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A STUDY ON QUANTIFYING THE FINANCIAL REPERCUSSIONS OF MATERIAL MANAGEMENT IN AUTOMOTIVE INDUSTRY WITH REFERENCE TO BMW PLANT CHENNAI

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ABSTRACT

This study examines raw material obsolescence in the automotive industry, specifically at BMW Plant Chennai. It investigates how outdated materials disrupt production and affect profitability. The goal is to provide actionable insights for mitigating financial repercussions through strategies like supplier diversification and optimized stock management. Raw material obsolescence poses a serious threat to financial stability, especially with technological advancements driving changes in the industry. The study aims to navigate these challenges and develop proactive strategies for long-term financial well-being.

INTRODUCTION

The terrain in which raw minerals are found is always changing. What is easily accessible one day may not be the next, pushing companies to find other solutions quickly. The financial stability of a corporation is seriously threatened by this. The automobile sector is going through an unparalleled period of change. The prospect of raw material obsolescence is a huge shadow thrown by technological breakthroughs in fields like electrification and autonomous driving, which are constantly driven by technological leaps and shifting environmental requirements. Production lines may stop altogether until substitute supplies are found when a crucial component goes out of stock, which results in lost sales.This study plunges into a comprehensive exploration of BMW Plant Chennai, with the primary focus of offering valuable insights to navigate the financial challenges of raw material obsolescence and develop proactive strategies for long term financial well-being.
This research endeavors to achieve few pivotal objectives,

- Financial modelling

To create a financial model to estimate the financial effects of obsolescence of raw materials, such as price increases and restricted supply. Making data-driven judgement is made possible by utilizing this approach to evaluate the return on investment (ROI) of various mitigation techniques.

- Inventory analysis

Analyze the financial impacts of current and potential alternative materials through various analysis like ABC analysis, EOQ analysis, VED analysis, HML analysis, SDE analysis and FSN analysis.

- Cost benefit analysis

Conduct a comprehensive cost benefit analysis of all mitigation strategies not only considering direct financial costs but also the potential impact on product quality, lead times and the overall timelines.

In order to address the complex problem of financial trenches and reach the strategic high ground, this project report identifies the hidden costs related to the obsolescence issue and creates a road map of workable solutions.

NEED OF THE STUDY

The automotive industry, driven by innovation, faces substantial financial and operational hurdles with obsolete parts, notably impacting giants like BMW. The unique requirements of the Chennai plant and its potential for advanced technologies like data analytics amplify the importance of our study. It aids in categorizing critical raw materials, forecasting part life cycles, and standardizing parts across models. Utilizing robust data management systems, it identifies root causes for mitigation strategies and fosters collaboration with suppliers. This research is pivotal for survival and success, offering practical solutions benefiting global operations.

OBJECTIVES OF THE STUDY

Primary Objective:

Estimate financial losses due to raw material obsolescence, prioritize mitigating financial risks, and explore expansion opportunities.

Secondary Objectives:

Utilize inventory analysis techniques for inventory policy establishment, assess cost savings through optimized inventory management, and establish clear reporting structures. Make informed financial decisions regarding inventory levels, budgeting, and prioritize research and development efforts for alternatives.

SCOPE OF THE STUDY

The study focuses on manufacturers' challenges with inventory obsolescence, emphasizing financial losses. It examines the BMW plant in Chennai for insights into real-world consequences and evaluates its inventory management procedures, including control, forecasting, and procurement strategies. It aims to identify causes of inventory obsolescence like supply chain changes and technology advancements, assesses direct and indirect financial effects, and provides suggestions and industry best practices for risk reduction. By exploring these aspects, the study aims to enhance inventory control procedures and mitigate financial risks in the automotive sector, particularly at BMW.

RESEARCH METHODOLOGY

The research methodology employed a quantitative approach, utilizing a descriptive research design to analyze financial data without manipulating variables. Systematic sampling reduced selection bias, covering the entire time range comprehensively. Secondary data collection from the company's official platform ensured accuracy, utilizing MS Excel and SAP for extraction and maintaining data integrity.

ANALYSIS AND INTERPRETATION

TABLE.1 Showing Inventory Dynamics for the past three years

	Price	COGS	Unit Price	Total Value
Count	299	299	299	299
Mean	3954912	2029509	107091.5	3554471
Std	2244241	8342456	162912.2	10824031
Min	821259	1676.12	21720.17	22996.4
25%	2387774	40967.42	28862.53	174772.1
50%	2724347	214906.4	37972.17	835200
75%	5008681	995554.5	75974	2200662
Max	10952396	99292000	1004874	95135990

These observations suggest that there may be a need to review inventory management policies, possibly improve sales strategies, or investigate changes in the market or operations that are impacting inventory dynamics.

TABLE.2 Showing Comprehensive Overview of Pricing and Cost Variability in Product Portfolio of BMW

Year	Opening stock	Closing Stock	Average inventory	COGS	Inventory Turnover ratio	Average holding Days
2021	2,05,62,71,246.00	1,29,05,14,457.00	2,70,15,28,474.50	23,02,11,98,203.26	8.52	42.83
2022	3,82,53,71,904.14	2,53,07,99,527.26	5,09,07,71,667.77	37,67,76,15,522	7.40	49.32
2023	5,39,83,55,170.39	18,42,82,66,624.88	14,61,24,88,482.83	61878702441	4.23	86.19

Count: Each financial metric has been calculated for 299 items, indicating a consistent data set with no missing values in these columns.

TABLE.3 showing Revenue and Cost Analysis by Raw Material Category

	Price sum	Price mean	COGS sum	COGS mean	Unit Price sum	Unit Price mean	Total Value sum	Total Value mean
Category of RM								
CV Axle	77658264.1	3698012.576	57617125	2743672.619	6014397.19	286399.8662	126842691.5	6040128.166
Consumables	176589083	3098054.087	13146537.16	230641.0028	2530337.97	44391.89421	78099531.55	1370167.22
Cooling Module	83477703.19	4173885.159	21691786.86	1084589.343	1663982	83199.1	44831012.73	2241550.637
Door Casing	418564571.7	3948722.375	69491647.94	655581.5843	15407384.24	145352.6815	599712681.8	5657666.809
Emergency kit	4135899.977	2067949.989	6385887.12	3192943.56	43797.76	21898.88	1094923.94	547461.97
Engine	61642576.17	4403041.155	290372443.6	20740888.83	741163.79	52940.27071	13666879.59	976205.685
Exhaust	43756817.46	2917121.164	18439352.7	1229290.18	575311.28	38354.08533	72877237.61	4858482.507
Seat	59076606.28	4219757.591	85134946.8	6081067.629	1570816.54	112201.1814	18331996.02	1309428.287
Tyre	6170784.009	3085392.004	4999019.66	2499509.83	108406.22	54203.11	400972.99	200486.495
Wiring loom	251446235.7	5238463.243	39544324.16	823840.0867	3364765.14	70099.27375	106928943	2227686.313

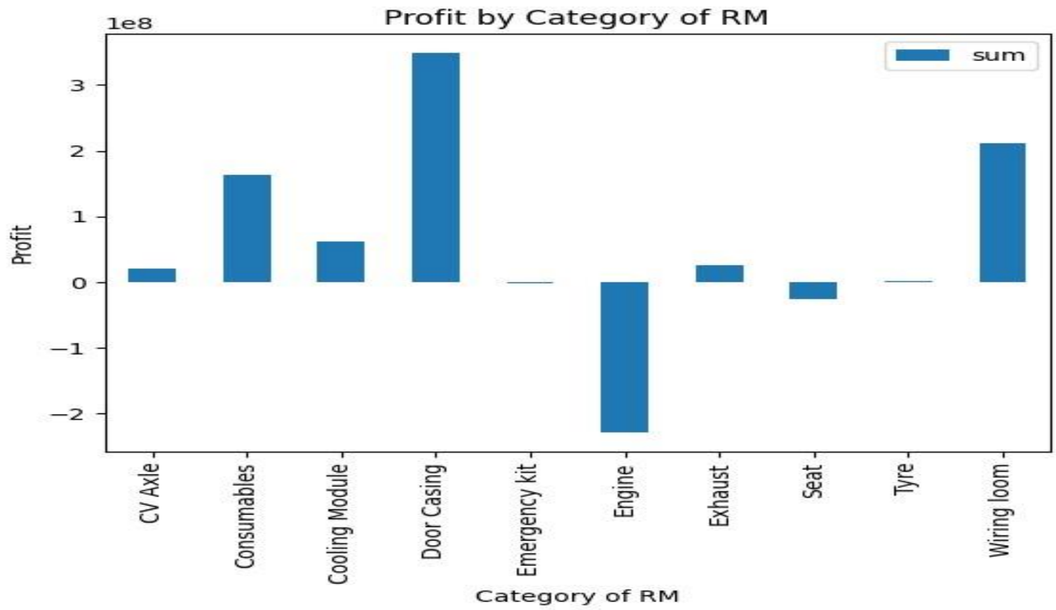
The provided table gives a breakdown of financial metrics by Category of Raw Material (RM), including Price, COGS (Cost of Goods Sold), Unit Price, and Total Value, both in total sum and average (mean) values:

This category analysis can provide strategic insights into which categories are the most valuable, which have the highest costs, and where there might be opportunities to improve margins or adjust pricing strategies. It also highlights the importance of balancing product mix to maintain profitability while catering to market demands.

TABLE.4 showing Profitability Assessment on High Impact Materials and Cost Optimization Opportunities

Category of RM	Sum	Mean
CV Axle	20041139.1	954339.9571
Consumables	163442545.8	2867413.084
Cooling Module	61785916.33	3089295.816
Door Casing	349072923.8	3293140.79
Emergency kit	2249987.143	1124993.571
Engine	228729867.5	16337847.68
Exhaust	25317464.76	1687830.984
Seat	26058340.52	1861310.037
Tyre	1171764.349	585882.1743
Wiring loom	211901911.5	4414623.157

CHART.1 showing Profitability Assessment on High Impact Materials and Cost Optimization Opportunities



From this analysis, we can gather that different RM categories vary widely in their financial impact.

Overall, this analysis indicates that while certain raw material categories contribute positively and significantly to the financial metrics, others detract from it.

TABLE.5 Showing Performance Segmentation by Series Comparative Analysis of Material Sales and Profitability

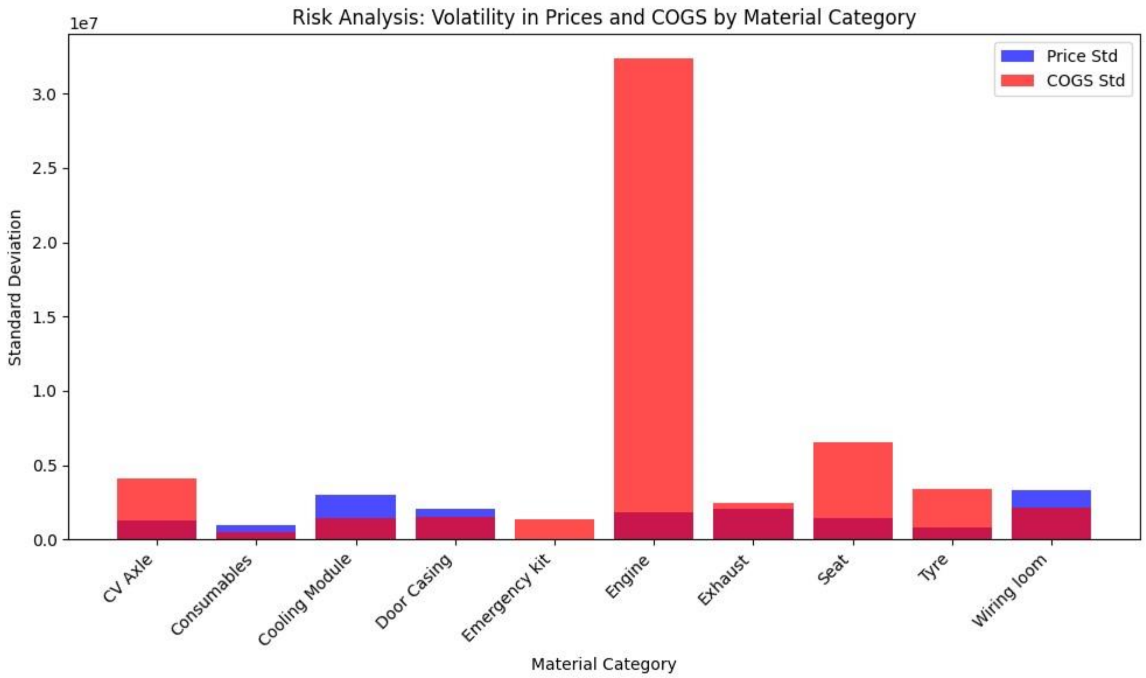
Series	Price	COGS	Unit Price	Total Value
BMW 2 Series Grand Coupe (F44)	2329005.128	2271359.502	50309.88511	3743155.339
BMW 3 Series Sedan (G20)	3951422.008	1438948.937	213148.661	5519804.589
BMW 3 Series Sedan (G28)	3783817.335	734174.5786	182455.301	2717410.635
BMW 3 Series Sports Activity Sedan (F34)	2306602.94	191856.8	77484.52667	1405827.32
BMW 5 Series Sedan (G30)	3956505.601	737741.0203	134374.3913	5326825.695
BMW 6 Series Sports Activity Sedan (G32)	4174554.551	412005.5086	224492.4829	10879406.02
BMW 7 Series Sedan (G70)	5272634.41	162192.2857	30810.14571	844062.5986
BMW X1 18 SUV (U11)	2688988.178	224659.9625	32297.18719	1479653.48
BMW X1 20 SUV (F48)	3245634.533	1076007.24	190832.5689	4109071.722
BMW X3 20 SUV (G01)	3757252.762	1397536.152	46666.80154	3387557.899
BMW X4 30 Sports Coupe (G02)	3424171.795	1125779.039	121184.3631	3015721.505
BMW X5 30 SUV (G05)	6596475.88	240119.94	54872.18	219488.52
BMW X7 30 SUV (G07)	5563458.198	17364077.04	31929.2125	1333907.586
CKD 7 Series Sedan Long (G12)	8704596.955	1256978.071	84250.27071	3959570.518
MINI Countryman (F60)	2418859.472	3342811.491	39528.36	1668621.479

Overall, the 'BMW 7 Series Sedan (G70)' stands out as a significant contributor in terms of price and total value, which could indicate a combination of high sales volume and profitability. In contrast, the 'MINI Countryman (F60)' seems to be the least significant contributor according to these metrics. However, it's important to note that without knowing the actual volume of units sold, these figures only give a partial view of performance. Additionally, the 'Unit Price' could be influenced by various factors such as the inclusion of optional extras, discounts, and the mix of different models within a series.

TABLE.6 showing risk analysis in price volatility and COGS by material category:

Category of RM	Price Volatility	COGS Volatility
CV Axle	1272126.427	4084935.151
Consumables	990938.9718	471583.75
Cooling Module	2992190.442	1424844.827
Door Casing	2080346.97	1467841.536
Emergency kit	9045.988391	1310527.101
Engine	1822580.13	32383781.19
Exhaust	2075449.236	2432566.785
Seat	1443910.813	6547953.905
Tyre	760431.1682	3422694.046
Wiring loom	3281120.858	2137999.697

CHART.2 showing risk analysis in price volatility and COGS by material category:



Overall, these findings highlight the need for strategic oversight and adaptive risk management approaches across all categories to safeguard against financial risks posed by price and COGS volatility. Effective pricing strategies and cost management are crucial in maintaining competitive advantages and achieving sustainable profitability.

TABLE.7 showing correlation analysis between Price, Cost of Goods Sold (COGS), Unit Price, and Total Value.

Variable 1	Variable 2	Spearman Correlation Coefficient	pvalue
Price	COGS	0.065273366	0.260523517
Price	Unit Price	0.548140813	7.55E25
Price	Total Value	0.186779729	0.001175345
COGS	Price	0.065273366	0.260523517
COGS	Unit Price	0.027465221	0.636200312
COGS	Total Value	0.054998887	0.34325486
Unit Price	Price	0.548140813	7.55E25
Unit Price	COGS	0.027465221	0.636200312
Unit Price	Total Value	0.347933781	6.19E10
Total Value	Price	0.186779729	0.001175345
Total Value	COGS	0.054998887	0.34325486
Total Value	Unit Price	0.347933781	6.19E10

The Spear man correlation coefficients indicate the strength and direction of the monotonic relationship between paired data. Values range from 1 to 1, where 1 represents a perfect negative correlation, 1 represents a perfect positive correlation, and 0 indicates no correlation. Pvalues assess the statistical significance of these correlations, with values less than 0.05 typically considered statistically significant.

FINDINGS

Inventory Dynamics:

- Opening stock surged by 86.03% from 2021 to 2022 and by 1311.23% from 2022 to 2023. However, closing stock rose by 96.11% from 2021 to 2022 but dipped by 26.97% from 2022 to 2023.
- Average inventory spiked by 88.44% from 2021 to 2022 and dramatically increased by 187.04% from 2022 to 2023, while COGS saw an 83.63% decrease from 2021 to 2022.
- Inventory turnover ratio decreased by 13.15% from 2021 to 2022 and sharply by 42.84% from 2022 to 2023, with average inventory days rising by 15.15% from 2021 to 2022 and significantly by 74.76% from 2022 to 2023.

Pricing and Cost Variability in BMW's Product Portfolio:

- A segmented approach to pricing and cost management is advised due to a complex sales structure and significant variability in metrics, suggesting a need to revisit inventory management strategies and optimize pricing strategies.

Analysis of Financial Metrics by Category of Raw Material (RM):

- Engine and Cooling Module categories show high total prices, indicating significant revenue contributions, with Engine and CV Axle categories having the highest COGS, implying substantial investment in production or procurement.
- Profitability varies across categories, suggesting opportunities for strategic decision-making regarding pricing, cost control, inventory management, and product development.

Profitability Assessment on High Impact Materials and Cost Optimization Opportunities:

- Tyre and Wiring Loom categories exhibit high averages, indicating potential for cost optimization, while Engine category presents significant negative sum, warranting further investigation for optimization opportunities.

Performance Segmentation by Series Comparative Analysis of Material Sales and Profitability:

- Variation in price, COGS, and total value among different BMW models suggests diverse pricing strategies, with BMW 7 Series Sedan (G70) appearing as the most profitable model.

Risk Analysis in Price Volatility and COGS by Material Category:

- Components like CV Axle, Engine, and Wiring Loom exhibit significant volatility in prices and COGS, highlighting challenges in cost management and pricing strategies, necessitating adaptive risk management approaches.

Correlation Analysis between Price, COGS, Unit Price, and Total Value:

- Significant positive correlation (0.548) exists between Price and Unit Price, while moderate positive correlation (0.348) is observed between Unit Price and Total Value. Limited correlation is found between COGS and other variables.

Regression Analysis for the Impact of COGS, Unit Price, and Price on Total Value:

- Approximately 13.9% of the variance in Total Value can be explained by independent variables, with Unit Price showing the most significant relationship. However, COGS and Price coefficients are not statistically significant, indicating minimal impact on Total Value.

TABLE.8 showing regression analysis

OLS Regression Results

Dep. Variable:	Total Value	R-squared:	0.139
Model:	OLS	Adj. R-squared:	0.130
Method:	Least Squares	F-statistic:	15.87
Date:	Sat, 27 Apr 2024	Prob (F-statistic):	1.36e-09
Time:	11:33:29	Log-Likelihood:	-5244.4
No. Observations:	299	AIC:	1.050e+04
Df Residuals:	295	BIC:	1.051e+04
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	2.34e+04	1.19e+06	0.020	0.984	-2.33e+06	2.37e+06
COGS	-0.0318	0.070	-0.451	0.652	-0.171	0.107
Unit Price	23.3541	3.731	6.260	0.000	16.012	30.696
Price	0.2768	0.271	1.023	0.307	-0.256	0.809

Omnibus:	398.130	Durbin-Watson:	1.442
Prob(Omnibus):	0.000	Jarque-Bera (JB):	31418.044
Skew:	6.332	Prob(JB):	0.00
Kurtosis:	51.595	Cond. No.	1.77e+07

This regression analysis examines the relationship between the Total Value and three independent variables: COGS, Unit Price, and Price. Rsquared (R^2): The Rsquared value indicates that approximately 13.9% of the variance in Total Value can be explained by the independent variables in the model. The overall regression model is statistically significant, as indicated by the Fstatistic (15.87) and its associated pvalue (1.36e09), suggesting that at least one of the independent variables has a significant effect on Total Value.

TABLE.9 showing regression analysis for the Impact of COGS, Unit Price, Total Value on Price

OLS Regression Results

Dep. Variable:	Price	R-squared:	0.076
Model:	OLS	Adj. R-squared:	0.066
Method:	Least Squares	F-statistic:	8.043
Date:	Sat, 27 Apr 2024	Prob (F-statistic):	3.61e-05
Time:	11:30:36	Log-Likelihood:	-4784.5
No. Observations:	299	AIC:	9577.
Df Residuals:	295	BIC:	9592.
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	3.512e+06	1.55e+05	22.651	0.000	3.21e+06	3.82e+06
COGS	0.0205	0.015	1.355	0.176	-0.009	0.050
Unit Price	3.3220	0.831	3.999	0.000	1.687	4.957
Total Value	0.0128	0.012	1.023	0.307	-0.012	0.037

Omnibus:	132.926	Durbin-Watson:	0.309
Prob(Omnibus):	0.000	Jarque-Bera (JB):	405.659
Skew:	2.081	Prob(JB):	8.17e-89
Kurtosis:	6.903	Cond. No.	1.41e+07

R^2 indicates 7.6% of Price variance is explained by COGS, Unit Price, and Total Value. Adjusted R^2 (0.066) suggests minimal improvement with more variables. The F-statistic (8.043) with a small P value (3.61e05) confirms model significance. Log-Likelihood (4784.5) indicates fit quality. Omnibus and JarqueBera Tests (both < 0.001) suggest non-normal residuals. DurbinWatson (0.309) indicates positive autocorrelation. Despite significance, model limitations persist.

SUGGESTIONS

1. Invest in Additive Manufacturing (3D Printing): Utilize 3D printing to reduce storage costs and enable rapid prototyping for spare parts. Develop a digital library of 3D models for efficient access.

2. Implement Life Cycle Management (LCM) Practices: Opt for future-proof materials with longer lifespans and establish clear procedures for disposal. Employ FIFO methods to minimize obsolescence risks.

3. Conduct Cost Benefit Analysis (CBA): Identify direct and indirect costs associated with obsolescence and develop a cost benefit model to prioritize investments and improve decision-making.

4. Utilize Inventory Management Software (ERP): Implement ERP systems for real-time data on stock levels and demand forecasts, aiding in better control over raw materials.

5. Leverage Predictive Analytics and Machine Learning: Develop models to predict potential risks and fluctuations in material prices. Use ML algorithms for dynamic adjustment of safety stocks.

6. Enable Real-Time Inventory Tracking: Implement IOT sensors for real-time tracking of inventory levels, facilitating early identification of slow-moving materials and production scheduling.

7. Adopt Circular Economy Strategies: Optimize resources through Reduce, Reuse, Recycle approaches to minimize waste generation and enhance brand reputation.

CONCLUSION

The automotive sector faces significant challenges from raw material obsolescence, necessitating strategic risk management and adaptation. Prioritizing supply chain resilience, predictive analytics, and flexibility in operations are crucial for long-term success. Collaboration and knowledge-sharing among stakeholders are essential for developing proactive measures and driving positive outcomes for the industry. Managing raw material obsolescence requires industry-wide cooperation to ensure sustained competitiveness in a changing environment.