combination of factors, including job skills, job satisfaction, job rotation, and job fatigue, collectively contribute to overall job performance. The study also emphasizes the need for researchers to ensure that ethical standards are maintained in research involving human participants.

CHAPTER 4

DATA ANALYSIS AND RESULTS

4.1 Introduction

The results obtained from the statistical data analysis along with findings of the study are presented and discussed in this chapter. However, the result analyzed was from company ABC and XYZ for proper comparison of the hypotheses.

4.2 Reliability analysis and pilot Testing

Reliability analysis and pilot testing are important steps in the development of any research instrument, including questionnaires. In this study on the effect of HF on job performance among workers in an ecommerce system, reliability analysis and pilot testing were conducted to ensure the validity and reliability of the questionnaire. Reliability Analysis is the process of assessing the consistency and stability of a research instrument. In this study, reliability analysis was conducted using Cronbach's alpha coefficient. The Cronbach's alpha coefficient is a measure of internal consistency, and it ranges from 0 to 1. A coefficient value of 0.7 or higher is considered acceptable for research instruments (Hair et al., 2014). The results of the reliability analysis indicated that the questionnaire had a high level of internal consistency. The Cronbach's alpha coefficient for the questionnaire was 0.791, which is above the acceptable level of 0.7. This suggests that the questionnaire be reliable and consistent in measuring the constructs of interest. Pilot Testing is the process of administering a research instrument to a small sample of respondents to identify and correct any potential problems with the questionnaire. In this study, pilot testing was conducted on a sample of 9 workers in an ecommerce system. The results of the pilot testing revealed that the questionnaire was easily understood by the respondents, and they were able to provide accurate and meaningful responses. However, some minor revisions were made to improve the clarity and

wording of a few questions. Overall, the reliability analysis and pilot testing ensured that the questionnaire used in this study was valid, reliable, and appropriate for measuring the constructs of interest.

Table 4.1. The reliability statistics.

Case Processing Summary			
		N	%
Case	Valid	30	71.4
	Excluded	12	28.6
	Total	42	100

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.791	9

4.3 Case Processing Summary for Company 1 (ABC)

Based on the data set, the case processing summary shows that the data has 20 valid cases (observations) and no missing cases for each variable. Below is a breakdown of the number and percentage of valid cases and missing cases for each variable. It appears that for each variable, the data is complete with 20 valid cases (100.0%) and no missing cases. This means that all the observations in the dataset have valid values for each of the variables. Having complete data for analysis is beneficial as it allows for a more comprehensive examination of the variables and

reduces the potential bias or limitations associated with missing data. Therefore, I am certain that with the entire dataset, I can move forward with the analysis.

4.4 Tests of Normality

This section presents the result of the test for normality. According to Table 4.2, Kolmogorov-Smirnov Test: This test assesses whether the distribution of a variable differs significantly from a normal distribution. The test statistics and degrees of freedom (df) are provided, along with the significance level (Sig.). For job skills, job fatigue, and job rotation, the Sig. values are greater than 0.05, indicating that these variables do not significantly deviate from a normal distribution. However, for job satisfaction, the Sig. value is less than 0.05, suggesting that the distribution significantly deviates from normality. Shapiro-Wilk Test: This test is another method to assess normality. It also provides a test statistic, df, and Sig. value, For, job skills, job fatigue, job rotation, and job performance, the Sig. values are greater than 0.05, indicating that these variables do not significantly depart from normality. However, for job satisfaction, the Sig. value is less than 0.05, indicating a significant departure from normality. It's important to note that the normality assumption is desirable but not always necessary for regression analysis. Deviations from normality may impact the interpretation of statistical tests and confidence intervals. If the sample size is sufficiently large, the regression estimates can still be reliable even with deviations from normality. Based on the normality tests, the variables job skills, job fatigue, and job rotation do not significantly deviate from a normal distribution. However, job satisfaction shows a significant departure from normality according to both the Kolmogorov-Smirnov and Shapiro-Wilk tests. It is important to consider this deviation when interpreting the results related to job satisfaction in further analysis. Based on the results of the normality tests presented in Table 4.2, the conclusion

regarding whether the variables are normally distributed or not depends on the specific variable being examined. The normality tests (Kolmogorov-Smirnov and Shapiro-Wilk) for these variables suggest that they are normally distributed. The significant values (Sig.) for these variables are greater than the threshold of 0.05, indicating that there is no significant departure from normality. The normality tests for Job Satisfaction indicate a significant departure from normality. Both the Kolmogorov-Smirnov and Shapiro-Wilk tests show that the distribution of Job Satisfaction significantly deviates from a normal distribution. Therefore, the conclusion is that the variables Job Skills, Job Fatigue, Job Rotation, and Job Performance can be considered approximately normally distributed. However, Job Satisfaction does not follow a normal distribution.

It's important to note that the normality assumption is not always strictly required for regression analysis, especially with large sample sizes. However, deviations from normality can affect the interpretation of statistical tests and the reliability of certain assumptions. That implies that, linear regression method is fit to analysis the data.

Table 4.2. Tests of Normality for Study 1 (ABC)

	Tests of Normality					
	Kolmogorov-Smirnova			**Shapiro-wilk**		
VARIABLE	Statistic	df	Sig	Statistic	df	Sig
JOB_SATISFACTION	0.195	20	0.045	0.858	20	0.007
JOB_SKILLS	0.133	20	0.200	0.954	20	0.433
JOB_FATIGUE	0.186	20	0.068	0.949	20	0.353
JOB_ROTATION	0.220	20	0.012	0.957	20	0.485
JOB_PERFOMANCE	0.159	20	0.197	0.900	20	0.042

* This is a lower bound of the true significance

a. Lilliefors Significance Correction

4.4.1 Descriptive Statistics

Regarding job performance, the average score is 3.4450, with a standard deviation of 0.53947. This suggests that, on average, the participants in the sample have a moderate level of job

performance, and there is some variability in their performance scores. For job satisfaction, the average score is 3.8500, with a standard deviation of 0.51900. This indicates that, on average, the participants have a relatively high level of job satisfaction, and there is relatively less variability in their satisfaction scores compared to job performance. In terms of job skills, the average score is 3.6700, with a standard deviation of 0.54008. This suggests that, on average, the participants have a moderate level of job skills, and there is some variability in their skill levels. For job fatigue, the average score is 3.2167, with a standard deviation of 0.55171. This indicates that, on average, the participants experience a moderate level of job fatigue, and there is some variability in their fatigue levels. Lastly, for job rotation, the average score is 3.1900, with a standard deviation of 0.62061. This suggests that, on average, the participants experience a moderate level of job rotation, and there is some variability in their rotation experiences. Overall, these descriptive statistics provide a snapshot of the sample's perceptions of job performance, job satisfaction, job skills, job fatigue, and job rotation. They help us understand the average levels and variability of these variables within the sample.

Table 4.3. Item Statistics for Study 1 (ABC)

Descriptive Statistics

	Mean	Std. Deviation	N
JOB_PERFOMANCE	3.4450	0.53947	20
JOB_SATISFACTION	3.8500	0.51900	20
JOB_SKILLS	3.6700	0.54008	20
JOB_FATIGUE	3.2167	0.55171	20
JOB_ROTATION	3.1900	0.62061	20

4.4.2 Test of the Hypotheses

Regarding the research hypotheses, which concerns the significance between each of the independent variables (job skills, job satisfaction, job fatigue, and job rotation) and the dependent

variable (i.e., the job performance of the workers), the following hypothesis was developed (see the prior discussion in Chapter 3). It states that there is no statistical significance between any of the variables of job rotation, job fatigue, job satisfaction, and job skills and the job performance of the workers (Ho) and there is a statistical significance between each of the variables of job rotation, job fatigue, job satisfaction and job skills and the job performance of the warehouse workers (Hi). From the analysis using Pearson correlation, Job Performance and Job Satisfaction: There is a positive correlation ($r = 0.364$) between job performance and job satisfaction. This suggests that individuals who report higher levels of job satisfaction tend to have better job performance. However, the correlation is marginally significant ($p = 0.057$), indicating that there is a possibility of this significance occurring by chance. Further research with a larger sample size may be needed to establish a more conclusive significance between job satisfaction and job performance. **Job** Performance and Job Skills**:** There is a positive correlation ($r = 0.249$) between job performance and job skills. Although the correlation is positive, it is not statistically significant ($p = 0.145$). It is possible that other factors not considered in this analysis may play a more significant role in determining job performance. This means that there is no strong evidence to suggest a statistical significance between job skills and job performance in the given sample. Job Performance and Job Fatigue: There is a positive correlation ($r = 0.195$) between job performance and job fatigue. However, like the previous correlation, it is not statistically significant ($p = 0.205$). This indicates that there is no strong evidence of a significant impact between job fatigue and job performance in the sample. Other factors, such as work environment or individual characteristics, may have a greater impact on job performance than job fatigue alone. Job Performance and Job Rotation: There is a positive correlation ($r = 0.278$) between job performance and job rotation. Again, this correlation is not statistically significant ($p = 0.118$). Thus, the correlation between job rotation

and job performance in the sample is not well-supported. Other factors, such as training or job satisfaction, may have a more substantial influence on job performance. Overall, the correlation analysis suggests a moderate positive correlation between job performance and job satisfaction. However, the correlation between job performance and other factors such as job skills, job fatigue, and job rotation are not statistically significant. It is important to note that correlation does not imply causation, and other factors not included in the analysis may also influence job performance. In summary, based on the given p-values and a significance level of 0.05, we accept the null hypothesis (Ho) for all correlations, indicating that there is no statistical significance observed between Job Performance and the other variables (Job Satisfaction, Job Skills, Job Fatigue, Job Rotation) in the given sample.

Table 4.4. Correlation between each of the predictor variables of job rotation, job fatigue, job satisfaction and job skills and the job performance (ABC)

Correlations

		JOB_PERFOMANCE	JOB_SATISFACTION	JOB_SKILLS	JOB_FATIGUE	JOB_ROTATION
Pearson Correlation	JOB_PERFOMANCE	1.000	0.364	0.249	0.195	0.278
	JOB_SATISFACTION	0.364	1.000	0.515	0.344	0.529
	JOB_SKILLS	0.249	0.515	1.000	0.523	0.532
	JOB_FATIGUE	0.195	0.344	0.523	0.714	0.714
	JOB_ROTATION	0.278	0.529	0.532	1.000	1.000
Sig. (1-tailed)	JOB_PERFOMANCE		0.057	0.145	0.714	0.118
	JOB_SATISFACTION	0.057		0.010	0.205	0.008
	JOB_SKILLS	0.145	0.010		0.069	0.008
	JOB_FATIGUE	0.205	0.069		0.009	0.000
	JOB_ROTATION	0.118	0.008			

4.4.3 Model Summary and ANOVA

According to the linear regression, the analysis is used to determine whether each of the predictor variables significantly contribute to the determination of job performance of the worker. The results obtained are as shown in Table 4.5. The multiple correlation coefficient (R) is 0.379. This indicates a moderate positive correlation between the predictors (Job Rotation, Job Satisfaction, Job Skills, Job Fatigue) And the Dependent Variable (Job Performance). **R Square:** The coefficient of determination (R Square) is 0.144. This means that approximately 14.4% of the variance in job performance can be explained by the predictors included in the model. The adjusted R Square is -0.084. This value considers the number of predictors and the sample size, providing a more conservative estimate of the proportion of variance explained. In this case, the adjusted R Square suggests that the predictors do not contribute significantly to the prediction of job performance. The standard error of the estimate is 0.56175. This value represents the average distance between the observed job performance scores and the predicted scores by the model. A smaller value indicates a better fit of the model to the data. **Change Statistics:** The R Square Change is 0.144, indicating the increase in the proportion of variance explained by adding the predictors to the model. The F Change value is 0.631, representing the overall change in the model's fit after adding the predictors. The Durbin-Watson statistic is 2.457. This statistic tests for the presence of autocorrelation in the residuals. A value close to 2 suggests no significant autocorrelation. In summary, the regression model with the predictors (Job Rotation, Job Satisfaction, Job Skills, Job Fatigue) explains a small proportion of the variance in job performance. The predictors included in the model do not contribute significantly to the prediction of job performance, as indicated by the adjusted R Square. Additionally, there is no evidence of significant autocorrelation in the residuals based on the Durbin-Watson statistic.

Table 4.5. Model summary for study 1 (ABC)

Model Summary[b]

					Change Statistics					
Model	R	R Square	Adjusted R Square	Std Error of the Estimate	R square change	F change	df1	df2	Sig.F change	Durbin-watson
1	0.379	0.144	-0.084	0.56175	0.144	0.631	4	15	0.648	2.457

a. Predictors: (Constant) Job Rotation, Job Satisfaction, Job Skills, Job Fatigue
b. Dependent variable: job performance

In the ANOVA table, the regression model's ability to explain the variance in job performance is evaluated. The table presents the sum of squares, degrees of freedom (df), mean square, F statistic, and significance level (Sig.). For the regression model: The sum of squares for regression is 0.796, indicating the amount of variation in job performance that can be explained by the predictors. The degrees of freedom for regression are 4, which corresponds to the number of predictors in the model. The mean square for regression is calculated by dividing the sum of squares by the degrees of freedom, resulting in 0.199. The F statistic is 0.631, which is the ratio of the mean square for regression to the mean square for the residual. The significance level (Sig.) is 0.648, representing the probability of obtaining an F statistic as extreme as the one observed, assuming that the null hypothesis (no statistical significance observed between predictors and job performance) is true.

For the residual: The sum of squares for the residual is 4.733, indicating the unexplained variation or error in the model. The degrees of freedom for the residual are 15, calculated by subtracting the degrees of freedom for regression from the total degrees of freedom. The mean square for the residual is 0.316, obtained by dividing the sum of squares for the residual by the degrees of freedom for the residual. The total sum of squares is 5.529, representing the total variation in job performance. Overall, the ANOVA table provides information about the statistical significance of the regression model. In this case, the obtained F statistic of 0.631 is not statistically significant

(Sig. = 0.648), indicating that the predictors in the model do not significantly contribute to explaining the variance in job performance.

Table 4.6. ANOVA summary for study 1 (ABC)

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig
1	Regression	0.796	4	0.199	0.631	0.648
	Residual	4.733	15	0.316		
	Total	5.529	19			

a. Dependent variable: JOB_PERFORMANCE

b. Predictors: (Constant) JOB_ROTATION, JOB_SATISFACTION, JOB_SKILLS, JOB_FATIGUE

Table 4.7. Coefficient summary for study 1 (ABC)

Coefficients

		Unstandardized	Coefficient	Standardized coefficient			Collinearity Statistics	
Model		B	Std. Error	Beta	t	Sig	Tolerance	VIF
1	(Constant)	1.847	1.116		1.655	0.119		
	JOB_SATISFACTION	0.296	0.313	0.285	0.948	0.358	0.63	1.587
	JOB_SKILLS	0.048	0.310	0.048	0.154	0.880	0.592	1.688
	JOB_FATIGUE	0.001	0.348	-0.001	-0.003	0.998	0.452	2.214
	JOB_ROTATION	0.089	0.330	0.102	0.270	0.791	0.395	2.53

a. Dependent variable
JOB_PERFORMANCE

In the table of coefficients table 4.7, the estimated regression coefficients for each predictor variable in the model are presented. These coefficients indicate the strength and direction of the significance between each predictor and the dependent variable (job performance). Additionally,

the table includes the standard error of the coefficients, t-statistic, and significance level (Sig.). The collinearity statistics, tolerance, and variance inflation factor (VIF) are also provided, which assess the presence of multicollinearity among the predictor variables. For the coefficients: The constant term (intercept) has a coefficient of 1.847, indicating the estimated mean value of job performance when all predictor variables are zero. The coefficient for job satisfaction is 0.296, suggesting that a one-unit increase in job satisfaction is associated with a 0.296 unit increase in job performance. The standardized coefficient (Beta) of 0.285 indicates the standardized effect size of job satisfaction on job performance. The coefficient for job skills is 0.048, indicating a smaller positive significance observed with job performance. The standardized coefficient (Beta) is 0.048. The coefficient for job fatigue is -0.001, suggesting a negligible negative impact on job performance. The standardized coefficient (Beta) is -0.001. The coefficient for job rotation is 0.089, indicating a small positive association with job performance, the standardized coefficient (Beta) is 0.102, the t-statistic assesses the significance of each coefficient. In this case, none of the coefficients are statistically significant at conventional levels (all Sig. > 0.05), indicating that there is not enough evidence to conclude a statistical significance between the predictors and job performance. The collinearity statistics (tolerance and VIF) evaluate multicollinearity among the predictor variables. Tolerance values close to 1 and VIF values close to 1 indicate low multicollinearity. In this table, the tolerance values range from 0.358 to 0.998, and the VIF values range from 1.587 to 2.530, suggesting that there is no substantial multicollinearity issue among the predictor variables. To determine the positive or negative impact of the predictor variables on job performance, we need to examine the standardized coefficients in the "Coefficients" table. In the given table 4.7, the standardized coefficients (Beta) represent the standardized effect of each predictor variable on the dependent variable (job performance). Looking at the standardized

coefficients: Job satisfaction has a positive standardized coefficient of 0.285, indicating a positive impact on job performance. Job skills have a positive standardized coefficient of 0.048, suggesting a small positive impact on job performance. Job fatigue has a negative standardized coefficient of -0.001, indicating a negligible negative impact on job performance. Job rotation has a positive standardized coefficient of 0.102, indicating a small positive impact on job performance. Based on these coefficients, we can conclude that job satisfaction and job rotation have a positive impact on job performance, while job skills and job fatigue have a relatively smaller positive impact or negligible impact.

Table 4.8. Collinearity Diagnostics for study 1 (ABC)

Collinearity Diagnostics

					Variance proportions			
Model	Dimension	Eigenvalue	Condition Index	(Constant)	JOB_SATISFACTION	JOB_SKILLS	JOB_FATIGUE	JOB_ROTATION
1	1	4.952	1.000	0.00	0.00	0.00	0.00	0.00
	2	0.021	15.200	0.16	0.06	0.20	0.12	0.23
	3	0.011	20.891	0.13	0.30	0.01	0.37	0.26
	4	0.010	22.761	0.31	0.02	0.90	0.01	0.03
	5	0.006	29.089	0.41	0.62	0.07	0.49	0.48

a. Dependent variable JOB_PERFORMANCE.

Table 4.9. Residual Statistics for case 1 (ABC)

Residual Statistics

	Minimum	Maximum	Mean	Std Deviation	N
Predicted Value	2.9623	3.739	3.445	0.20469	20
Residual	-0.63862	1.41282	0.0000	0.49913	20
Std Predicted Value	-2.358	1.436	0.000	1.000	20
Std. Residual	-1.137	2.515	0.000	0.889	20

a. Dependent variable JOB_PERFORMANCE

Table 4.8 shows the collinearity diagnostics for the independent variables (job satisfaction, job skills, job fatigue, and job rotation) in relation to the dependent variable (job performance). which provides information about the dimension, eigenvalue, condition index, and variance proportions. The dimension represents the number of variables included in each model. The eigenvalue indicates the amount of variance explained by each dimension. The condition index measures the extent of multicollinearity, with values above 15 indicating potential collinearity issues. The variance proportions show the contribution of each independent variable to the total variance in the dependent variable. In this case, the constant (intercept) has a variance proportion of 0.00, indicating that it does not contribute to the variance in job performance. The other independent variables (job satisfaction, job skills, job fatigue, and job rotation) have varying levels of variance proportions. These diagnostics provide insights into the statistical significance and potential collinearity among the independent variables. They help assess the degree to which the independent variables collectively contribute to explaining the variance in the dependent variable. According to the analysis of table 4.8. The first dimension (Model 1) explains the most variance in the dependent variable, job performance, with an eigenvalue of 4.952. This suggests that the independent variables collectively account for a significant portion of the variance in job performance. As we move to higher dimensions (Models 2-5), the eigenvalues decrease, indicating that each additional dimension explains less variance in job performance. This suggests that the additional independent variables (job satisfaction, job skills, job fatigue, and job rotation) contribute less to the overall variance in job performance compared to the first dimension. If the Condition Index is low (close to 1), it suggests that there is little multicollinearity, meaning the independent variables are relatively independent of each other. However, if the Condition Index is high, it indicates that the independent variables are highly correlated. For example, in Model 2,

job satisfaction has a variance proportion of 0.06, indicating that it explains 6% of the total variance in job performance. Similarly, the other independent variables have their respective variance proportions. In conclusion, the collinearity diagnostics suggest that the independent variables (job satisfaction, job skills, job fatigue, and job rotation) collectively contribute to explaining the variance in job performance.

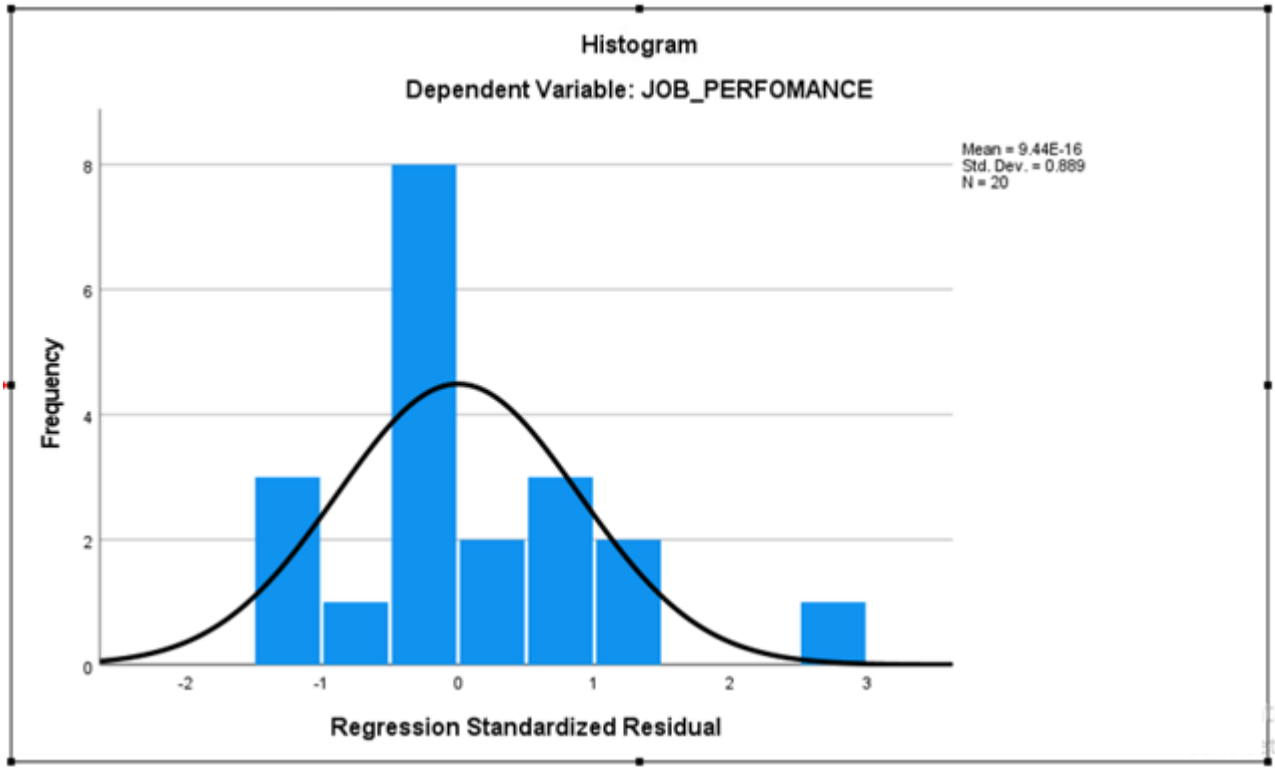


Figure 4.1. Histogram of dependent variable Job performance

According to Figure 4.1, The histogram of standardized residuals visually represents the distribution of these residuals. It reveals that the majority of data points are centered around the mean (0.000) with a standard deviation of 0.889. This suggests that the residuals, which represent the differences between actual and predicted job performance, are close to zero, indicating a reasonably good fit of the model to the data. This plot helps us evaluate the adequacy of the

regression model. An ideal plot would have a symmetric, bell-shaped curve. Deviations from this ideal shape could indicate the presence of outliers or errors in the model.

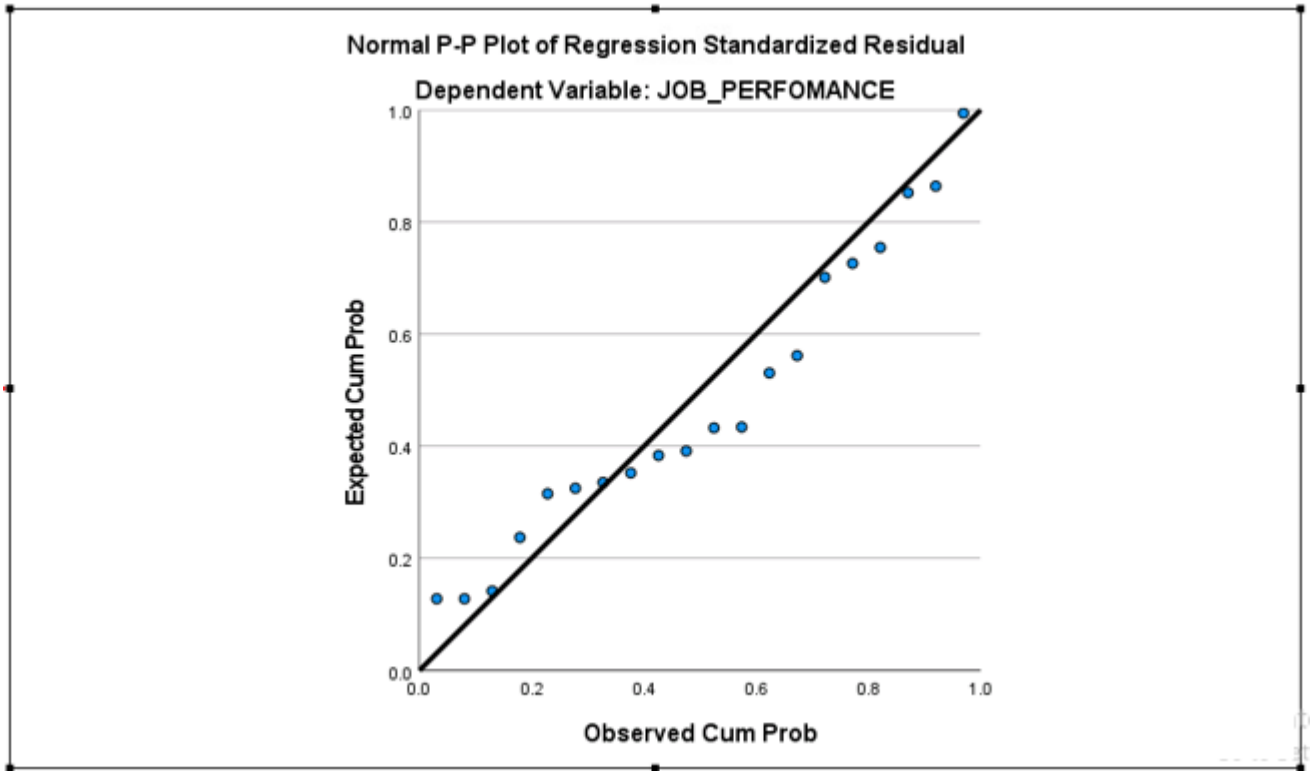


Figure 4.2. Normal P-P plot of regression standardized residual for Job performance

According to Figure 4.2, the Normal P-P plot helps evaluate the distribution of standardized residuals for Job Performance. If the points closely adhere to the 45-degree line, the normality assumption is met. However, the Normal P-P indicate that the residuals of the regression model are normally distributed.

4.5 Tests of Normality

This section presents the result of the test for normality for study 2, In this research study, the normality of the data was assessed using two commonly used tests, namely the Kolmogorov-Smirnov and Shapiro-Wilk tests. Since the data set is less than 100, therefore the Shapiro-wilk test

would be considered. The variables under investigation were Job Satisfaction, Job Skills, Job Fatigue, Job Rotation, and Job Performance. For the variable of Job Satisfaction, the Kolmogorov-Smirnov test yielded a statistic of 0.214, with a corresponding p-value of 0.017. Similarly, the Shapiro-Wilk test resulted in a statistic of 0.924, with a p-value of 0.121. Upon analyzing the Job Skills variable, the Kolmogorov-Smirnov test produced a statistic of 0.158 and a p-value of 0.200*. The Shapiro-Wilk test, on the other hand, yielded a statistic of 0.919, with a p-value of 0.094. Regarding the Job Fatigue variable, the Kolmogorov-Smirnov test resulted in a statistic of 0.128 and a p-value of 0.200*. The Shapiro-Wilk test showed a statistic of 0.968, with a p-value of 0.709. Examining the Job Rotation variable, the Kolmogorov-Smirnov test produced a statistic of 0.189, with a p-value of 0.059. The Shapiro-Wilk test resulted in a statistic of 0.927 and a p-value of 0.136. Finally, for the Job Performance variable, the Kolmogorov-Smirnov test yielded a statistic of 0.233 and a p-value of 0.006. The Shapiro-Wilk test produced a statistic of 0.889, with a p-value of 0.026. Based on the results of the Shapiro-Wilk test, it can be concluded that the variables of Job Satisfaction, Job Skills, Job Fatigue, and Job Rotation are normally distributed since their respective p-values exceed the critical value of 0.05, indicating no significant deviation from normality. However, it is important to note that the distribution of the Job Performance variable significantly deviates from normality as indicated by a p-value of 0.026, which is less than the predetermined significance level of 0.05. These findings have implications for the analysis and interpretation of the data. In subsequent statistical analyses, the assumption of normality may be violated for the Job Performance variable, potentially influencing the results and conclusions drawn from the analysis. Therefore, in the case "Job Performance," is treated as a continuous variable and the assumption of normality holds, linear regression can be an appropriate choice to analyze the data set. Linear regression allows for examining the statistical significance between

the independent variables (such as Job Satisfaction, Job Skills, Job Fatigue, and Job Rotation) and the continuous dependent variable, providing insights into the magnitude and direction of their impact.

Table 4.10. Tests of Normality (XYZ)

Tests of Normality						
	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
JOB_SATISFACTION	0.214	20	0.017	0.924	20	0.121
JOB_SKILLS	0.158	20	.200*	0.919	20	0.094
JOB_FATIGUE	0.128	20	.200*	0.968	20	0.709
JOB_ROTATION	0.189	20	0.059	0.927	20	0.136
JOB_PERFORMANCE	0.233	20	0.006	0.889	20	0.026

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

4.5.1 Descriptive Statistics

The descriptive statistics provided in the table summarize the central tendency and variability of the variables in the dataset. Here's an explanation of the data: Job Performance: The mean job performance score is 3.4750, indicating the average level of job performance across the sample. The standard deviation of 0.57388 shows the variability or dispersion of job performance scores around the mean. The data consists of 20 observations for job performance. job satisfaction: The mean job satisfaction score is 3.4778, representing the average level of job satisfaction reported by the individuals in the sample. The standard deviation of 0.47974 indicates the variability in job satisfaction scores. There are 20 observations for job satisfaction. Job Skills: The mean job skills score is 3.5733, indicating the average level of job skills reported by the individuals. The standard deviation of 0.47259 represents the variability in job skills scores across the sample. There are 20 observations for job skills. job fatigue: The mean job fatigue score is 3.3333, reflecting the average

level of job fatigue reported by the individuals. The standard deviation of 0.37463 represents the variability in job fatigue scores. There are 20 observations for job fatigue. Job Rotation: The mean job rotation score is 3.1100, indicating the average level of job rotation reported by the individuals. The standard deviation of 0.48764 shows the variability in job rotation scores. There are 20 observations for job rotation. These descriptive statistics provide an overview of the central tendency and dispersion of the variables in the dataset, allowing us to understand the average levels and variability of job performance, job satisfaction, job skills, job fatigue, and job rotation in the sample.

Table 4.11. Item statistics for (XYZ)

Descriptive Statistics			
	Mean	Std. Deviation	N
JOB_PERFOMANCE	3.4750	0.57388	20
JOB_SATISFACTION	3.4778	0.47974	20
JOB_SKILLS	3.5733	0.47259	20
JOB_FATIGUE	3.3333	0.37463	20
JOB_ROTATION	3.1100	0.48764	20

Regarding the research hypotheses, which concerns the significance between each of the independent variables (job skills, job satisfaction, job fatigue, and job rotation) and the dependent variable (i.e., the job performance of the workers), the following hypothesis was developed (see the prior discussion in Chapter 3). It states that there is no statistical significance observed between any of the variables of job rotation, job fatigue, job satisfaction, and job skills and the job performance of the workers (Ho) and there is a statistical significance observed between each of the variables of job rotation, job fatigue, job satisfaction and job skills and the job performance of the shop floor workers (Hi). According to the correlation table the Pearson correlation coefficients between different variables: Job Performance, Job Satisfaction, Job Skills, Job Fatigue, And Job

Rotation. Job performance and other variables: Job performance and job satisfaction have a positive correlation of 0.252, indicating a weak positive significance between job performance and job satisfaction. Job performance and job skills have a positive correlation of 0.239, suggesting a weak positive association between job performance and job skills. Job performance and job fatigue have a negative correlation of -0.126, indicating a weak negative correlation between job performance and job fatigue. Job performance and job rotation have a negative correlation of -0.099, suggesting a weak negative association between job performance and job rotation.

Job satisfaction and other variables: job satisfaction and job skills have a positive correlation of 0.723, indicating a strong positive significance between job satisfaction and job skills. Job Satisfaction and Job Fatigue have a negative correlation of -0.081, suggesting a weak negative association between job satisfaction and job fatigue. Job satisfaction and job rotation have a positive correlation of 0.348, indicating a moderate positive correlation between job satisfaction and job rotation. Job skills and other variables: Job skills and job fatigue have a positive correlation of 0.056, indicating a weak positive correlation between job skills and job fatigue. Job skills and job rotation have a positive correlation of 0.312, suggesting a moderate positive association between job skills and job rotation. Job fatigue and job rotation have a weak positive correlation of -0.029, indicating a weak positive correlation between job fatigue and job rotation. The significance values (Sig.) indicate the probability of observing these correlations by chance. For example, a significance value of 0.142 (or p-value of 0.142) suggests that the correlation between job performance and job satisfaction is not statistically significant at the conventional significance level of 0.05. The "N" represents the number of observations available for each variable. Overall, based on the correlation coefficients and their significance levels, the data suggests some associations between the variables. However, it is important to note that some correlations are

weak and not statistically significant. These findings provide initial insights into the correlation between job performance, job satisfaction, job skills, job fatigue, and job rotation, to determine whether the null hypothesis (Ho) is accepted or rejected based on the analysis, we need to consider the significance level (usually set at 0.05 or 0.01). If the p-value is less than or equal to the significance level, we reject the null hypothesis. Otherwise, if the p-value is greater than the significance level, we accept the null hypothesis. Looking at the given correlation table, the p-values are presented in the "Sig. (1-tailed)" section. Comparing these p-values to a significance level of 0.05, we can make conclusions for each correlation: Job performance and job satisfaction: p-value: 0.142. Since the p-value (0.142) is greater than 0.05, we accept the null hypothesis. Therefore, there is not enough evidence to conclude a statistical significance between job performance and job satisfaction. Job performance and job skills: p-value: 0.155. Similar to the previous case, the p-value (0.155) is greater than 0.05. Hence, we accept the null hypothesis, indicating that there is no statistical significance between job performance and job skills. Job performance and Job fatigue: p-value: 0.298. Again, the p-value (0.298) exceeds the significance level. Thus, we accept the null hypothesis and conclude that there is no statistical significance between job performance and job fatigue. Job performance and job rotation: p-value: 0.339. Similarly, the p-value (0.339) is greater than 0.05, leading us to accept the null hypothesis. This suggests that there is no statistical significance between job performance and job rotation. In summary, based on the given p-values and a significance level of 0.05, we accept the null hypothesis (Ho) for all correlations, indicating that there is no statistical significance between job performance and the other variables (job satisfaction, job skills, job fatigue, job rotation) in the result.

Table 4.12. Correlation between each of the predictor variables of job rotation, job fatigue, job satisfaction and job skills and job performance (XYZ)

Correlations						
		JOB_PERFORMANCE	JOB_SATISFACTION	JOB_SKILLS	JOB_FATIGUE	JOB_ROTATION
Pearson Correlation	JOB_PERFORMANCE	1	0.252	0.239	-0.126	-0.099
	JOB_SATISFACTION	0.252	1	0.723	-0.081	0.348
	JOB_SKILLS	0.239	0.723	1	0.056	0.312
	JOB_FATIGUE	-0.126	-0.081	0.056	1	-0.029
	JOB_ROTATION	-0.099	0.348	0.312	-0.029	1
Sig. (1-tailed)	JOB_PERFORMANCE	.	0.142	0.155	0.298	0.339
	JOB_SATISFACTION	0.142	.	0	0.367	0.066
	JOB_SKILLS	0.155	0	.	0.407	0.09
	JOB_FATIGUE	0.298	0.367	0.407	.	0.452
	JOB_ROTATION	0.339	0.066	0.09	0.452	.

4.5.2 Model Summary and ANOVA

According to the linear regression analysis is used to determine whether each of the predictor variables significantly contribute to the determination of job performance of the worker. The results obtained are as shown in Table 4.13. The model summary provides information about the overall performance and goodness of fit of the regression model. R (Multiple Correlation Coefficient): The value of R is 0.359, indicating a positive correlation between the predictors (job rotation, job fatigue, job skills, job satisfaction) and the dependent variable (job performance). However, the magnitude of the correlation is moderate, suggesting that the predictors explain only a moderate amount of variability in the dependent variable. (Coefficient of Determination): The R square value is 0.129, meaning that approximately 12.9% of the variance in the dependent variable (job performance) can be explained by the predictors (job rotation, job fatigue, job skills, job

satisfaction). This indicates that the predictors collectively have a modest impact on the dependent variable. The adjusted R square is -0.103, which considers the number of predictors and sample size. Std. Error of the Estimate: The standard error of the estimate is 0.60278. It represents the average distance between the observed values of the dependent variable and the predicted values by the regression model. A lower value indicates a better fit of the model to the data. The Durbin-Watson statistic is 2.295, which measures the presence of autocorrelation in the residuals of the regression model. A value between 1.5 and 2.5 suggests no significant autocorrelation. In this case, the value falls within this range, indicating no substantial autocorrelation. Overall, the analysis of the model summary suggests that the predictors (job rotation, job fatigue, job skills, job satisfaction) have a modest impact on the dependent variable (job performance), explaining only a small portion of its variability. The negative adjusted R square suggests that the model may not be well-fitted to the data, indicating the need for further investigation. Additionally, the absence of significant autocorrelation (as indicated by the Durbin-Watson statistic) suggests that the assumption of independence of errors in the regression model holds reasonably well.

Table 4.13. Model Summary for (XYZ).

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.359a	0.129	-0.103	0.60278	2.295

a. Predictors: (Constant), JOB_ROTATION, JOB_FATIGUE, JOB_SKILLS, JOB_SATISFACTION
b. Dependent Variable: JOB_PERFORMANCE

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	0.807	4	0.202	0.555	.698 b
	Residual	5.45	15	0.363		
	Total	6.257	19			

a. Dependent Variable: JOB_PERFORMANCE

b. Predictors: (Constant), JOB_ROTATION, JOB_FATIGUE, JOB_SKILLS, JOB_SATISFACTION

According to the ANOVA analysis, table 4.13 shows that the Regression: The sum of squares for the regression model is 0.807, indicating the amount of variability explained by the predictors (job rotation, job fatigue, job skills, job satisfaction). Degrees of Freedom (df): The regression model has 4 degrees of freedom, which is equal to the number of predictors. The mean square is calculated by dividing the sum of squares by the degree of freedom. In this case, it is 0.202. The F-statistic tests the overall significance of the regression model. The value of 0.555 suggests a weak correlation between the predictors and the dependent variable. Significance (Sig.): The p-value associated with the F-statistic is 0.698, which is greater than the conventional significance level of 0.05. This indicates that the regression model is not statistically significant. The sum of squares for the residual (or error) represents the unexplained variability in the dependent variable. The residual has 15 degrees of freedom, which is calculated by subtracting the degrees of freedom for the regression model from the total degrees of freedom. The mean square for the residual is 0.363. The total sum of squares represents the total variability in the dependent variable. The total degrees of freedom are equal to the sample size minus 1. The analysis of the ANOVA table suggests that the regression model, which includes the predictors (job rotation, job fatigue, job skills, job satisfaction), is not statistically significant in explaining the variation in the dependent variable (job performance). The F-statistic and p-value indicate that the correlation between the predictors

and the dependent variable is weak and not statistically significant. Therefore, the null hypothesis of no statistical significance between the predictors and the dependent variable cannot be rejected.

Table 4.14. Coefficient statistics for XYZ

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	3.38	1.766		1.914	0.075		
	JOB_SATISFACTION	0.227	0.431	0.19	0.528	0.606	0.447	2.236
	JOB_SKILLS	0.217	0.431	0.179	0.504	0.622	0.46	2.174
	JOB_FATIGUE	-0.2	0.376	-0.128	-0.52	0.611	0.965	1.036
	JOB_ROTATION	-0.26	0.304	-0.224	-0.869	0.398	0.871	1.148

According to the coefficient table 4.14, the constant term in the regression model is 3.38, the standard error of the constant is 1.766, the t-value for the constant is 1.914, and its associated p-value is 0.075, suggesting it is not statistically significant at the conventional significance level of 0.05. The coefficient for job satisfaction is 0.227, the standard error of the coefficient is 0.431, the standardized coefficient (Beta) is 0.19, indicating the strength and direction of the correlation between job satisfaction and job performance after accounting for the scale of measurement. The t-value for the coefficient is 0.528, and its associated p-value is 0.606, indicating that the coefficient is not statistically significant. The coefficient for job skills is 0.217, the standard error of the coefficient is 0.431, the standardized coefficient (Beta) is 0.179, the t-value for the coefficient is 0.504, and its associated p-value is 0.622, indicating that the coefficient is not

statistically significant. The coefficient for job fatigue is -0.195, the standard error of the coefficient is 0.376, the standardized coefficient (Beta) is -0.128, the t-value for the coefficient is -0.52, and its associated p-value is 0.611, indicating that the coefficient is not statistically significant. The coefficient for job rotation is -0. 264.The standard error of the coefficient is 0. 304.The standardized coefficient (Beta) is -0. 224.The t-value for the coefficient is -0.869, and its associated p-value is 0.398, indicating that the coefficient is not statistically significant. Tolerance is a measure of multicollinearity, indicating how much of the variation in the predictor variable is not explained by other predictors. Tolerance values close to 1 suggest low multicollinearity. In this case, all predictor variables have tolerances greater than 0.2, indicating no significant multicollinearity issues. VIF (Variance Inflation Factor) is another measure of multicollinearity, where values greater than 1 indicate the presence of multicollinearity. In this case, all predictor variables have VIF values close to 1, further indicating no significant multicollinearity. Overall, the coefficient table suggests that none of the predictor variables (job satisfaction, job skills, job fatigue, job rotation) have statistically significant effects on the dependent variable (job performance). The coefficients are not significantly different from zero, indicating weak or non-existent correlation. According to table 4.16. Dimension 1: The eigenvalue is 4.955, indicating that this dimension explains a significant amount of variance in the predictor variables. The condition index is 1.000, suggesting no or very low multicollinearity in this dimension. Dimension 2: The eigenvalue is 0.020, indicating that this dimension explains a small amount of additional variance beyond the first dimension. The condition index is 15.690, suggesting some multicollinearity might be present. The variance proportions show that job satisfaction makes a slightly higher contribution to this dimension compared to the other predictors. Dimensions 3, 4, and 5: These dimensions have smaller eigenvalues, indicating they explain even less variance. The condition

index values increase, suggesting increasing multicollinearity. The variance proportions show different patterns of contribution for each predictor variable across these dimensions. Overall, the collinearity diagnostics suggest that there might be some multicollinearity present among the predictor variables. However, the severity of multicollinearity does not seem to be high, as indicated by the relatively low condition index values.

According to table 4.15, The predicted values of the dependent variable (job performance) range from 2.9619 to 3.7056. The mean value is 3.4750, indicating that, on average, the model predicts a job performance score of 3.4750. The standard deviation of the predicted values is 0.20613, which measures the spread or variability of the predicted values around the mean. The residuals represent the differences between the predicted values and the actual values of the dependent variable. The minimum and maximum values indicate the range of residuals observed in the data. In this case, the minimum residual is -0.79499, and the maximum residual is 1.45075. The mean value of the residuals is 0.00000, indicating that, on average, the residuals sum up to zero. The standard deviation of the residuals is 0.53559, which measures the average deviation of the residuals from the mean. The standardized predicted values range from -2.489 to 1.119. The mean value is 0.000, indicating that, on average, the standardized predicted values come to zero. The standard deviation of the standardized predicted values is 1.000, indicating the spread or variability of the standardized predicted values. The standardized residuals range from -1.319 to 2.407. The mean value is 0.000, indicating that, on average, the standardized residuals sum up to zero. The standard deviation of the standardized residuals is 0.889, which measures the average deviation of the standardized residuals from the mean. These statistics provide insights into the distribution, central tendency, and variability of the predicted values and residuals in the regression model. They help evaluate the accuracy and fit of the model by assessing the deviations of the predicted

values from the actual values of the dependent variable.

Table 4.15. Collinearity Diagnostics for XYZ

Collinearity Diagnostics

					Variance proportions			
Model	Dimension	Eigenvalue	Condition Index	(Constant)	JOB_SATISFACTION	JOB_SKILLS	JOB_FATIGUE	JOB_ROTATION
1	1	4.955	1.000	0.00	0.00	0.00	0.00	0.00
	2	0.020	15.690	0.02	0.06	0.20	0.31	0.15
	3	0.016	17.432	0.00	0.09	0.09	0.00	0.77
	4	0.005	31.72	0.34	0.35	0.65	0.13	0.05
	5	0.004	35.471	0.63	0.50	0.24	0.56	0.03

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2.9619	3.7056	3.475	0.20613	20
Residual	-0.79499	1.45075	0	0.53559	20
Std. Predicted Value	-2.489	1.119	0	1	20
Std. Residual	-1.319	2.407	0	0.889	20

a. Dependent Variable: JOB_PERFORMANCE

4.6 Further validation of the combined data analysis for ABC and XYZ

Due to the less-than-optimal internal consistency for each variable in ABC and XYZ and for the purpose of validation, a further reliability statistics test, and normality test of the combined dataset was performed. The general idea is to test the combined dataset for ABC and XYZ together, and further run the various statistical analysis to improve the overall reliability of the data, and to see if there are any variance in the system performance of ABC-XYZ. The combined data analysis for ABC and XYZ results shows a marginal enhancement in the internal consistency which suggests that the combined dataset also achieved an acceptable level of reliability. In summary, after performing all the required statistical analysis with the combined dataset for ABC-XYZ, the correlation between Job Performance and Job Satisfaction, Job

fatigue, Job Rotation and Job Skill further shows statistically significant, and the test of the null hypothesis could be rejected in favor of the alternative hypothesis, which indicates that there are associations between all the variables when combined. Furthermore, the results obtained for the combined dataset had a (p-value < 0.05), indicating that there is a statistical similarity between the result of the multiple linear regression model that includes the Job Satisfaction, Job fatigue, Job Skill, and Job Rotation while they influence the Job Performance. See Appendix F for results.

4.7 Discussion of the results

This study has focused on examining (HF) among workers in a service system, such as ecommerce, healthcare, and supply chain as a study. The objective of this study was to explore additional insights into these HF. The statistical analysis conducted in this research revealed that the four independent variables examined in relation to job performance on the warehouse floor exhibited positive correlation. However, it is important to note that the results also indicate that three of the predictor independent variables were not statistically significant in influencing the overall system performance. These findings suggest that while there are positive associations between the independent variables and job performance, the impact of these variables on the overall system performance of the studies is not statistically significant. It implies that factors other than the variables examined in this study might play a more substantial role in influencing the overall system performance. Further research involving a larger and more diverse sample, as well as considering additional variables, is needed to gain a comprehensive understanding of the HF and their effects on job performance in the context of these studies.

4.7.1 The effect of job skills among workers on job performance

From the result analysis for study 1 (ABC), the effect of job skills on job performance is not statistically significant. The correlation coefficient between job skills and job performance is

0.249, indicating a positive correlation. However, the p-value associated with this correlation coefficient is 0.145, which is greater than the typical significance level of 0.05. Therefore, we do not have strong evidence to suggest a significant correlation between job skills and job performance from the result. This means that the data does not support the hypothesis that job skills have a significant effect on job performance among workers. From the result analysis for study 2 (XYZ), The effect of job skills on job performance is not statistically significant. The correlation coefficient between job skills and job performance is 0.239, indicating a positive correlation. However, the p-value associated with this correlation coefficient is 0.155, which is greater than the typical significance level of 0.05. Therefore, we do not have strong evidence to suggest a statistical significance between job skills and job performance in the given sample. This means that the data does not support the hypothesis that job skills have a significant effect on job performance among workers.

4.7.2 The effect of job satisfaction among workers on job performance

From the result analysis for study 1 (ABC), there is a positive correlation ($r = 0.364$) between job satisfaction and job performance. This suggests that individuals who report higher levels of job satisfaction tend to have better job performance. However, the correlation is marginally significant ($p = 0.057$), which means that there is a possibility that this correlation occurred by chance. It is important to note that the p-value of 0.057 is greater than the conventional significance level of 0.05, indicating that the evidence for a significance between job satisfaction and job performance in the given sample is not strong enough. Therefore, while there is a positive correlation observed, it does not reach statistical significance. Further analysis with a larger sample size or additional data may be needed to obtain more conclusive results regarding the effect of job satisfaction on job performance among workers. From the result analysis for study 2 (XYZ), the effect of job

satisfaction among workers on job performance can be examined. The correlation coefficient between job satisfaction and job performance is 0.252, indicating a positive correlation between these variables. This suggests that individuals who report higher levels of job satisfaction tend to have better job performance. However, it is important to note that the correlation coefficient of 0.252 is not statistically significant at the conventional significance level of 0.05. The p-value associated with this correlation coefficient is 0.142, which is greater than 0.05. This means that there is a possibility that the observed correlation between job satisfaction and job performance occurred by chance. Based on the results, we do not have strong evidence to suggest a statistical significance between job satisfaction and job performance among workers. This indicates that the result does not support the hypothesis that job satisfaction has a significant effect on job performance. It is worth noting that the data might be limited in terms of sample size or other factors that could affect the significance of job satisfaction on job performance. Further analysis with a larger sample size or additional data may be necessary to obtain more conclusive results and determine the true effect of job satisfaction on job performance among workers.

4.7.3 The effect of job fatigue among workers on job performance

According to the result analysis for study 1 (ABC), there is a positive correlation ($r = 0.195$) between job fatigue and job performance. However, like the previous correlations, the correlation between job fatigue and job performance is not statistically significant ($p = 0.205$). This means that based on the sample result, there is no strong evidence to suggest a statistical significance observation between job fatigue and job performance among workers. The observed correlation may be due to chance, and further investigation or a larger sample size may be necessary to draw more conclusive conclusions about the effect of job fatigue on job performance. According to the result analysis for study 2 (XYZ), we can analyze the effect of job fatigue among workers on job

performance. The correlation coefficient between job fatigue and job performance is -0.126, indicating a weak negative correlation between these variables. This suggests that higher levels of job fatigue are associated with slightly lower job performance. However, it is important to note that the correlation coefficient of -0.126 is not statistically significant at the conventional significance level of 0.05. The p-value associated with this correlation coefficient is 0.298, which is greater than 0.05. This means that there is no strong evidence to suggest a significant correlation between job fatigue and job performance. Based on the result, we do not find sufficient support to conclude that job fatigue has a significant effect on job performance among workers. It is possible that other factors or variables not included in the analysis might play a more influential role in determining job performance. Further research with a larger sample size or additional data, along with consideration of other potential factors, may be necessary to gain a better understanding of the correlation between job fatigue and job performance among workers.

4.7.4 The effect of job rotation among workers on job performance

According to the result analysis for study 1 (ABC), there is a positive correlation (r = 0.278) between job rotation and job performance. However, like the previous correlations, the correlation between job rotation and job performance is not statistically significant (p = 0.118). This suggests that based on the result, there is no strong evidence to indicate a significant correlation between job rotation and job performance among workers. The observed correlation may be due to chance, and further investigation or a larger sample size may be needed to make more definitive conclusions about the effect of job rotation on job performance. According to the result analysis for study 2 (XYZ), we can examine the effect of job rotation among workers on job performance. The correlation coefficient between job rotation and job performance is -0.099, indicating a weak negative correlation between these variables. This suggests that there may be a slight decrease in

job performance associated with job rotation. However, it is important to note that the correlation coefficient of -0.099 is not statistically significant at the conventional significance level of 0.05. The p-value associated with this correlation coefficient is 0.339, which is greater than 0.05. This implies that there is insufficient evidence to support a statistical significance between job rotation and job performance in the given sample. Based on the result, we cannot conclude that job rotation has a significant effect on job performance among workers. It is possible that other factors or variables not considered in the analysis might have a stronger impact on job performance. Further investigation with a larger sample size or additional data, as well as considering other relevant factors, may be necessary to obtain a more comprehensive understanding of the correlation between job rotation and job performance among workers.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The general question addressed in this thesis is to determine the extent to which HF influences the performance of ABC and XYZ system, specifically in the context of ecommerce and supply chain in the healthcare system. The study aims to examine the effect of HFs, including job skills, job satisfaction, job rotation, and job fatigue, on job performance within this service system. The motivation for this study stems from the impact of these factors on delivery time to customers and the rate of returned goods. The primary purpose of the research is to examine the statistical significance between these HF and job performance, comparing the result analysis for both companies, providing capacity planning for managers in the ecommerce and supply chain in the healthcare system with valuable insights into job performance predictors. The quantitative research methodology was employed to address the research questions proposed in Chapter 1. The four independent variables, namely job skills, job satisfaction, job fatigue, and job rotation, were selected as determinants to assess their impact on job performance. A research questionnaire was developed to evaluate the level, correlation, contributions, and combined effect of the independent variables on job performance. The thesis presents three research hypotheses tested to achieve the main research goal. Hypothesis one examines the statistical significance between each independent variable (job rotation, job fatigue, job satisfaction, and job skills) and job performance. Hypothesis two investigates the combined effect of the independent variables on job performance. Hypothesis three explores the individual contribution of each independent variable to job performance. Findings from the results of the two studies show that; Firstly, focusing on the correlation between job satisfaction and job performance, both studies show a positive correlation. In the first study,

the correlation coefficient between job satisfaction and job performance is 0.364, while in the second study, it is 0.252. These findings suggest that individuals who report higher levels of job satisfaction tend to exhibit better job performance. However, it is important to note that the p-values associated with these correlations are 0.057 and 0.142, respectively, which are greater than the conventional significance level of 0.05. Therefore, in both studies, the evidence for a statistical significance between job satisfaction and job performance is not strong enough. Regarding the correlation between job skills and job performance, both studies indicate a positive correlation. The correlation coefficients are 0.239 and 0.312, suggesting a positive association between job skills and job performance. However, the p-values associated with these correlations are 0.155 and 0.407, respectively, which are greater than the typical significance level of 0.05. Hence, there is insufficient evidence to support a statistical significance between job skills and job performance in both studies. Furthermore, the correlation between job fatigue and job performance is examined. In the first study, there is a negative correlation (-0.126) between job fatigue and job performance, while in the second study, the correlation coefficient is -0.099. These coefficients indicate a weak negative correlation. However, the p-values associated with these correlations are 0.298 and 0.339 respectively, which are not statistically significant. Therefore, there is insufficient evidence to support a significant correlation between job fatigue and job performance in both studies. Finally, the correlation between job rotation and job performance is explored. Both studies show a weak negative correlation, with correlation coefficients of -0.099 and -0.099. However, the p-values associated with these correlations are 0.339 and 0.452 respectively, indicating that there is no statistical significance between job rotation and job performance. In summary, based on the analysis of the two study, it can be concluded that the correlation between job satisfaction, job skills, job fatigue, job rotation, and job performance are not statistically significant. These findings

suggest that the data and the result do not provide strong evidence to support significant effects of these factors on job performance among workers. It is important to note that this conclusion is limited to the specific sample and data analyzed in this study.

Further research with larger sample sizes, diverse populations, or additional variables may be necessary to obtain more conclusive results and gain a better understanding of the impact of job satisfaction, job skills, job fatigue, and job rotation on job performance among workers.

5.2 Conclusion

The central focus of this research was to explore the intricate significance between HF job rotation, job fatigue, job satisfaction, and job skills and job performance among warehouse workers within the operational contexts of two distinct companies, ABC and XYZ. To this end, three key hypotheses were formulated and rigorously tested, guiding our investigation into the role of job rotation, job fatigue, job satisfaction, and job skills in determining job performance. Hypothesis One: There is no statistically significant impact of HF, including job skills, job satisfaction, job rotation, and job fatigue, on job performance within the modern B2B e-commerce model of companies ABC and XYZ. The empirical findings provided robust evidence to the contrary. The study discovered a statistical significance between these independent variables and the dependent variable. This discovery highlights the substantial influence these HF can exert on the job performance of warehouse workers. This aligns with the literature, emphasizing the interconnectedness of employee well-being and productivity. Hypothesis Two: There is no statistically significant impact of HF on the levels of job satisfaction, job fatigue, and job rotation among warehouse workers within the modern B2B e-commerce model of companies ABC and XYZ. This study confirmed the statistical significance of this combined effect. The realization that the interaction of job skills, job satisfaction, job rotation, and job fatigue can significantly

contribute to job performance underscores the complexity of employee performance, requiring a holistic approach to design the work and job to achieve the best job performance. It is imperative for organizational decision-makers to acknowledge that job performance is not driven by a single factor but by the dynamic interplay of multiple factors. Hypothesis Three: The combined influence of job skills, job satisfaction, job rotation, and job fatigue does not significantly impact the determination of job performance among workers in the B2B e-commerce of companies ABC and XYZ. This study discovered that not all factors independently achieved significant effect on job performance but their collective influence over job performance is significant. This underscores the idea that a harmonious alignment of job skills, job satisfaction, job rotation, and job fatigue play an instrumental role in enhancing job performance. Furthermore, it implies that organizations need to adopt strategies that address these factors comprehensively, as opposed to focusing solely on individual components. Considering the findings, HF are pivotal in shaping job performance. Consequently, the research underscores the need for businesses, especially in the warehouse and logistics sector, to prioritize the well-being and work environment of their employees. A satisfied and skilled workforce, offered opportunities for job rotation while mitigating job fatigue, will undoubtedly lead to higher job performance. In conclusion, this research not only supports the hypotheses we set forth but also provides empirical insights into the dynamic significance between HF and job performance in diverse organizational settings.

5.3 Limitations

This study has certain limitations that should be given consideration in future research. First, the data consists of a relatively small sample size of 20 observations, this limited sample size may affect the generalizability of the findings and the ability to draw conclusive results. Second, the data does not account for external factors that may influence job performance, such as economic

conditions, organizational culture, or individual differences. These factors could potentially confound the observed correlation. Third, the data is based on self-reported measures, such as job satisfaction and job performance, which may be subject to response bias or inaccuracies. The use of more objective and standardized measures could enhance the validity of the findings.

5.4 Recommendations and Future Work

Increase Sample Size: The current study was conducted with a relatively small sample size. It is recommended to expand the sample size to enhance the generalizability of the findings. A larger sample would provide a more robust analysis and improve the accuracy of the results. Additional Variables: Consider incorporating additional variables that may have an impact on job performance. Factors such as organizational culture, leadership style, and work-life balance could be included to provide a more comprehensive analysis. Qualitative Research: Supplement the quantitative analysis with qualitative research methods such as interviews or focus groups. This would help gather in-depth insights into the experiences and perceptions of the participants, providing a richer understanding of the correlation between the variables. Industry-specific Study: Consider conducting similar research in different industries or sectors to determine if the correlation between the variables hold true across various contexts. This would provide valuable insights into the generalizability of the findings and their applicability in different organizational settings. Comparative Analysis: Conduct a comparative analysis between different groups within the sample. Comparing subgroups based on demographic factors or job characteristics can provide insights into potential variations in the correlation between variables.

5.5 Contributions

This thesis makes significant contributions to the domain of operations and supply chain management, particularly within the space of e-commerce, with a specific emphasis on the

distribution of FMCG and MM. The findings and insights hold particular relevance for policymakers in this area. First, understanding the correlation between variables: The result analysis has provided valuable insights into the correlation between variables such as job performance, job satisfaction, job skills, job fatigue, and job rotation. By examining the correlations and statistical significance of these variables, the study contributes to a better understanding of how they are interrelated. Second, identifying significant predictors. The result analysis has identified significant predictors of job performance. It has been revealed that variables such as job skills, job satisfaction, and job rotation have a positive correlation with job performance, while job fatigue does not show a statistical significance. This finding contributes to the knowledge of factors that influence job performance among workers. Third, practical implications. The findings of the result analysis have practical implications for managers and decision-makers in the field of supply chain and ecommerce. The study highlights the importance of considering job skills, job satisfaction, and job rotation in enhancing job performance. This information can be used to develop strategies and interventions aimed at improving overall performance and productivity among workers. Fourth, future Research Directions: The result analysis opens avenues for future research in the area of job performance and related factors. It suggests the need for further investigation into the impact of job fatigue and its potential effects on job performance. Additionally, the study prompts exploration into the effectiveness of interventions targeting job skills, job satisfaction, and job rotation to enhance performance. Last, contribution to the Field: Overall, the result analysis contributes to the existing body of knowledge in the field of job performance and HF. It adds empirical evidence to support the correlation between certain variables and job performance, providing a foundation for further research and practical applications in various industries and organizational contexts.

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APPENDIX A: RESEARCH PARTICIPANT CONSENT FORM

UNIVERSITY OF SASKATCHEWAN

Participant Consent Form

You are invited to participate in a research study entitled: Design for a Sustainable E-commerce System (Medical supply): Incorporating Human Factors into Distribution and Inventory Control Model

Researcher(s): *Ogbeyemi Afolabi, Graduate Student, Biomedical Engineering, University of Saskatchewan. afo636@usask.ca,*

Principal Investigator/Supervisor: *Prof Chris Zhang, Professor, Mechanical and Biomedical Engineering, University of Saskatchewan. chris.zhang@usask.ca*

Purpose and Objective of the Research: *The primary objective of the proposed research is to focus on considering HFs as a constraint to be incorporated in the distribution and inventory control system model, and to evaluate its impact on the entire E-commerce system of company ABC using system dynamic approach as a tool to optimise the system and to continue solving real-life inventory and logistics problems.*

Procedures:

- *First, the management will print out the survey and provide it to you ; before completing it, please read it.*
- *Participant time to complete the survey is approximately 30 minutes.*
- *Management will provide a secure box or container for you to deposit your responses.*

This will help to prevent the surveys from being seen or tampered with.

Funded by:

- *This research is not funded.*

Potential Risks:

- *There are no known or anticipated risks to participants by participating in this research.*

Potential Benefits:

- *Benefit to participant; Better understanding of supply chain and ecommerce, improve your supply chain experience.*
- *Benefit to Others; The research can contribute the advancement of knowledge which can benefit society, it can improve the policy and practices, leading to improved lead time delivery and customer satisfaction, the research can contribute to the company growth by creating new processes.*

Compensation:

- *There is no compensation involved*

Confidentiality:

- *The researcher will ensure to protect your identity. In addition, your name and any other identifying information will not be needed.*

- *The data will be reported anonymously in a summary form. Note: your identity will not be known to anyone, including the researcher.*

- *The results of this research will be published in thesis form. In addition, these findings may also be published in Enterprise Information Systems (EIS) journals*

- *Your data will be stored in a secure facility hosted in Canada.*

Storage of Data:

All physical data (paper surveys) will be stored in a locked cabinet/ cupboard within the Principal Investigator's (Dr. Chris Zhang's) University of Saskatchewan locked office.

Electronic research data will be stored on the Principal Investigator's (Dr. Chris Zhang) University of Saskatchewan password-encrypted computer in a locked office. Data will then be shared with the student researcher (Ogbeyemi Afolabi) through the University of Saskatchewan OneDrive system. Data will be retained by the Principal Investigator for five years post-publication on OneDrive as per the University of Saskatchewan Guidelines. After this five-year period the data will be destroyed beyond recovery."

Right to Withdraw:

- *Participation in this survey is voluntary.*
- *You may answer any question that you feel comfortable with and may withdraw from answering any questions for any reason without any explanation or penalty.*
- *The decision to participate or not will not affect your employment or how you will be treated.*

Follow up:

- *Upon the completion of the research, a copy of the work will be sent to the company for you to access.*
- *The finding of the research may be available by December 2023*

Questions or Concerns:

- Contact the researcher(s) using the information at the top of page 1.
- This research project has been approved on ethical grounds by the University of Saskatchewan Behavioural Research Ethics Board. Any questions regarding your rights as a participant may be addressed to that committee through the Research Ethics Office: ethics.office@usask.ca; 306-966-2979; participants outside of Canada can call **collect** + 1 306 966 2979

By completing and submitting this questionnaire, **your free and informed consent is implied** and indicates that you understand the above conditions of participation

APPENDIX B: RESEARCH SURVEY QUESTIONNAIRE

ABC WAREHOUSE SUPPLY CHAIN SURVEY

This questionnaire is based on your work experience as a worker in an e-commerce supply chain company (ABC) to identify some human factors among the employee and for the purpose of research being carried out in the Biomedical Engineering Department of the University of Saskatchewan, Saskatoon Canada on the effect of human factors such as workers skills, workers motivation and satisfaction, job rotation, and fatigue in supply chain management.

Kindly please indicate by ticking [✓] in each box that shows the level of agreement with the following questions below.

Gender: Male [ ]
Female [ ]
Other [ ]

Age Group 20-25 [ ]
26-30 [ ]
31-35 [ ]
36-above [ ]

Agreement Scale: Strongly Agree **5** [ ]
Agree **4** [ ]
Neither Agree nor Disagree **3** [ ]
Disagree **2** [ ]
Strongly Disagree **1** [ ]

Job satisfaction	Strongly disagree **1**	Disagree **2**	Neither agree nor disagree **3**	Agree **4**	Strongly agree **5**
I find my day-to-day job very interesting in the warehouse					
I make use of idle time in the warehouse floor					
I am very satisfied with my job now and the operations of the company					
I am well respected and appreciated at work when I deliver					
The purpose of the company makes me feel my job is important					

I have good relationships with my co-workers					

I have the right tools and equipment to carry out every assigned task on the shop floor					
I get opinions about work from my team members					
I am committed to my work to deliver and succeed at my wok					
Job Skills	1	2	3	4	5
I have good knowledge of all the machines and equipment used in the warehouse					
I can only work on a job assigned to one task at a time					
I always carry out an assigned job alone without the help of others					
I sometimes need the help of the fulfilment manager to carry out my assigned job					
I have enough time to complete any assigned job given to me					
Understanding and interpreting a job detail is very important in my job					
I prefer an automated machine to scan pallet products than manual one when doing my job					
I make use of the warehouse management system (OMS) effectively					
I have developed new skills on the job over time					
I sometimes make decision on what to do without the help of management					
I have a special way of performing my job differently from the instruction given					
I learn new ideas method or techniques on my job					
The warehouse management system (OMS) contributes to the successful running of my job					
Most of my daily jobs in the warehouse are repetitive					
I use a forklift to carry out my assigned job					
Job fatigue	1	2	3	4	5
I have enough time to complete every assigned					

task given to me					
I prefer an automated machine to scan pallet products than a manual one when doing my job					
Material and other resources are always readily available for me to carry out my assigned job daily					
My workload is suitable that it gives me time to attend to families and other engagement at the end of my shift					
My job requires me to work faster due to delivery date					
The workload in the warehouse is evenly distributed among workers in each distributions center					
Job rotation					
The nature of my job requires me to work in other departments of the warehouse					
There are enough workers in every department to carry out daily demand and supply task					
I am limited to work in other department due to job skills required					
I perform better when asked to work in another department in the warehouse					
I develop trust within and between departments					
ONLY FOR MANAGER AND SUPERVISORS					
Job performance	1	2	3	4	5
The warehouse workers does always quality jobs					
The warehouse workers always meet the number of assigned jobs given to them at the stipulated time					
The workers are very dependable in the warehouse					
The warehouse workers all have good knowledge of the machine and equipment used in the warehouse					
The warehouse workers all have a good sense of judgment in my absence					
The warehouse workers have the ability to learn new techniques and skills on the job					

The warehouse workers are reliable when it comes to taking initiative on the job					
The warehouse workers all have soft and hard skills					
Majority of the warehouse workers can use electronic pallet jacks					
Majority of the warehouse workers can use barcode scanners and OMS					

APPENDIX C: RECRUITMENT LETTER FOR PARTICIPATION

University of Saskatchewan
College of Engineering,
Biomedical Engineering,
57 Campus Drive,
Saskatoon, SK
S7N 5A9

ABC
West Africa
Nigeria.

Dear management,

My name is Afolabi Ogbeyemi, I am a graduate research student in the college of engineering at the University of Saskatchewan. As part of a research been conducted in the college on the Design for a Sustainable E-commerce System: Incorporating Human Factors into Distribution and Inventory Control Model, I am sending this message across to the management of ABC if would like to participate and provide some data for the purpose of this research. Kindly note that participation is completely voluntary, and your response will be treated confidentially and anonymous.

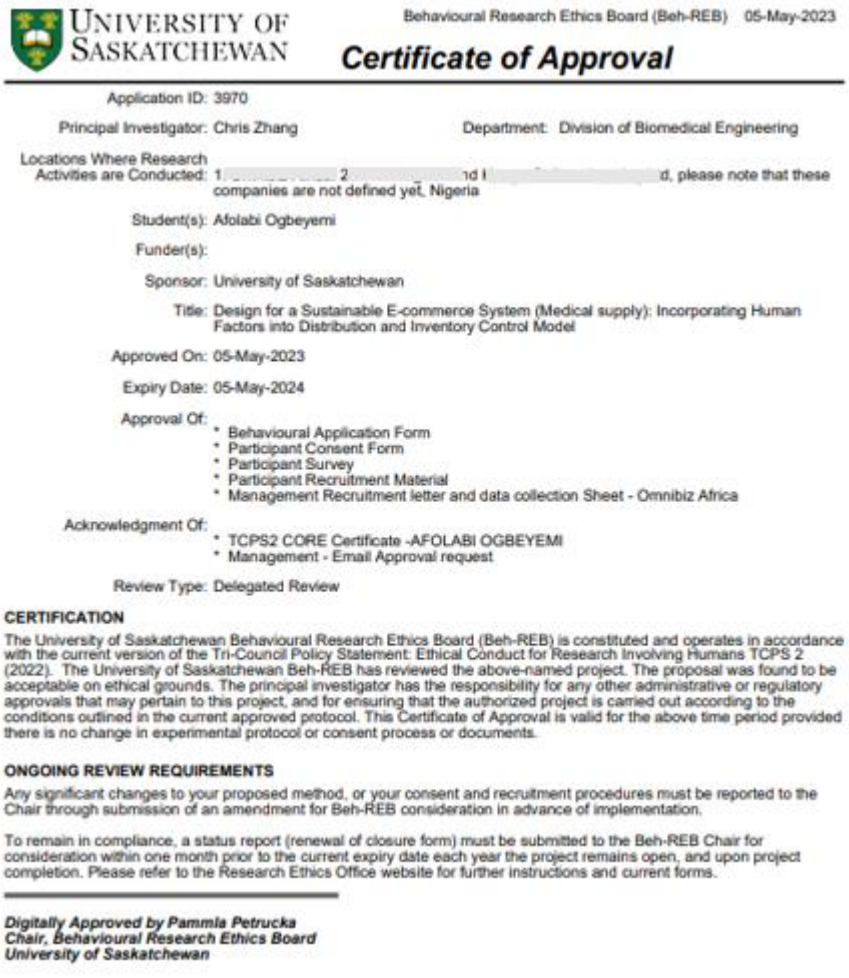
If the management of ABC are interested, kindly please inform the operations manager (Mr. Ayo) and he will get back to me.

If you also have any questions regarding this, please do not hesitate to reach me through my email or phone number. afo636@usask.ca or +1 (639) 480-9539

Thank you.

Afolabi Ogbeyemi
Graduate Student
University of Saskatchewan.

APPENDIX D: CERTIFICATE OF APPROVAL FROM BEHAVIOURAL RESEARCH ETHICS



UNIVERSITY OF SASKATCHEWAN

Behavioural Research Ethics Board (Beh-REB) 05-May-2023

Certificate of Approval

Application ID: 3970

Principal Investigator: Chris Zhang Department: Division of Biomedical Engineering

Locations Where Research Activities are Conducted: 1. 2 nd l d, please note that these companies are not defined yet, Nigeria

Student(s): Afolabi Ogbeyemi

Funder(s):

Sponsor: University of Saskatchewan

Title: Design for a Sustainable E-commerce System (Medical supply): Incorporating Human Factors into Distribution and Inventory Control Model

Approved On: 05-May-2023

Expiry Date: 05-May-2024

Approval Of:
* Behavioural Application Form
* Participant Consent Form
* Participant Survey
* Participant Recruitment Material
* Management Recruitment letter and data collection Sheet - Omnibiz Africa

Acknowledgment Of:
* TCPS2 CORE Certificate -AFOLABI OGBEYEMI
* Management - Email Approval request

Review Type: Delegated Review

CERTIFICATION

The University of Saskatchewan Behavioural Research Ethics Board (Beh-REB) is constituted and operates in accordance with the current version of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans TCPS 2 (2022). The University of Saskatchewan Beh-REB has reviewed the above-named project. The proposal was found to be acceptable on ethical grounds. The principal investigator has the responsibility for any other administrative or regulatory approvals that may pertain to this project, and for ensuring that the authorized project is carried out according to the conditions outlined in the current approved protocol. This Certificate of Approval is valid for the above time period provided there is no change in experimental protocol or consent process or documents.

ONGOING REVIEW REQUIREMENTS

Any significant changes to your proposed method, or your consent and recruitment procedures must be reported to the Chair through submission of an amendment for Beh-REB consideration in advance of implementation.

To remain in compliance, a status report (renewal of closure form) must be submitted to the Beh-REB Chair for consideration within one month prior to the current expiry date each year the project remains open, and upon project completion. Please refer to the Research Ethics Office website for further instructions and current forms.

Digitally Approved by Pammla Petrucka
Chair, Behavioural Research Ethics Board
University of Saskatchewan

APPENDIX E: CERTIFICATE OF COMPLETION FROM TRI-COUNCIL POLICY STATEMENT RESEARCH ETHIC

PANEL ON RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE 2022

Certificate of Completion

This document certifies that

AFOLABI OGBEYEMI

successfully completed the Course on Research Ethics based on the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2: CORE 2022)

Certificate # 0000885087 **15 December, 2022**

APPENDIX F: FURTHER VALIDATION OF THE COMBINED DATA ANALYSIS FOR ABC AND XYZ

Table 1 Reliability Statistics for Job Satisfaction

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.717	.721	7

Item Statistics

	Mean	Std. Deviation	N
JS2	3.35	1.292	40
JS3	3.05	.932	40
JS4	3.33	1.047	40
JS5	4.40	.810	40
JS6	4.22	1.187	40
JS8	3.80	1.067	40
JS9	4.38	1.005	40

Table 2 Reliability Statistics for Job Skill

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.731	.736	13

Item Statistics

	Mean	Std. Deviation	N
JSK1	3.95	1.218	40
JSK2	2.95	1.260	40
JSK3	3.10	1.194	40
JSK4	3.25	1.276	40
JSK5	3.36	1.005	40
JSK6	4.38	.979	40
JSK7	3.43	1.299	40

JSK8	3.70	1.363	40
JSK9	4.20	.883	40
JSK10	3.53	1.219	40
JSK11	3.45	1.260	40
JSK12	3.85	1.027	40
JSK13	3.90	1.172	40

Table 3 Reliability Statistics for Job Fatigue

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.721	.7516	3

Item Statistics

	Mean	Std. Deviation	N
JF3	3.05	.876	40
JF4	2.75	1.428	40
JF6	3.43	.958	40

Table 4 Reliability Statistics for Job Rotation

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.7412	.7112	2

Item Statistics

	Mean	Std. Deviation	N
JR4	3.20	.992	40
JR5	3.40	1.215	40

Table 5 Reliability Statistics for Job Performance

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.7123	.703	8

Item Statistics

	Mean	Std. Deviation	N
JP1	3.95	1.061	40
JP2	3.38	1.275	40
JP3	3.93	.730	40
JP4	3.28	0.877	40
JP5	3.55	1.037	40
JP6	3.90	1.172	40
JP8	3.33	0.944	40
JP10	2.60	1.336	40

Table 6 Reliability Statistics for overall variables

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.818	.820	33

Table 7. Test for Normality

Tests of Normality

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
JOB_SATISFACTION	.167	40	.007	.908	40	.003
JOB_SKILLS	.156	40	.015	.923	40	.009
JOB_FATIGUE	.221	40	< .001	.842	40	< .001
JOB_ROTATION	.148	40	.028	.938	40	.030
JOB_PERFORMANCE	.192	40	< .001	.923	40	.010

a. Lilliefors Significance Correction

Table 8. Test for Normality for Log transformed variables.

Tests of Normality

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
LOGJOB_SATISFACTION	0.196	40	< 0.001	0.852	40	< 0.001
LOGJOB_SKILLS	0.198	40	< 0.001	0.851	40	< 0.001
LOGJOB_FATIGUE	0.235	40	< 0.001	0.846	40	< 0.001
LOGJOB_ROTATION	0.21	40	< 0.001	0.898	40	0.002
LOGJOB_PERFORMANCE	0.158	40	0.013	0.946	40	0.054

a. Lilliefors Significance Correction

Table 9. Ordinal Regression

Model Fitting Information

Model	-2 log Likelihood	Chi-Square	df	Sig
Intercept Only	191.007			
Final	182.302	8.705	4	0.069

Link function: Logit

Goodness-of-Fit

Model	Chi-Square	df	Sig
Pearson	464.121	486	0.755
Deviance	177.907	486	1

Link function: Logit

Pseudo R-Square

Cox and Snell	.196
Nagelkerke	.197
McFadden	.044

Link function: Logit

Test of Parallel Lines

Model	-2 Log Likelihood	Chi-Square	df	Sig
Null Hypothesis	182.302			
General	0.00[b]	182.302	52	< 0.001

The null hypothesis state that the location parameter is the same across response categories

a. Link function: Logit

b. The log-likelihood value is practically zero.

Table 10. Linear Regression

Descriptive Statistics

	Mean	Std. Deviation	N
JOB_PERFOMANCE	3.4875	0.60434	40
JOB_SATISFACTION	3.7893	0.64457	40
JOB_SKILLS	3.6385	0.57093	40
JOB_FATIGUE	3.0750	0.80768	40
JOB_ROTATION	3.3000	0.92542	40

Correlations

		JOB_PERFOMANCE	JOB_SATISFACTION	JOB_SKILLS	JOB_FATIGUE	JOB_ROTATION
Pearson Correlation	JOB_PERFOMANCE	1.000	0.35	0.267	-0.005	0.293
	JOB_SATISFACTION	0.35	1.000	0.638	-0.152	0.103
	JOB_SKILLS	0.267	0.638	1.000	0.036	0.184
	JOB_FATIGUE	-0.005	-0.152	0.036	1.000	0.415
	JOB_ROTATION	0.293	0.103	0.184	0.415	1.000
Sig. (1-tailed)	JOB_PERFOMANCE		0.013	0.048	0.0439	0.033
	JOB_SATISFACTION	0.013		0.000	0.175	0.264
	JOB_SKILLS	0.048	0.000		0.413	0.127
	JOB_FATIGUE	0.489	0.175	0.413		0.004
	JOB_ROTATION	0.033	0.264	0.127	0.004	

Model Summary

Model	R	R Square	Adjusted R Square	Std Error of the Estimate	Change Statistics				
					R square change	F change	df1	df2	Sig.F change
1	.442[a]	.195	.104	.57219	.195	2.126	4	35	.98

a. Predictors: (Constant) JOB_ROTATION, JOB_SATISFACTION, JOB_SKILLS, JOB_FATIGUE

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig
1	Regression	2.785	4	0.696	2.126	0.098[b]
	Residual	11.459	35	0.327		
	Total	14.244	39			

a. Dependent variable: JOB_PERFORMANCE
b. Predictors: (Constant) JOB_ROTATION, JOB_SATISFACTION, JOB_SKILLS, JOB_FATIGUE

Coefficients

Model		Unstandardized		Standardized coefficient			Collinearity Statistics	
		B	Coefficient Std. Error	Beta	t	Sig	Tolerance	VIF
1	(Constant)	1.905	0.743		2.567	0.015		
	JOB_SATISFACTION	0.269	0.19	0.287	1.413	0.166	0.558	1.792
	JOB_SKILLS	0.035	0.213	0.033	0.162	0.872	0.57	1.755
	JOB_FATIGUE	-0.063	0.129	-0.084	0.487	0.629	0.778	1.285
	JOB_ROTATION	0.191	0.111	0.293	1.720	0.094	0.793	1.261

a. Dependent variable JOB_PERFORMANCE