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An Ergonomic Approach for Inventory Planning, Cost Forecasting of Materials Handling Task

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Abstract

This study was conducted to identify the impact of handling materials at work. The main purpose of the study is to improve techniques and safety factors when handling materials. The factors were considered as Independent variable that were Equipment's and attributes, design methods, safety, cost forecasting and inventory planning. While the subject of the study Material Handling Techniques was taken as the dependent variable.

The research design was Exploratory Research. Companies use exploratory research methods to uncover facts and opinions regarding a particular subject. The population of the study consisted of 90 firms considered as the respondents, out of which 30 responses were taken up for the pilot study, which was helpful in determining the reliability of the questionnaire the study. The respondents were the firms that indulged in the process of MH. The tests conducted were reliability analysis, factor analysis, chi-square test, t-test, one-way ANOVA, correlation, and regression. Correlation analysis was used to determine if there was a relationship between the variables that were taken for the study. The relationship between MH and the independent variable was then analyzed using multiple regression analysis. The challenges faced in implementing the product handling technique vary between companies. Benefits of Process The study suggests that improving productivity, reducing time lags, and streamlining safety practices are key variables in handling goods, and that appropriate investment in appropriate technology and comprehensive relocation strategies for new products is needed.

Keywords: Material Handling; Equipment; and attributes; safety; design methods; inventory planning; cost forecast; Material Handling techniques.

1. Introduction

Material handling is an activity that involves the movement of material or products within an organization from one place to another place or the flow of material. The activities are usually confined within the boundaries of an organization. The movement of material from one organization to another

is categorized as transportation work, which is not part of material handling activities. It is not only about the movement of material. It also involves storage, protection, and control of material while it moves in different departments like a warehouse, production, and manufacturing departments. It is one of the essential tasks for organizations. A poorly handled material become waste before it can be used for production purpose or before it is sent to retail stores.

In the old times, it was mostly done manually because of the lack of technology. On account of that, the number of accidents during handling work was quite high. In present times, with the introduction of technology, almost all of the work is done using automation or semi-automation. The introduction of technology not only reduced the cases of accidents occurred but also made the work fast.

1.1 MEANING OF MATERIAL HANDLING

Material Handling is the field concerned with solving the pragmatic problems involving the movement, storage in a manufacturing plant or warehouse, control and protection of materials, goods and products throughout the processes of cleaning, preparation, manufacturing, distribution, consumption and disposal of all related materials, goods and their packaging. The focus of studies of Material Handling course work is on the methods, mechanical equipment, systems and related controls used to achieve these functions. The material handling industry manufactures and distributes the equipment and services required to implement material handling systems, from obtaining, locally processing and shipping raw materials to utilization of industrial feed stocks in industrial manufacturing processes. It has been estimated that the average material handling cost is roughly 30 to 60% of the cost of production. However, this cost can be reduced by proper selection, operation, maintenance and layout of material handling devices but cannot be totally eliminated.

The material handling problem must be analyzed thoroughly at the time planning of various machines and tools needed before erection of factory building. While designing new plants, materials handling is a prime consideration and several existing plants can be modified by the utilization of modern material handling devices. The cost of production is decreased by the use of these devices since these devices increase output, improve the quality and speed up the deliveries.

1.2 PRINCIPLES OF MATERIAL HANDLING

The material handling methods are designed based on principles. The principles are following

1. Cost Principle

To encourage minimum expenditure while handling the materials.

2. Computerization Principle

To encourage maximum use of computers and automation.

3. Energy Principle

This principle is concerns about the consumption of energy.

4. Ergonomic Principle

To identify the human limitations and capabilities to do the work.

5. Ecology Principle

To ensure the least impact on the ecological system because of material handling work.

6. Flexibility Principle

To encourage the use of tools and methods which can be used in different types of work conditions.

7. Gravity Principle

To promote the consideration of gravity principle in materials handling.

8. Layout Principle

The layout principle is concerned with the sequential order of material handling operations.

9. Maintenance Principle

The maintenance principle is for regular maintenance and repair of machinery and device in materials handling.

10. Mechanization Principle

Mechanization principle is concerned with the deployment of mechanization methods to speed up the work and reduce the efforts of humans.

1.3 GLOBAL PERSPECTIVE

Manufacturing and distribution companies must concentrate on keeping costs under control, since they operate in an industry with very slim margins. As a result, they often spend a great deal of time on continuous improvement programs focused on operational productivity advancements. However, one aspect that can have a profound effect on overall productivity and profitability is frequently missed in material handling. Material handling affects every aspect of the operation, from forecasting to production and even after-sales service and support. Yet many people have little knowledge of how complex material handling can be and how it can influence operating margins.

Automation will help eliminate accidents and occupational safety issues associated with manual labor contributing towards better worker safety, health, wellness, and reduced company expenditure on employee insurance and compensation. The importance of the financial savings that can accrue from ensuring conformance to safety regulations cannot be undermined especially against the backdrop where legislations are becoming stringent and exceedingly punitive.

The global market for Material Handling Equipment is projected to reach US\$190.3 billion by 2025, driven by the strong emphasis on production and operational efficiency and worker safety. The concept of 'last mile' is widely popularized in supply chain management and transportation planning for its ability to increase customer satisfaction and profitability. Automation, optimization, and delivery route planning are therefore vital strategies adopted by companies to improve their last mile performance. Of equal importance are the 'first mile' operations involving indoor material handling on the plant floor. Raw material being the primary and most importance element in manufacturing needs to move through multiple stages of production and final packaging in a smooth and seamless manner to prevent logistical bottlenecks in production. Timely handling of materials is important to ensure that right materials in the right quantities are delivered to the right locations at the right time.

1.4 OBJECTIVES OF THE STUDY

Primary Objective

To study the impact of “MATERIAL HANDLING TECHNIQUES” in supply chain Management.

2. REVIEW OF LITERATURE

2.1 SAHAND HAJIFAR, HONGYUE SUN, FADEL M. MEGAHED, L. ALLISON JONES-FARMER, EHSAN RASHEDI, LORA A. CAVUOTO (2021)

The authors states that advancements in sensing, computation, and network technologies have increased the amount of data being collected in the workplace. This may seem like common sense but the more resources that is placed into material handling the more profitable it will become , also the focus on resource commitments to handling operations have an influence of the company. Not only addresses revenue but costs savings as well are maintained.

Through the application of the forecasting framework presented, RPEs can be used for accurate forecasting of future RPEs, whether the forecasting accuracy, and how far in advance a reliable forecast can be generated in MHE. This articles provides an argument as to how important it is to implement forecasting tool to a material handling operation. For a company that has to deal with different cultures, and has in the past in order to get other actions done, would see that material handling is a worthwhile endeavor, regardless of the potential barriers.

Source - (A forecasting framework for predicting perceived fatigue: Using time series methods to forecast ratings of perceived exertion with features from wearable sensors)

Link - <https://sci-hub.se/https://doi.org/10.1016/j.apergo.2020.103262>

2.2 STEVEN J. WURZELBACHER, MICHAEL P. LAMPL, STEPHEN J. BERTKE, CHIH-YU TSENG (2020)

This study states that work-related musculoskeletal injuries and illnesses in material handling at ergonomic interventions. It was evaluated 33 employers and 535 employees at baseline from 2012 to 2017. This survey was depending on two dependent variables that is Intervention and Individual and three Dependent variables that is Low back pain, Upper extremity pain and Safety incidents. Employee-reported safety incidents were assessed using a survey that was administered to each employee up to nine times (collected at baseline and every three months for up to two years). This survey was designed by NIOSH specifically for this study and conclude with any Safety Events Frequency >0 which was measured whether there was any employee reported safety related incidents at work within the last 3 months. Material Handling Task-related Safety Events Frequency >0 which was measured whether there was any employee reported safety related incidents at work associated with specific material handling tasks within the last 3 months. This study evaluated the effectiveness of a variety of ergonomic interventions in material handling operations in a number of employers and industries including construction, manufacturing, and services. Interventions included largely material handling equipment such as powered hand trucks and lift tables.

Source - The effectiveness of ergonomic interventions in material handling operations Received 28 August 2019; Received in revised form 31 January 2020; Accepted 22 April 2020

Link - <https://www.sciencedirect.com/science/article/abs/pii/S000368702030096X>

2.3 BAMBANG SUHARDI, ELDIANA JUWITA AND RAHMANYAH DWI ASTUTI (2019)

This paper elaborated the design of facility layout is an influential factor in a company's performance to support the streamlined production process. This study used Systematic Layout Planning (SLP) method this method is a planning procedure that allows to identify, visualize, and assess various activities, relationships, and alternatives involved in facility layout. In addition, SLP is also used to increase productivity by comparing the layout of facility that have been designed with the current facility layout. The literature shows that research in the field of MH is growing and is a detailed review of planning and implementation, product revenue forecasting, security, various design methods and inventory. This study outlines the gaps in these issues, and outlines future directions for research based on research gap analysis. For a company that has to deal with different cultures, and has in the past in order to get other actions done, would see that MH is a worthwhile endeavor, regardless of the potential barriers.

Source- (Facility layout improvement in sewing department with Systematic Layout planning and ergonomics approach)

link- <https://www.tandfonline.com/doi/full/10.1080/23311916.2019.1597412>

2.4 AYDIN AZIZI, POORYA GHAFOORPOOR YAZDI, ALI AL HUMAIRI, MOHAMMAD ALSALMI, BASMA AL RASHDI, ZUWAINA AL ZAKWANI, SULTAN ALSHEIKAILI (2018)

The authors state that intelligent material handling is depends to the modern manufacturing with industry 4.0 approaches. The core of this paper was to design and fabricate a smart material handling system that has evolved during the latest manufacturing decades using 4.0 approaches. This approaches had optimized by the following principles

- Planning principle
- Standardization principle
- Work principle
- Unit load principle
- Space utilization
- Environmental principles

Material handling techniques considered as the recovery of Import/Export Oriented Units products as a business opportunity, where these activities are taken into account in their strategic processes of decision making. Nowadays material handling system became the key component in many industries. However, the system can be designed in many ways depending on certain requirements. Therefore, this study was including the proposed and the design of the system with its suitable dimensions. In this study was established the development of Fabrication of material handling system specialized in conveyers. The main core of this paper is to have an automated smart system. However, to integrate the system with the control units, a design and a model was needed.

Source – (Design and fabrication of intelligent material handling system in modern manufacturing with industry 4.0 approaches Received: May 15, 2018 | Published: May 31 2018)

Link - [\(PDF\) Design and fabrication of intelligent material handling system in modern manufacturing with industry 4.0 approaches \(researchgate.net\)](#)

2.5 Z. JAMALUDIN , C.Y. HUONG , L. ABDULLAH, M.H. NORDIN, M.F. ABDULLAH , R. HARON, AND K.B.A. JALAL (2018)

With this approach the authors came with an overview that major issue facing the manufacturing industries. To remain competitive, manufacturers need to ensure that all manufacturing activities carried out at all levels of the organization are efficient, innovative, prudent, and most importantly, sustainable. Implementation of green related technologies in work process supports sustainability with positive impacts on the society and the environment.

So that, author introduced the Automated Tracking System Using RFID of Material Handling in an Automobile Parts Manufacturer. Radio Frequency Identification Device (RFID) belongs to a class of electronic device that promotes sustainability to the environment, economy and social wellbeing of the people. This paper presents outcomes of a work performed in collaboration with an automotive parts manufacturer on design and implementation of UHF RFID based trolleys tracking system focusing on gains in efficiency related to speed of handling the receiving and dispatching of metal assets items between the parts manufacturer and its vendors. RFID technology consists of an interrogator, a transponder, and a host computer. This review is a study for MHT which explains how to effectively handle objects with RFID technology. Extending the case study for MHT for most products is a challenge. Moreover, the generality of the model for MHT is not satisfactory because there are different situations in each industry.

Source- Automated Tracking System Using RFID for Sustainable Management of Material Handling in an Automobile Parts Manufacturer

Link- <https://jtec.utem.edu.my/jtec/article/view/3595/2488>

3. RESEARCH METHODOLOGY

3.1 SAMPLING TECHNIQUE

In This Study Convenience Sampling Technique Has Been Adopted.

Convenience Sampling - It is a type of non-probability sampling that involves the sample being drawn from that part of the population that is close to hand. This type of sampling is most useful for pilot testing.

3.2 SAMPLE SIZE

Size of the sample refers to the number of items to be chosen from the universe to form a sample. The size of sample must be optimum. An optimum sample may be defined as the one that satisfies the requirements of representativeness, flexibility, efficiency, and reliability. A sample size of 90 respondents were taken for the study.

3.3 TARGET RESPONDENTS

The target respondents are the organizations that are involved in supply chain management

4. DATA ANALYSIS

4.1 ONE WAY ANOVA

4.1.1 MATERIAL HANDLING VS EQUIPMENTS AND ATTRIBUTES

TABLE: 1 MH VS EA

FACTOR		F	Sig.
MEAT	Between groups (Combined)	3.568	<0.01
	Linear Term Weighted	0.453	0.50
	Deviation	3.851	<0.00

Source- Primary Data

HYPOTHESIS

Null Hypothesis - There is no significance difference between the equipment's and attributes and material handling techniques

Alternative Hypothesis - There is a significance difference the equipment's and attributes and material handling techniques

INFERENCE

From the above table, it is inferred that the P value of the variable equipment and attribute is less than 0.05. Hence, Null hypothesis is rejected and alternative hypothesis is accepted.

4.1.2 MATERIAL HANDLING VS DESIGN

TABLE: 2 MH VS DS

FACTOR		F	Sig.
MDST	Between groups (Combined)	1.054	0.411
	Linear Term Weighted	0.069	0.793
	Deviation	1.143	0.341

Source- Primary Data

Hypothesis

Null Hypothesis - There is a significance difference between the design methods in relation to material handling techniques.

Alternative Hypothesis - There is no significance difference between the design methods in relation to material handling techniques.

INFERENCE

From the above table, it is inferred that the P value of the variable design methods is greater than 0.05. Hence, Null hypothesis is accepted and alternative hypothesis is rejected.

4.1.3 MATERIAL HANDLING VS SAFETY

TABLE: 3 MH VS SF

FACTOR		F	Sig.
SFT	Between groups (Combined)	2.860	<0.03

	Linear Term	Weighted	6.834
		Deviation	2.499
			0.01

Source- Primary Data

HYPOTHESIS

Null Hypothesis - There is no significance difference between the safety to implementation of material handling techniques.

Alternative Hypothesis - There is a significance difference between the safety to implementation of material handling techniques.

INFERENCE

From the above table, it is inferred that the P value of the variable safety is less than 0.05. Hence, Null hypothesis is rejected and alternative hypothesis is accepted.

4.1.4 MATERIAL HANDLING VS INVENTORY PLANNING

TABLE: 4 MH VS INP

FACTOR		F	Sig.
MINPT	Between groups (Combined)	4.34 2	<0.001
	Linear Term	Weighted	5.00 4
		Deviation	4.28 2
			<0.001

Source- Primary Data

HYPOTHESIS

Null Hypothesis - There is no significance difference between the Inventory Planning in relation to Material Handling Techniques.

Alternative Hypothesis - There is a significance difference between the Inventory Planning in relation to Material Handling Techniques.

INFERENCE

From the above table, it is inferred that the P value of the variable inventory planning is less than 0.05. Hence, Null hypothesis is rejected and alternative hypothesis is accepted.

4.1.5 MATERIAL HANDLING VS COST FORECASTING

TABLE: 5 MH VS FC

FACTOR		F	Sig.
MICFT	Between groups (Combined)	5.106	<0.001
	Linear Term	Weighted	26.322
		Deviation	3.177
			0.001

Source- Primary Data

HYPOTHESIS

Null Hypothesis - There is no significance difference between the Cost Forecasting to the implementation of material handling techniques

Alternative Hypothesis - There is a significance difference between the Cost Forecasting to the

implementation of Material Handling Techniques

INFERENCE

From the above table, it is inferred that the P value of the variable cost forecasting is less than 0.05. Hence, Null hypothesis is rejected and alternative hypothesis is accepted.

4.2 MULTIPLE PERCEPTION

MULTILAYER PERCEPTRON MODEL SUMMARY

TABLE: 6 MULTILAYER PERCEPTION

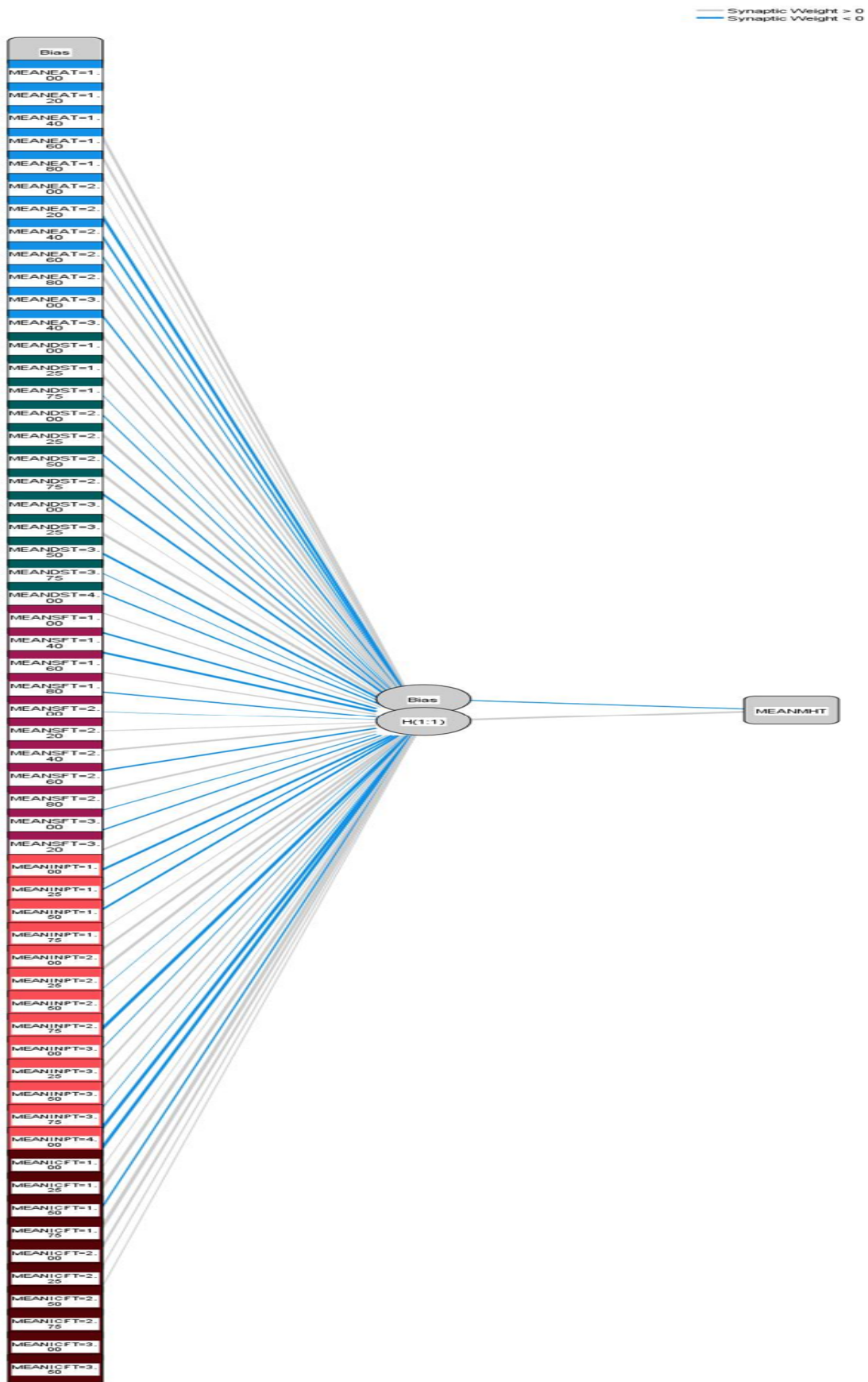
Training	Sum of Squares Error	9.448
	Relative Error	0.305
	Stopping Rule Used	1 consecutive step(s) with no decrease in error ^a
	Training Time	0:00:00.01
Testing	Sum of Squares Error	4.982
	Relative Error	0.424

Source- Primary Data

Dependent Variable: MH

INFERENCE

The error is the sum of squares error when the identity, sigmoid or hyperbolic tangent activation function is applied to the output layer. It is the cross-entropy error when the soft Max activation function is applied to output layers. Relative errors or percentages of incorrect predictions are displayed depending on the dependent variable measurement's levels. If any dependent variable has scale measurement level, then the average overall relative error is displayed. If all dependent variables are categorical then the average percentage of incorrect predictions is displayed. Relative errors or percentage of incorrect predictions is displayed. Relative errors or percentages of incorrect predictions are also displayed for individual dependent variables



Hidden layer activation function: Hyperbolic tangent
Output layer activation function: Identity

INFERENCE

The diagram was formed due to the reliability and the correctness of the variables.

4.4 CORRELATION HYPOTHESIS

Null Hypothesis: There is no relationship among the variables of the study

Alternative Hypothesis: There is relationship among the variables of the study

TABLE: 7 CORRELATION

FACTORS		EA	DS	SF	MH	INP	CF
EA	PEARSON CORRELATION	1					
DS	PEARSON CORRELATION	0.269	1				
SF	PEARSON CORRELATION	0.080	-0.115	1			
MH	PEARSON CORRELATION	0.061	-0.028	0.248	1		
INP	PEARSON CORRELATION	0.320	0.443	0.069	0.197	1	
CF	PEARSON CORRELATION	0.164	0.168	0.307	0.436	0.334	1

Source- Primary Data

INFERENCE

The inter correlation for all the constructs of Material Handling Techniques, design had negative correlation with equipment’s and attributes, design methods, cost forecasting and inventory planning which is statistically significant at 0.00 has a positive correlation.

4.5 MULTIPLE REGRESSION

Null Hypothesis - There is no significance difference among the dimension of independent variables as predictors of in explaining the study.

Alternative Hypothesis - There is a significance difference among the dimension of independent variables as predictors in explaining the study.

TABLE: 8 MUTIPLE REGRESSION

Model	R	R Square	Adjusted R Square	Std. Error of estimate	Change statistics					Durbin-Watson
					R Square change	F Change	Df1	Df2	Sig.F Change	
1	0.436 ^a	0.190	0.181	0.43298	0.190	20.691	1	88	<0.001	1.819

Source: Primary Data

Durbin- Watson

DW= 1.819

- The Durbin-Watson statistic will always have a value ranging 0-
- If DW=2 indicates there is no autocorrelation
- If DW=less than 2 there is positive correlation
- If DW=greater than 2 there is negative correlation
- Here DW=1.819 Durbin-Watson statistic is positive correlation

INFERENCE

The above regression table summarizes the model. Where, R represents the multiple correlation coefficient with a range lies between -1 and +1. Since the R value is 0.436, it means material handling techniques has a positive relationship with equipment and attributes, design Methods, Safety, cost forecasting and inventory planning. R square represents the coefficient of determination and ranges between 0 and 1. Since the R square value is 0.190 that is 70 per cent of the variation in material handling techniques percentage is enhanced by equipment and attributes, design Methods, Safety, cost forecasting and inventory planning.

ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	3.879	1	3.879	20.691	0.001 ^b
	Residual	16.498	88	0.187		
	Total	20.377	89			

TABLE: 9 ANOVA

Source-Primary Data

INFERENCE

From the above ANOVA table F value is significant (sig value is less than 0.05) it means Dependent variable material handling techniques percentage is not reliable.

TABLE: 10 COEFFICIENT TABLE

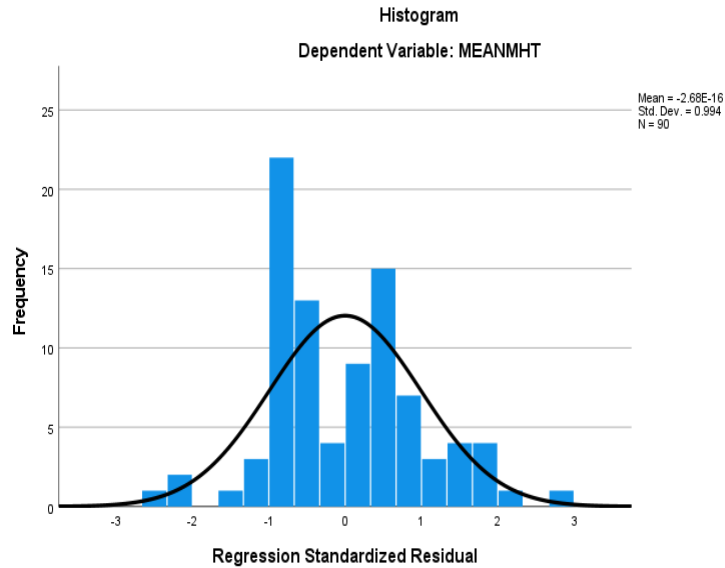
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std.Error	Beta		
(Constant)	1.434	0.159	0.436	8.994	<0.001
MICFT	0.357	0.078		4.549	<0.001

Source: Primary Data

INFERENCE

The above regression model coefficient table shows the coefficients for cost forecasting that helps in analyzing the impact of material handling in Supply Chain Management. A low significance value of less than 0.05 is shown for cost forecasting.

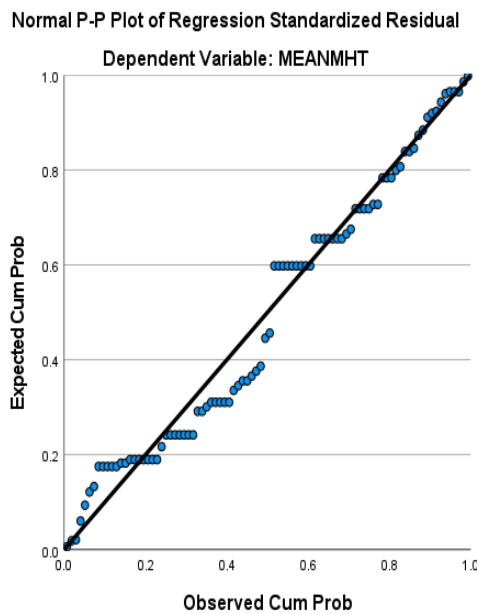
HISTOGRAM



INFERENCE

The chart represents that the mean value is 2.68, standard deviation value is 0.994 and the N value is 90.

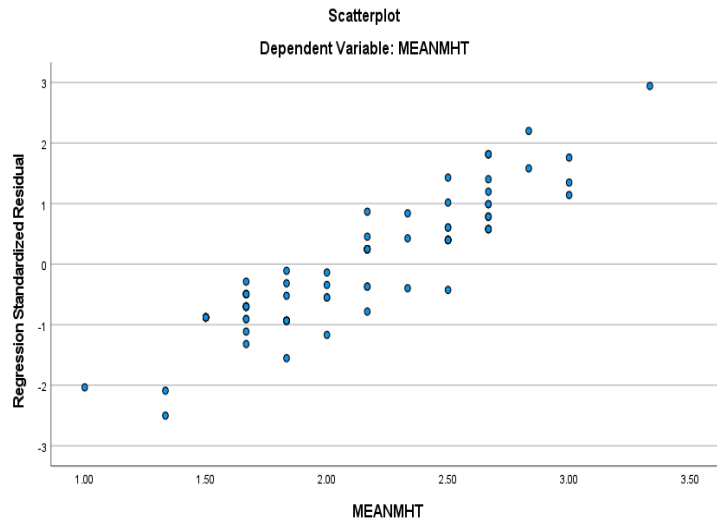
P – PLOT



INFERENCE

The chart represents that the Y axis is the expected cum prob and X axis represents the observed cum prob. The dependent variable is Material handling.

SCATTER PLOT



INFERENCE

The above chart shows a scatter-plot for the Material Handling. The X axis displays the regression standardized predicted value, and the X axis displays Mean of Material Handling.

5. FINDINGS AND SUGGESTIONS

SUMMARY OF FINDINGS OBJECTIVES	HYPOTHESES	ANALYSIS	FINDINGS
<p>To evaluate the challenges faced by Firms in implementing material handling using appropriate equipment</p>	<p>Null Hypothesis - There is no significance difference between the equipment’s and attributes and material handling techniques Alternative Hypothesis - There is a significance difference the equipment’s and attributes and material handling techniques</p>	<p>ONE WAY ANOVA</p>	<p>There is a significance difference between Equipment’s and attributes and Material Handling Techniques.</p>

<p>To examine how to avoid both overstocking and under-stocking of inventory</p>	<p>Null Hypothesis - There is a significance difference between the design methods in relation to material handling techniques. Alternative Hypothesis - There is no significance difference between the design methods in relation to material handling techniques.</p>	<p>ONE WAY ANOVA</p>	<p>There is a significance difference between Material Handling Techniques and Inventory Planning.</p>
<p>To explore the cost and efficiency benefits of Material Handling to the supply chain.</p>	<p>Null Hypothesis - There is no significance difference between the cost forecasting to the implementation of material handling techniques. Alternative Hypothesis - There is a significance difference between the cost forecasting to the implementation of material handling techniques</p>	<p>ONE WAY ANOVA</p>	<p>There is a significance difference between Material Handling Techniques and Cost Forecasting.</p>

<p>To Facilitate the reduction in material damage as to improve quality.</p>	<p>Null Hypothesis - There is no significance difference among the dimension of independent variables as predictors of challenges faced in material handling techniques Alternative Hypothesis - There is a significance difference among the dimension of independent variables as predictors of challenges faced in material handling techniques.</p>	<p>MULTIPLE REGRESSION</p>	<p>There is a significant difference between the dimensions of the independent variables challenges faced in implementing material handling techniques.</p>
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5.1 SUGGESTIONS

Suggestions for Academics

The study's variables have a positive correlation, which means there is a positive relationship between the dependent and independent variables.

There can be more focus on exploring more variables that might affect the study directly or indirectly

Suggestion for the Firms

Appropriate equipment should be used when handling the material safely to reduce loading and unloading time. The firm should consider purchasing the right equipment for their use.

The company can provide safety awareness and safety equipment so that the employees can continue their work happily. With the support of vendors, the company can improve the design of its products or hold a conference to learn the latest handling skills, resulting in the development of a high-quality product and pushing the company.

5.1 CONCLUSION

Material handling practises differ from one company to the next. Better material handling techniques and processes are required in industries with a high return on operational costs. The primary motivation for altering MH's techniques is to save time. Implementing MH's strategy will significantly improve the company's operations. Every stage of the supply chain will be improved as a result of this. Material handling is directly related to safety. Therefore the appropriate equipment must be used in a safe manner for the appropriate action. Material handling system and processes are put in place to improve customer service, reduce inventory, shorten delivery time, and lower overall handling costs in manufacturing, distribution and transportation. There will be fewer misplaced items in a well-organized warehouse using the most effective materials handling tools. Employees will spend less time looking for items. Warehouses are often necessary for the day-to-day operations of huge corporations. Thousands of products, large and small, are stored in each warehouse, which necessitates frequent product transportation from one location to another.

The purpose of this research was to determine the influence of MH when handling the substance. The study's major goal is to determine the influence of MH practices on the material handling process as well as the problems that organizations face while implementing MH. Equipment and Attributes, Design Methods, Safety, Cost Forecasting, and Inventory Planning were deemed Independent Variables, while the study's subject, Material Handling Techniques, and was considered the Dependent Variable.

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