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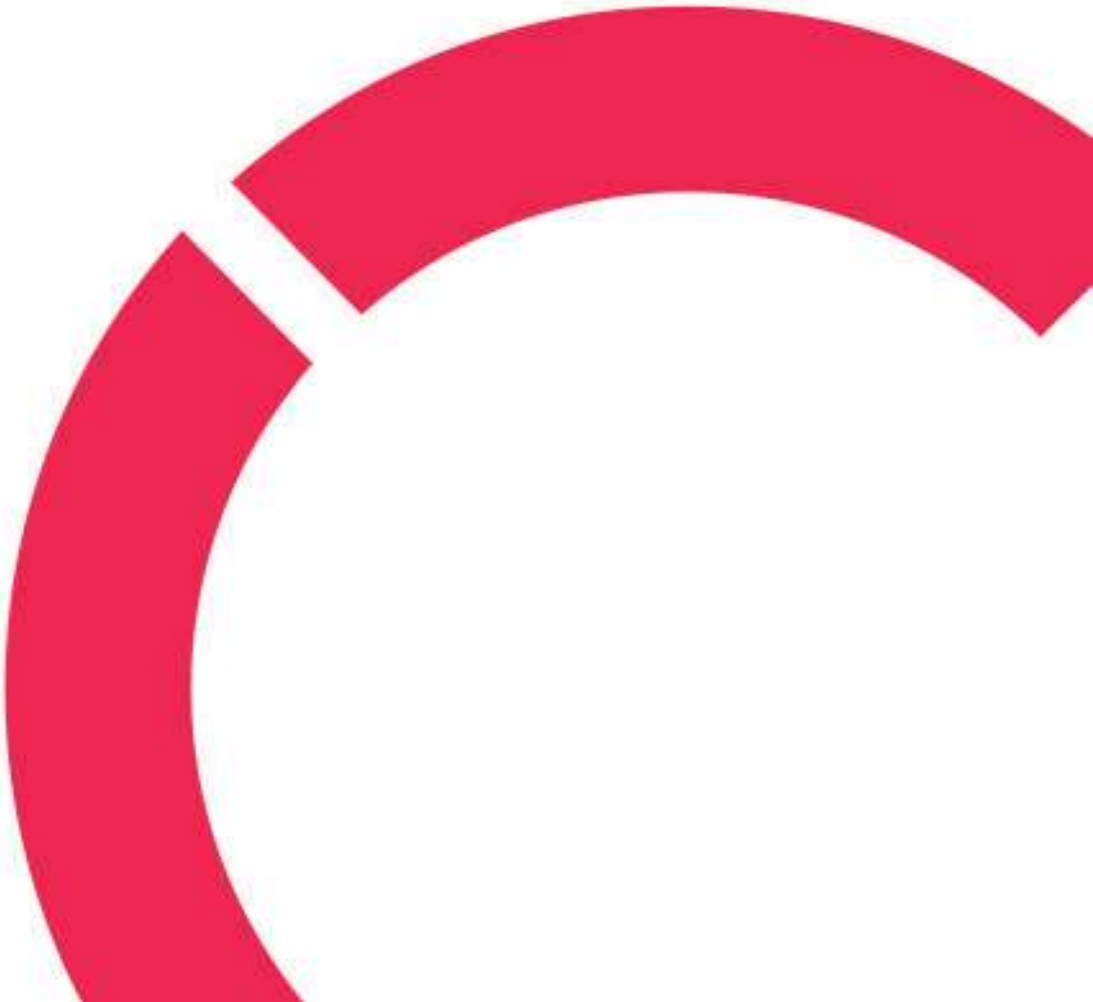
DYNAMIC EBITDA FORECASTING USING ERP & CRM DATA

A case of combining various data sources to increase forecasting accuracy

Thesis
CENTRIA UNIVERSITY OF APPLIED SCIENCES
Masters Degree Programme
June 2024



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ABSTRACT

Centria University of Applied Sciences	**Date** 28/04/2024	**Author** Shayekh Ahmed
Degree program Master of Business Administration, International Business Management		
Name of thesis DYNAMIC EBITDA FORECASTING USING ERP & CRM DATA A case of combining various data sources to increase forecasting accuracy		
Centria supervisor Janne Peltoniemi		**Pages** 59+4
Instructor representing commissioning institution or company		

For a company operating in a highly competitive market, it is essential to maintain a clear understanding of its financial performance and make informed decisions to stay ahead of its competitors. Accurately forecasting financial metrics such as EBITDA and inventory level is crucial to achieving this.

Herrmans Bike Components Oy is a Finnish company specializing in manufacturing and supplying bicycle components to bike manufacturers and distributors globally. With a wide range of products, including lights, grips, rim tapes, reflectors, and other bicycle accessories, the company has established itself as a leader in the European market. This case study is focused on improving the accuracy of the financial forecast for Herrmans Bike Components Oy.

This paper investigates the reasons behind the inaccuracy of the current forecasting model and develops a dynamic new forecasting model that combines data from several modules of an ERP and CRM system to improve the accuracy of EBITDA and inventory forecasts. By leveraging data from multiple ERP modules and information systems, the new model aimed to provide a more comprehensive view of a company's financial performance ahead of time.

The new forecasting model is designed to comply with Finnish accounting GAAP and provide a more accurate forecast of a company's EBITDA, helping decision-makers make better-informed decisions. The new approach enhanced the accuracy of financial forecasting and provided a more accurate representation of a company's future financial health during a highly volatile market situation. The model also allowed dynamic adjustments to the scale of operation, including the production level, to adapt to uncertainty and minimize the impact of losses arising from overcapacity.

A research-based development method was used to develop the EBITDA forecasting model. The method involved analyzing quantitative data from historical income statements, identifying gaps in the old model, and integrating data from several information systems to develop a more accurate dynamic forecasting model. The new model was tested using quantitative methods, and the results showed that the new model improved the accuracy of financial forecasts.

Keywords

Capacity, EBITDA, Enterprise resource planning, Forecast, Inventory, Management forecasting

CONCEPT DEFINITIONS

BOM

A Bill of Materials is a comprehensive list of components, parts, and materials needed to manufacture a final product.

BOO

A Bill of Operations refers to a sequential list of manufacturing processes necessary to produce or assemble a product.

CRM

Customer Relationship Management (CRM) is often used to refer to software and technology that helps to maintain customer relationships.

EBITDA

Earnings Before Interest, Tax, Depreciation, and Amortization.

ERP

Enterprise resource planning (ERP) is a software that integrates data from core business processes.

CIP

Carriage and Insurance Paid (Incoterm).

This month-end balance

The balance is at the end of the current month or at the end of the month one is forecasting. E.g. May will be current or this month. In May, if one forecasts for June, June is also referred to as this month.

Tableau

Tableau is a visual analytics platform that allows us to process data and visualize outcomes.

Text Inside double inverted commas

A text in an inverted comma may refer to a parameter in the formula in the flow chart. E.g. “New Finished goods”. It can also refer to a system or a field from any information system. E.g. “WorkCost1”

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1 INTRODUCTION

Earnings before interests, taxes, depreciation, and amortization (EBITDA) is a metric used for managing financial performance, solvency, and corporate valuation. It became prominent for leveraged buyouts in the 1980s. Gradually, it gained popularity in capital-intensive industries, where expensive assets depreciated over time. Local generally accepted accounting principles (GAAP) or international financial reporting standards (IFRS) do not obligate a company to report EBITDA. EBITDA is a measure used to reflect profitability and cash flow. Although EBITDA does not reflect the efficiency in investment decisions, it is a relatively good measure of management performance. (Bouwens, De Kok & Verriest 2019, 55-105.)

Herrmans Bike Components Oy (Herrmans), a Finnish company, specializes in the manufacturing and supply of bicycle components to manufacturers and distributors worldwide. The company has become established in the European market by offering a diverse range of products such as lights, grips, rim tapes, reflectors, and other accessories.

Herrmans has chosen EBITDA as a key metric, as it enables the management team to make adequate decisions to allocate resources effectively. Management needs to be aware of the risks and opportunities involved in forecasting EBITDA, which is the foundation for budgeting, strategic planning, and decision-making. Quite often, this is done by collecting and analyzing historical financial data, market trends, and economic conditions. At a time of highly volatile market conditions, the management must be able to analyze various datasets to identify parameters that impact financial performance. There needs to be a model that will allow making changes to those parameters in order to simulate probable future scenarios. It should also be capable of making educated projections about future revenue, expenses, and profits. Many organizations have implemented enterprise resource planning (ERP) systems and customer relationship management (CRM) to manage their business operations. Data from these systems are highly beneficial in predicting future EBITDA.

Although the data is available, it is immensely challenging to effectively combine the data from different sources and to use it in a forecasting model that is capable of handling the interdependencies and simulating the outcome that is accurate enough and close to real-time results in the future. The accuracy of forecasting depends on various factors, such as the quality of data, the forecasting method used, and the complexity of the business environment.

This thesis aims to develop a dynamic forecasting model to improve the accuracy of EBITDA for Herrmans Bike Components Oy, a leading Finnish company that specializes in manufacturing and supplying high-quality bicycle components to bicycle manufacturers around the world. The company has a wide range of products, including lights, grips, rim tapes, reflectors, and other bicycle accessories, and is a key supplier to the European market. The outcome of this thesis will help Herrmans Bike Components Oy to make better-informed decisions and sail through the volatile market condition.

This thesis will utilize a research-based development method. The existing financial forecasting process at Herrmans Bike Components Oy and the challenges it faces in achieving accurate predictions of EBITDA and cash flow will be analyzed. Additionally, time-series analysis will be done, which involves analyzing past financial data at the end of each month to identify trends and patterns that can be used to predict future financial outcomes. A dynamic forecasting model will be developed and tested to combine data from the ERP and CRM systems.

Initial investigation reveals that the company's old forecasting model sometimes provides an inaccurate projection of future results. The main reasons are identified as not monitoring and making use of key parameters that are crucial to predict future financial performance, although these parameters can easily be collected from ERP and CRM systems. CRM system is used to send out quotations and receive requests from customers. This will be used to predict sales at a greater level of detail.

ERP systems are another source of useful data. Purchasing material, receiving goods, sales invoicing, delivery of the product, production, consumption of material for production, all payments to internal and external stakeholders, and quality management are recorded in the ERP systems. The system can provide the past accounting data for each of these operations. Data related to EBITDA, which can improve the prediction performance, will be utilized.

Material cost prediction is a big part of predicting EBITDA, and it is tightly linked to inventory valuation. Bill of material and bill of operation are data from ERP that can be of great use to forecast inventory valuation. A list of materials and components that are used in each product is maintained in the ERP system. This is called the bill of material (BOM). Similarly, the list of time and resources for each action that is utilized is listed, which is called the bill of operation (BOO). The new model should be able to make use of these data to improve EBITDA forecast accuracy.

The purchase of raw materials, consumption from the inventory, production schedule, fixed cost, salary-related cost, and other costs of running the operation need to be reliably predicted to predict the EBITDA and cash flow. The model will be developed to predict the EBIDTA and connect variables of cash flow for the year 2023. The model will be with real-time data from April 2023 onward.

2 LITERATURE REVIEW

Creating a new forecasting model necessitates a robust comprehension of its scope, including its dos and don’ts. A thorough grasp of relevant academic resources is essential before embarking on model development. Establishing principles and maintaining focus on the objective is vital for the successful implementation of the new model.

2.1 Financial Forecasting

Financial forecasting predicts a company's future financial state based on historical data, involving some degree of guesswork due to unforeseen factors. It informs decisions on hiring, budgeting, revenue prediction, and strategic planning, guiding attention to expense items. The level of detail in forecasting varies based on the significance of future events like mergers or acquisitions. (Boyles 2022.)

EBITDA was selected as the key financial measure for the study of financial forecasting. Despite no planned mergers or acquisitions in the next twelve months, the heightened focus on financial forecasting was driven by changing market conditions and the necessity for capacity adjustments.

Pro forma statements, common in financial accounting, project a business’s future performance based on assumptions like expected market conditions. They encompass income statements, balance sheets, and cash flow statements, serving both internal and external purposes. Internally, they aid in strategic planning by forecasting revenues and expenses and influencing decisions on hiring and budgeting. Externally, they facilitate comparisons of potential risks in investing in a business. (Boyles 2022.)

The scope of this paper is limited to the income statement. However, the new forecast model also generated inventory value and unused capacity, which enhanced the forecast of certain accounts of the balance sheet and cash flow statement.

Forecasting can be categorized into two main types: quantitative and qualitative methods. Quantitative methods mostly depend on historical data to make predictions. One approach is the Percent of Sales method, which calculates financial line items as a percentage of sales to forecast future metrics. Another method is the straight-line technique, which assumes a constant historical growth rate for revenue. Moving Average forecasting involves averaging the previous period’s data to forecast future

trends, while Simple Linear Regression and Multiple Linear Regression use mathematical models to predict outcomes based on relationships between variables. (Boyles 2022.)

On the other hand, qualitative methods like the Delphi Method and Market Research rely on expert opinions, market analysis, and consumer behaviour to make forecasts. The Delphi Method involves consulting experts anonymously and iteratively until a consensus is reached on future performance predictions. Market Research, crucial for startups and businesses without extensive historical data, provides insights into market conditions, competition, and consumer patterns. These qualitative approaches complement quantitative methods by considering factors that can't be captured solely through numerical data. (Boyles 2022.)

In this study, the percentage of sales method and moving average method are extensively deployed. Additionally, financial line items are forecasted as a percentage of another independent variable to predict future metrics, mirroring the approach of the percentage of sales method.

Moon, Mentzer, Smith and Garver (1998) argued that there are seven keys to making a better forecast. First, the difference between forecasts, plans, and goals needs to be clear. The focus should not be solely on systems; rather, the proper focus should be on management processes and control. The second is to make sure that demand is forecasted accurately. The third is to establish proper communication and collaboration among all the involved parties so that information flows efficiently. Fourth is to make sure that there exists an efficient forecasting infrastructure. All users and developers of the forecasts should be properly trained. The fifth is to integrate different sources of quantitive and qualitative data effectively to improve forecasting accuracy. The sixth is to make sure that everybody involved in the organization understands the importance of forecasting. The seventh is to establish key measures and check the accuracy of the updated measures consistently. (Moon, Mentzer, Smith & Garver 1998, 2.)

All of the above steps have to be carefully considered while generating the new forecast process and developing the forecasting model. These are the primary requirements for accurate forecasting. FIGURE 1 below stated all the seven steps mentioned by Moon et al. (1998).

Figure 1
The Seven Keys to Better Forecasting

Keys	*Issues and Symptoms*	*Ac ions*	*Results*
Understand what forecasting is and is not.	• Computer system as focus, rather than management processes and controls • Blurring of the distinction between forecasts, plans, and goals	• Establish forecasting group • Implement management control systems before selecting forecasting software • Derive plans from forecasts • Distinguish between forecasts and goals	• An environment in which forecasting is acknowledged as a critical business function • Accuracy emphasized and game-playing minimized
Forecast demand, plan supply.	• Shipment history as the basis for forecasting demand • "Too accurate" forecasts	• Identify sources of information • Build systems to capture key demand data	• Improved capital planning and customer service
Communicate, cooperate, collaborate.	• Duplication of forecasting effort • Mistrust of the "official" forecast • Little understanding of the impact throughout the firm	• Establish cross-functional approach to forecasting • Establish independent forecast group that sponsors cross-functional collaboration	• All relevant information used to generate forecasts • Forecasts trusted by users • Islands of analysis eliminated • More accurate and relevant forecasts
Eliminate islands of analysis.	• Mistrust and inadequate information leading different users to create their own forecasts	• Build a single "forecasting infrastructure" • Provide training for both users and developers of forecasts	• More accurate, relevant, and credible forecasts • Optimized investments in information/communication systems.
Use tools wisely.	• Relying solely on qualitative or quantitative methods • Cost/benefit of additional information	• Integrate quantitative and qualitative methods • Identify sources of improved accuracy and increased error • Provide instruction	• Process improvement in efficiency and effectiveness
Make it important.	• No accountability for poor forecasts • Developers not understanding how forecasts are used	• Training developers to understand implications of poor forecasts • Include forecast performance in individual performance plans and reward systems	• Developers taking forecasts seriously • A striving for accuracy • More accuracy and credibility
Measure, measure, measure.	• Not knowing if the firm is getting better • Accuracy not measured at relevant levels of aggregation • Inability to isolate sources of forecast error	• Establish multidimensional metrics • Incorporate multilevel measures • Measure accuracy whenever and wherever forecasts are adjusted	• Forecast performance can be included in individual performance plans • Sources of errors can be isolated and targeted for improvement • Greater confidence in forecast process

FIGURE 1. 7 Keys to Better Forecasting (adapted from Moon, Mentzer, Smith & Garver 1998, 2)

2.2 ERP and CRM Systems

Customer Relationship Management (CRM) is a software used to manage interactions with customers and potential customers. It helps to stay connected with customers and improve sales processes. It enables businesses to maintain up-to-date customer records, track interactions, and enhance customer relationships and lifetime value. CRM centralizes scattered customer and sales data and provides actionable insight to improve customer relationships and sales potential. Most CRM systems are cloud-based, which allows the sales team to access and update customer records, quotations, and product information from anywhere. Key features of a CRM system include contact management of customers, lead

management to track the pipeline of sales, sales forecasting, communication between employees, file and content sharing, and sales analytics. (Salesforce 2024.)

Herrmans uses the Salesforce CRM system developed by Salesforce Inc. This CRM system stores all the information regarding the sales and the pipeline of all potential sales. All the offers and quotations are found in this system. CRM systems provide data and analytics that can be used for sales forecasting.

Enterprise resource planning (ERP) is a business software that integrates data from all core business processes, such as finance, logistics, production, etc. Usually, within an ERP system, there is a centralized database connected to different applications. These applications are used to manage the core business processes. Data flows more efficiently between different core business processes within the ERP systems, which enhances management's decision-making capability. (Investopedia 2024)

ERP systems have advanced levels of centralized databases and data analysis capabilities. These systems are likely to provide better information for decision-making. Therefore, the business can achieve better operational efficiency, better management, and more strategic guidance. ERP systems help to reduce costs, improve decision-making, enable business growth, make IT infrastructure flexible, and empower the organization. So, in summary, ERP systems facilitate better resource management and performance by enabling efficient planning across different organizational divisions. (Shang & Seddon 2000, 1006.)

Herrmans Bike Components Oy uses the LEAN System developed by Roima Intelligence Inc. In Herrmans, it is used to manage order intake, sales, sourcing, logistics, productions, and quality management. Within the system, master data for customers, products, and suppliers are managed, which will be used to forecast the financial outcome of the operation. There exists a lot of important information in the ERP system which can be utilized to increase the accuracy of the forecasting process.

2.3 IFRS Vs FAS

It is necessary to understand the regulatory environment to which the new forecasting model should adhere. Therefore, an analysis was conducted to dAGetermine the key distinctions between FAS and IFRS, specifically focusing on their implications for forecasting EBITDA for a company following FAS reporting standards. A condensed comparison table is provided below.

Upon thorough examination, it was determined that only employee benefits (IAS 19), inventories (IAS 2), and leases (IAS 17) are particularly relevant for this study. As FAS does not require the revaluation of the pension obligation at present value, salary cost calculation becomes fairly simple. Inventory valuation, according to FAS, does not require the inventory to be valued at full cost; only material cost and capacity cost are included in the inventory valuation. Leases could be classified as operational leases and could be expensed under FAS. There was no need to analyze the impact of a financial lease, which complicates the forecasting of EBITDA. Jarva and Lantto (2012) presented these differences clearly in a table. This table is attached below.

TABLE 1. FAS vs IFRS main differences (Jarva & Lantto 2012, 15)

Accounting treatment (IFRS standard)	FAS	IFRS
Employee benefits (IAS 19)	All post-employment benefit plans are treated as defined contribution plans.	Requires post-employment benefit plans to be classified (and treated) as defined contribution or defined benefit plans. Requires employee benefits, such as pension, and obligations to be measured at the present value. Requires pension assets to be measured at fair value.
Income taxes (IAS 12)	The deferred tax can be calculated based on timing differences rather than temporary differences. The deferred tax assets are not required to be recognized.	Requires a deferred tax liability to be recognized for all taxable temporary differences (some exceptions). Requires a deferred tax asset to be recognized for all deductible temporary differences to the extent that the deductible temporary difference can probably be utilized (with some exceptions).
Intangible assets (IAS 38)	Emphasizes prudent capitalization of development expenditures.	Stipulates that an asset can be recognized when it will probably entail future benefits and when the cost of the asset can be reliably measured.
Construction contracts (IAS 11)	The recognition by the stage of completion is optional.	Requires the costs and revenues of construction contracts to be recognized on a stage of completion basis.
Inventories (IAS 2)	Inventories can be valued without the inclusion of production overheads.	Requires inventory to be valued at full cost.

Accounting treatment (IFRS standard)	FAS	IFRS
Leases (IAS 17)	Does not require the rules to be followed, and all leases can be treated as operating leases.	Requires leases to be classified (and treated) as operating leases and finance leases.
Share-based payments. (IFRS 2)	Information about the transactions in which share options are granted to employees is disclosed in the notes but not recognized.	Requires an entity to reflect in its profit or loss and financial position the effects of share-based payment. Transactions. This includes expenses associated with transactions in which share options are granted to employees. Requires share-based payment liabilities to be measured at fair value.
Impairment of assets (IAS 36)	In rare cases, it allows downward valuations for permanent impairments of long-term assets.	Requires assets with indefinite useful life to be assessed for impairment. Requires assets/intangible assets impairment to fair value.
Financial instruments (IAS 39)	Measurement at historical cost, but measurement at fair value allowed.	Requires fair value for most financial instruments.
Agriculture (IAS 41)	Measurement at historical cost.	Requires fair value for biological assets.
Investment property (IAS 40)	Measurement at historical cost.	Allows investment property to be measured at fair value.
Property, plant and equipment (IAS 16)	It allows the measurement of market value if the fair value of a land or water area is permanently and significantly higher than its historical cost.	Allows property, plant, and equipment to be measured at fair value.
Business combinations (IFRS 3)	Allows the pooling of interests method to be used. Requires goodwill to be amortized systematically.	Requires the purchase method to be used. Assets and liabilities are measured at their acquisition-date fair value. Requires goodwill to be assessed for impairment annually.

2.4 The Research Methodology

Research-based development is a method to address issues or obstacles encountered in everyday practice. Through this method, existing concepts or practices are renewed and usually generate new insights and understanding. This approach is characterized by a structured, analytical, and evaluative framework guiding developmental efforts. An inherent aspect of research-based approaches is the utilization of existing information or knowledge as a foundation for developing solutions and generating

new insights. The symbiotic relationship between theory and practice is central to the development process. Methodologies for research-based development encompass action research and constructive research, among others. (Ojansalo, Moilanen & Ritalahti 2015, 18-21.)

This is a research-based development project that aims to improve the accuracy of financial forecasting for Herrmans Bike Components Oy. The flaws and weaknesses of the old forecasting model will be investigated. A thorough analysis will be conducted to identify potential improvements. A new model will be developed and implemented. This new model will be used for over one year to measure the accuracy of the forecast.

3 REVIEW OF THE OLD FORECASTING MODEL

Substantial alterations in the business environment, such as introducing new products or competitive strategies, reduce the resemblance between past and future scenarios. While recent changes may not immediately alter overall patterns in the short term, their impact is expected to amplify over time. It is imperative for executives and forecasters to thoroughly address these considerations through discussion. (Chambers, Mullick & Smith, 1971.)

Given the notable shift in the market condition and company structure, it became imperative to reassess the old forecasting model. However, in February 2023, the old model exhibited significant errors, prompting the overhaul of the model. The absolute error of the old model shown in the graph below also shows that there is a high level of inaccuracies in some months, and it often gives wrong forecasts.

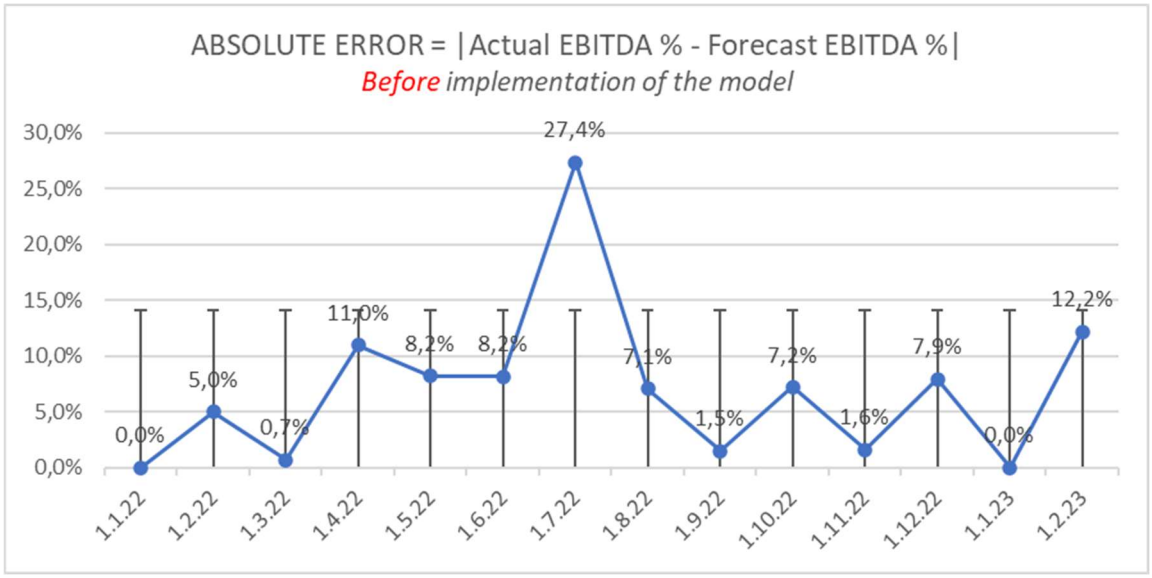


FIGURE 2. Absolute Error of Existing Model.

3.1 Old Forecasting Model

The old forecasting model was considerably simpler, relying on fewer data points to generate output. A percentage of Sales methods was used. Both gross margin and cost forecasts were based on a percentage of sales and historical trends. The forecast for 2022 began with the relevant cost percentage in 2021, adjusted by known or predicted changes in cost percentages. For instance, material costs started at -44,0%, representing the end-of-year 2021 material cost percentage. Anticipated changes in 2022

include a 3,6% increase in material costs, a 1,0% increase in assembly costs, a 0,2% increase in freight costs, a 0,5% increase in currency costs, and a 2,0% improvement in capacity utilization. These assumptions were derived from market analysis, macroeconomic indicators, and cost trends. A similar process was performed for all line items included in gross margin calculations. Aggregated total sales for the month were then multiplied by this cost % to get the absolute value of the gross margin.

Predicting fixed costs was even more straightforward. The cost from the most recent month was extrapolated over the remainder of the year, with adjustments made for known significant events. However, any actions aimed at improving or incidents likely to decrease EBITDA would prompt corresponding adjustments.

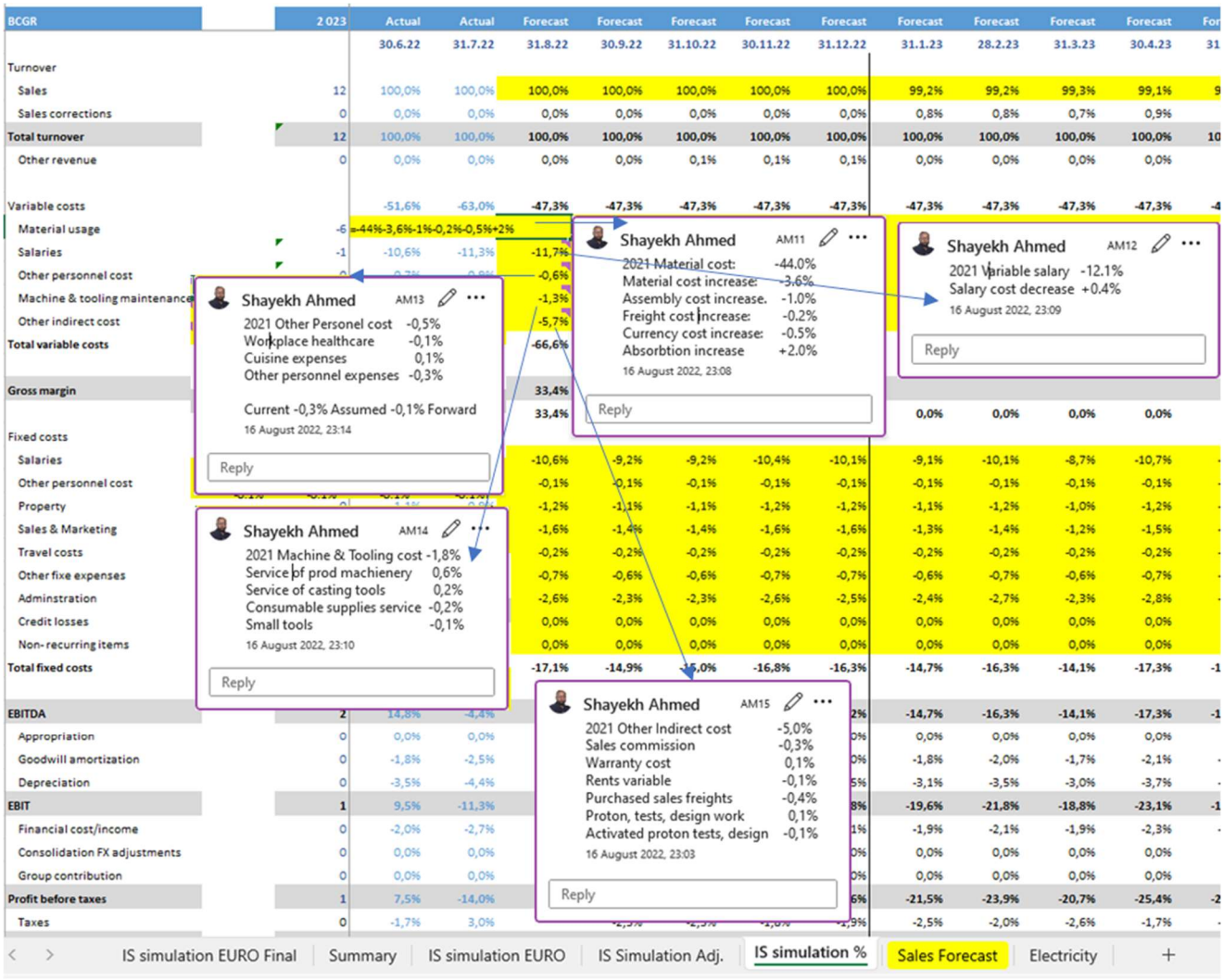


FIGURE 3. Old Forecasting Model

3.2 Limitations and Improvement Potentials

Since sales were forecasted at an aggregate level, less attention was paid to individual factors that could impact the overall sales projection. For instance, sales within particular product groups could vary, as could sales across different regions for the same product group. The forecast for order intake did not receive the attention it warranted. The overall sales forecast relied more on optimism and was susceptible to cognitive biases rather than being grounded in market trends and factual data. Sales forecasts could be improved by better utilizing the data from all the systems available and giving due care to all the data points.

Analyzing product mix is crucial for identifying margin impacts and directing efforts toward improving sales of higher-margin products. Changes in product mix, often overshadowed by volume changes, can erode margins if left unaddressed. Understanding the drivers behind product mix shifts, whether market/customer-driven or sales incentive-driven, enables the focus on short-term strategies to enhance margins. Actions such as discontinuing low-margin products, implementing targeted price adjustments, or refreshing products through R&D can all contribute to margin improvement. (Tech News PWC 2011.)

Since the forecast relied on total aggregated sales, it failed to account for the influence of changes in product mix on gross margin. Consequently, the forecast did not prompt the appropriate actions to enhance the gross margin, leading to a decline over time. Recognizing the importance of forecasting gross margin at a product group level would represent a vital enhancement for the new forecasting model.

The conflict between Russia and Ukraine led to a substantial increase in material and energy costs. However, since the old forecasting model did not factor in the rise in direct material costs independently, it did not anticipate the erosion of gross margin caused by this increase. Hence, it is necessary to separately forecast the direct material cost percentage to enhance the accuracy of the forecast.

Inventories are deemed obsolete when they become unsuitable due to factors such as a substantial surplus beyond actual demand, obsolescence caused by outdated materials, or the inability to repurpose them in other products. Effectively managing slow-moving inventories and accurately forecasting future demand for obsolete inventories can lead to improved inventory management. (Grondys, Kott & Strzelczyk 2014, 89-96.)

In the old model, there were no options to independently account for changes in obsolete inventories. Instead, they were integrated into the material cost percentage. However, this integration was erroneous. Material costs can rise due to price hikes, increased usage, higher scrap levels, or an uptick in obsolete inventory. Thus, it is imperative to forecast obsolete inventory separately.

It is crucial to assess the utilization of existing capacity to accurately predict the gross margin. The unused capacity inversely impacts gross margin, a factor overlooked in the old model. Forecasting utilized capacity requires reliable predictions of production requirements for the upcoming month. The old model failed to consider future production levels and required capacity. Consequently, it completely disregarded the relationship between fluctuations in production and fluctuations in gross margin. As production volume declined, the old model inaccurately forecasted significantly higher gross margin percentages than actual gross margin. This can be rectified by considering production requirements and capacity utilization in the new forecasting model.

The old model forecasted salary costs as a percentage of sales from the previous year, adjusting for yearly salary increases. However, in practice, salary costs were tied to the planned number of employees. As the organizational structure evolved, using salary cost as a percentage of sales became an outdated method for predicting future salary expenses. This could be enhanced by calculating the number of employees and their salaries based on known other employment costs.

Other variable costs were initially forecasted as percentages of sales. However, upon investigation, it became evident that there are independent variables with stronger correlations. Therefore, utilizing these independent variables could enhance the predictability of some of the variable costs, such as assembly service cost, machine & tooling cost, etc.

The prediction of fixed costs relied on data from the most recent month, which was then extrapolated to subsequent months. However, a more effective approach would involve creating a comprehensive fixed-cost plan for the entire year during the budgeting process and then adhering to this plan while remaining adaptable if adjustments are needed.

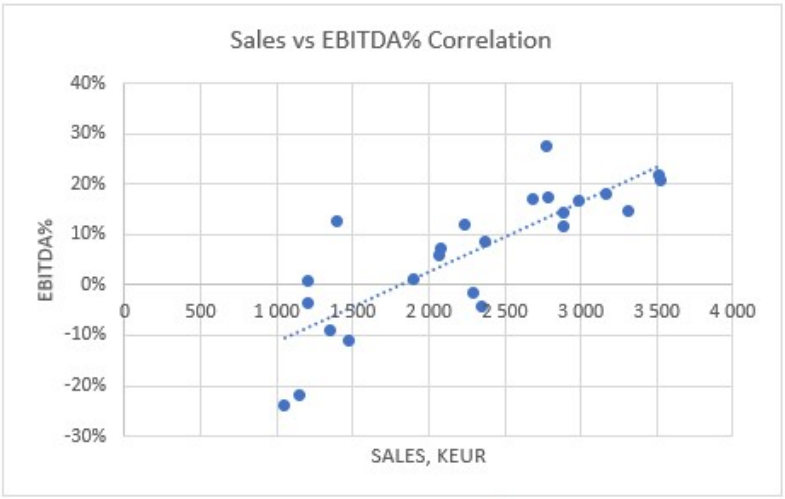
4 DEVELOPMENT OF THE DYNAMIC FORECASTING

After considering all the missing ingredients and the potential for improved forecasting, a new forecasting model has been developed. As it is a very complex model with many interdependencies, a flow chart has been developed that includes all new calculation methods and formulas to help you understand it better. This flowchart is attached to the Appendix 1.

Each formula undergoes testing and development through a trial-and-error process utilizing sample data. The subsequent sections provide explanations for undertaking specific calculations, detailing input parameters and their sources, presenting output results, and analyzing their impact on forecast accuracy.

4.1 Sales Forecasting

Forecasting sales accurately for the next twelve months is crucial for the success of the new model. Analysis of data from 2022 to 2023 reveals a very high positive correlation of 0.82 between sales and EBITDA%, highlighting the significance of precise sales forecasting for EBITDA prediction. This accuracy in sales forecast also directly impacts inventory management, production requirements, procurement planning, and contribution margin to address semi-variable costs.



	SALES, KEUR	*EBITDA%*
SALES, KEUR	1	
EBITDA%	0,82	1

FIGURE 4. Correlation Between Sales and EBITDA%

Three separate systems contain the information to complete the sales forecast. These are LEAN, an ERP system provided by Roima Intelligence Inc., internally developed management information systems using Tableau that visualize order intake trends (Tableau), and customer relationship management (CRM) software provided by Salesforce, Inc (Salesforce).

As soon as an order is placed by the customer, it is recorded in the LEAN, and it is added to the order book. These are called orders. Lead time for an order to be delivered could be six weeks to several months. Therefore, at any given point, there is a prefilled order book, which is the first block of the estimated sales for any future month. This information is derived from the LEAN system by an internally developed management information system using Tableau. This is called an order book report. The sales director uses this order information at the product group level.

The second block consists of forecasts for highly probable future orders that are collected from key customers by the sales team and inserted into the LEAN system. These data are collected from the LEAN system and watered down according to the management judgment of the sales director.

The third block of information comes from Salesforce, which sends out quotations to customers for new business opportunities. Historical trends show that the success rate of capturing those opportunities is 50%. Therefore, only 50% of the value of those business opportunities is considered during the sales forecast.

The fourth block of sales forecast is based on the historical trend of getting orders that are neither in the LEAN as forecast nor in salesforce as new business opportunities. There are usually recurring orders from the customers where the components are already part of the bike design but come in smaller quantities with a short lead time for small-scale bike production.

All the predictions are made at the product group level. There are seven product groups: lights, grips, rim tapes, reflectors, chainguards, and Nordic lights. Not all product groups have the same gross margin. Material and work costs needed for each product group are different. Hence, having the sales forecast ready at the product group level enables us to predict the material cost, procurement need, inventory value, capacity cost, and gross margin effectively. An example of a sales forecast for a few product groups is given above in FIGURE 5.

Product Type	2023	
	December	January
LIGHTS		
Orders	331 616	264 848
Forecasts		216 478
Salesforce(new specs, new business, cut by 50% because part is represented by the order income value)		27 000
Order intake estimated	128 000	55 148
SUM	**426 454**	**493 694**
GRIPS		
Orders	199 828	91 898
Forecasts		205 625
Salesforce(new specs, new business, cut by 50% because part is represented by the order income value)		28 000
Order intake estrimated	92 000	39 638
SUM	**271 845**	**355 971**
RIMTAPES		
Orders	70 793	70 793
Forecasts		95 791
Salesforce(new specs, new business, cut by 50% because part is represented by the order income value)		13 000
Order intake estimated	40 000	17 234
SUM	**103 714**	**170 580**

FIGURE 5. Sales Forecast Example

Throughout 2023, Herrmans experienced progress in the accuracy of its sales forecast. This improvement was primarily attributed to a deeper understanding of the macroeconomic landscape and closer collaboration with customers to learn their actual demands. The sales team's awareness of Herrman's customer sales data directly correlated with the quality of their sales forecasts. Additionally, a crucial contributing factor was the insight into the inventory maintained by customers for components supplied by Herrmans. By amalgamating this information with an understanding of the seasonality in bike production, the sales team successfully elevated the accuracy of incoming order predictions. In Table 2 provided below, figures in a darker background depict actual values, while those in a white background represent estimated values. It is obvious from the table that the October 2023 onward sales prediction started to be more accurate.

TABLE 2. Sales Forecast Accuracy

SALES	31.1.23	28.2.23	31.3.23	30.4.23	31.5.23	30.6.23	31.7.23	31.8.23	30.9.23	31.10.23	30.11.23	31.12.23	2023
Jan	2 685	2 299	2 371	2 340	2 891	2 528	2 311	2 504	2 447	2 392	2 215	2 075	**29 057**
Feb	2 685	2 288	2 371	2 340	2 891	2 528	2 311	2 504	2 447	2 392	2 215	2 075	**29 046**
Mar	2 685	2 288	2 064	1 463	2 306	1 969	2 535	2 497	2 577	2 260	2 283	2 083	**27 009**
Apr	2 685	2 288	2 064	1 480	2 306	1 805	1 529	2 008	2 071	2 258	2 263	2 201	**24 957**
May	2 685	2 288	2 064	1 480	2 081	1 895	1 183	1 636	2 207	2 329	2 455	2 171	**24 474**
Jun	2 685	2 288	2 064	1 480	2 081	1 905	1 000	1 636	2 207	2 329	2 455	2 171	**24 301**
Jul	2 685	2 288	2 064	1 480	2 081	1 905	1 053	1 667	1 688	2 202	2 247	1 992	**23 352**
Aug	2 685	2 288	2 064	1 480	2 081	1 905	1 053	1 394	1 688	1 202	1 744	1 674	**21 258**
Sep	2 685	2 288	2 064	1 480	2 081	1 905	1 053	1 394	1 208	1 467	1 267	1 119	**20 011**
Oct	2 685	2 288	2 064	1 480	2 081	1 905	1 053	1 394	1 208	1 349	1 267	1 180	**19 953**
Nov	2 685	2 288	2 064	1 480	2 081	1 905	1 053	1 394	1 208	1 349	1 146	1 062	**19 715**
Dec	2 685	2 288	2 064	1 480	2 081	1 905	1 053	1 394	1 208	1 349	1 146	1 202	**19 854**

4.2 Variable Cost Prediction

Variable costing is an approach to cost calculation that considers only variable production costs—such as direct material, direct labour, and variable factory overhead—as inventory or product costs. In this method, product costs are specifically defined as the expenses directly associated with actual production. Unlike fixed factory overhead, which remains constant even in the absence of production, variable costing proponents argue that fixed factory overhead does not meet the criteria for product cost. Consequently, fixed factory overhead costs are treated as period expenses and are charged against revenue as they are incurred. (Raiborn & Barfield & Kinney 1996, 371.)

Accurate forecasting of variable costs requires precise estimation of three distinct cost types: direct material cost, direct labour cost, and variable factory overhead. This estimation relies on deriving product costs from the product structure, which includes the Bill of Materials and Bill of Operations (routing).

4.2.1 Utilization of Bill of Materials and Bill of Operation (Routing)

A Bill of Materials is a comprehensive list of components, parts, and materials needed to manufacture a final product. It specifies the hierarchical structure of a product, detailing the relationships between the final product and its sub-assemblies, components, and raw materials. The representation of the set of all "gozinto-relationships" of a parent product P is referred to as the Bill of Materials (BOM) of P. The BOM essentially outlines how a product is built by listing all the necessary parts and their relationships in a structured manner. (Van Veen 1991, 4-5.)

In the LEAN ERP system at Herrmans, a Bill of Materials (BOM) is maintained for each product, encompassing information on both material quantities and material costs. The cost data for any material is determined by the average cost of the material in the inventory. Should a material be purchased at a cost higher or lower than the current average, the system will update the material's average cost per unit overnight. By aggregating the total BOM costs for all items sold in a month, the system provides a direct link between material costs and the sales of all products during that month.

In the context of Manufacturing Resource Planning (MRP)-oriented software, a "routing" or "Bill of Operations (BOO)" refers to a sequential list of manufacturing processes necessary to produce or

assemble a product. This list, integral to controlling manufacturing processes, includes operations uniquely identified by numbers and described with attributes such as operation type, resource requirements, and setup times. Operations are associated with specific products, and a relationship is established between the component products in the Bill of Materials (BOM) and the operations in the routing. (Van Veen 1991, 7-8.)

Furthermore, within the LEAN ERP system at Herrmans, a Bill of Operations (BOO) is maintained for each product, outlining all the requisite processes for manufacturing a product. This comprehensive record specifies the time required from resources in terms of machine hours and labour hours, accompanied by corresponding hourly rates for both machine and labour hours. Consequently, the system enables the determination of the total cost required for manufacturing an item, referred to as work cost. The cumulative work cost for all items sold in a month should equal the combined direct labour cost and variable factory overhead cost, collectively termed as production capacity cost.

These BOM costs and work costs will be fundamental blocks of forecasting variable costs for each month. As the product mix will change each month, the total cost is also expected to change accordingly.

4.2.2 Standard Costing

Standard Costing offers a prospective approach to costing as a control mechanism rather than a standalone product costing method. It involves establishing standards for each cost element and ensuring activities align with predetermined or standard costs. According to the Chartered Institute of Management Accountants (CIMA), it includes preparing and utilizing standard costs, comparing them with actual costs, and analyzing variances to identify causes and points of impact. (Madegowda 2006, 555.)

Standard Cost precisely outlines the expected cost for a product or service, establishing the acceptable expenditure for producing a unit or a specific quantity of a product. It serves as a benchmark for assessing cost efficiencies, as the primary goal of setting standards is to maintain costs within predefined limits. (Madegowda 2006, 558.)

Both the BOM and BOO are calculated based on the standard cost principle. In the LEAN ERP systems, inventory valuation is provided for both standard and average costs. As it was decided to present

the inventory value at a standard cost in financial accounting, the same was used to forecast the material cost for the future.

4.2.3 Material Cost

Direct materials comprise all materials purchased for a particular job, materials issued from stores, components purchased or produced by passing material from one process to another, and primary packaging materials. Items such as import duties and transport costs are also part of direct materials costs. (Coombs, Hobbs & Ellis 2005, 35-36.)

To enhance predictability and simplify the process, material cost forecasting has been divided into two segments. In the first part, only the intrinsic cost of the material, excluding expenses such as freight cost and import duties, is predicted.

“Material cost (excluding freight, import duties, electricity, and currency differences)” is calculated as the sum of the purchase of material, changes in raw material, changes in finished goods, and changes in obsolete inventory. A decrease in raw material or finished goods increases material cost and vice versa. However, an increase in obsolete inventory increases the material cost.

“Other Variable Cost Excluding Direct Material Cost” is calculated by summing up cost components such as purchase freight, import duties, assembly services, electricity, consumable supplies for production, purchase discounts, currency differences, unrealized currency differences, and internal margin stock. This is also referred as “Material cost (Freight, import duties, electricity, and currency difference)” in the flow chart.

4.2.4 Material cost (Excluding Freight, Duties, Electricity, & Currency Difference)

Forecasting the intrinsic cost of materials involves four essential steps, each requiring a distinct forecasting approach and potentially necessitating the unravelling of multiple layers to arrive at the final figures.

In the production of the new product, raw material is utilized, either through procurement or withdrawal from inventory. The material balance at the beginning of the month decreases as it is used in

production and increases when new material is acquired. Consequently, the consumption of materials for the month's sales can be derived from the change in material during the month.

The four steps that need to be forecasted to predict the material cost include forecasting the purchase of material, change in raw material, change in finished goods, and change in obsolete inventory during the month. This forecast relies on data extracted from product cost, Bill of Materials (BOM), and Bill of Operations (BOO) to anticipate future material cost requirements.

The diagram below visually illustrates the connection and equation required for accurately calculating material costs. It provides an overview of the key relationships without delving into specific calculations. Further formulas are required within each category to complete the calculation process.

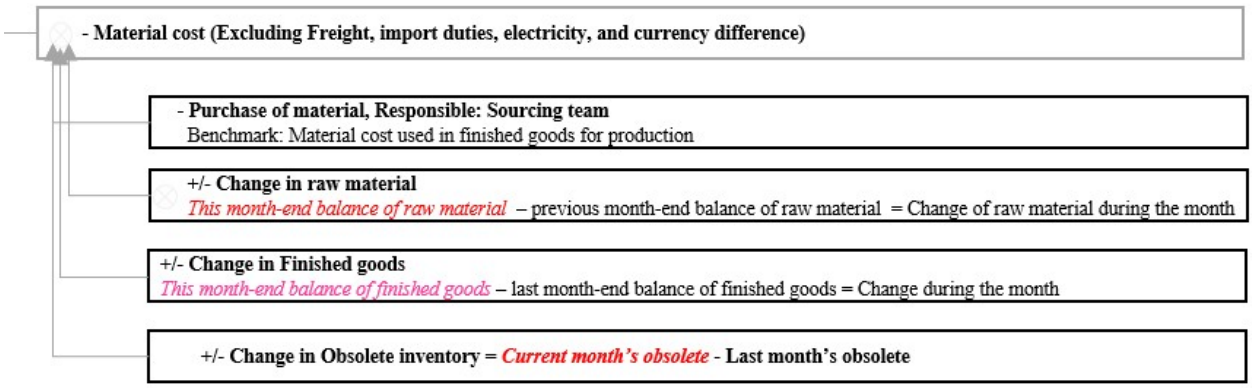


FIGURE 6. Material Cost Forecast Methodology.

The first step in forecasting material costs is to calculate the expense of material purchases. This process entails grasping the interconnectedness of managing various aspects of stocks.

Managing stocks requires managing uncertainties effectively; correct settings of parameters like safety stocks, safety lead time, lot-sizing rules, and planning horizon are crucial as they directly impact inventory levels. Incorrect parameter settings can lead to the wrong demands for stocks. (Weierink 2017, 36.)

All the above-mentioned parameters are set properly in LEAN. The sourcing team predicts material purchases for upcoming months with the help of LEAN ERP, which calculates material requirements based on sales forecasts and sales orders, utilizing the Bill of Materials (BOM) for each product. It also considers the economic order quantities based on the preset parameters. This calculation involves a

comparison with the existing inventory, and if any materials are found to be lacking, it triggers a purchase requirement.

While it is feasible to accurately project the purchasing needs of material for the next two months using the LEAN system, forecasting beyond this window is limited due to the six-week lead time for placing orders. Customers are not obligated to place orders more than six weeks in advance. When sales orders are absent in the LEAN system, the purchasing team resorts to the sales forecast provided by the sales team. Using this forecasted volume, the purchasing team predicts future raw material requirements based on management's judgment and their knowledge of material needs for production. This prediction then serves as an internal purchasing expense target.

To enhance this analysis, the finance team conducts a comparable assessment at a broader product group level during forecasting. Utilizing historical sales and gross margin data, they compute the average material usage for each product group. This enables us to determine the material cost as a percentage of the standard product cost. If finance derives completely different numbers than the sourcing team, further investigation is needed to determine the correct level of purchasing.

2023	Jan.23	Feb.23	Mar.23	Apr.23	May.23	Jun.23	Jul.23	Aug.23	Sep.23	Oct.23	Nov.23	Dec.23	YEAR
PURCHASE INPUT	852 915	754 775	887 935	517 964	578 247	1 147 712	147 660	807 643	336 669	495 526	400 499	257 141	7 184 684
Purchases Raw Material	*624 795*	*667 126*	*322 010*	*997 380*	*595 042*	*197 378*	*660 094*	*577 804*	*374 930*	*313 044*	*346 688*	*570 193*	6 246 484

FIGURE 7. Forecasting of material purchase.

The second phase in forecasting material costs, outlined in FIGURE 6, involves computing changes in raw materials. This task necessitates understanding the causes behind shifts in raw material consumption and escalation.

Raw materials constitute a portion of the inventory. These raw materials are directly involved in the production and can be found in the final product, either wholly or partially, in their original form or after transformation. (Ciuhureanu & Baltes 2012, 72.)

In financial accounting, the change of raw materials in the inventory is used to correctly record the material used in the finished product. This is simply the difference between the month-end balance of the current month and the previous month, which is stated in the formula below.

Typically, the ending balance from the previous month is accessible. Nevertheless, to accurately forecast the current or upcoming month's raw material balance, several complex formulas must be applied sequentially, as demonstrated in FIGURE 8.

The initial challenge is to precisely forecast the " This month-end balance of raw materials.". This entails accurately estimating both the materials procured and those consumed in manufacturing finished goods throughout the month. "This month-end balance of raw materials" is calculated by adding the previous month's end balance of raw materials to the purchase of material and then subtracting the raw material used in production.

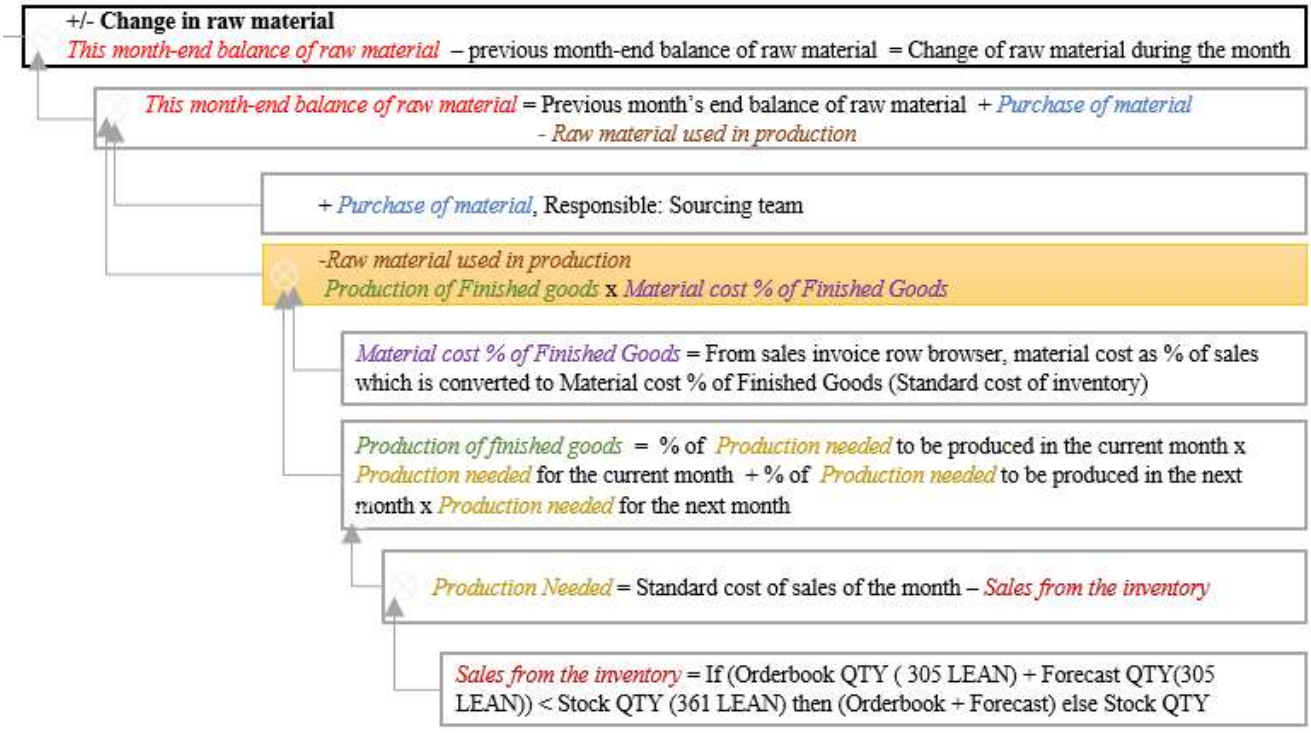


FIGURE 8. Change in Raw Material Flow Chart

As previously mentioned, Herrmans relies on forecasts from the purchasing team to gauge the expected material purchases for the ongoing month. The purchasing team utilizes the LEAN ERP system, which integrates current stock levels, anticipated order quantities for the month, and material requirements from the Bill of Materials to generate an estimate of purchase requirements for raw materials. This "Purchase of material" increases the amount of material in the inventory. Hence, this is added to the "Previous month's end balance of raw material".

Estimating the “Raw material used in production” involves determining the monthly production of goods and the associated material costs, as explained below. The raw material utilized in production equals the absolute value of production of finished goods multiplied by the material cost percentage of finished goods. To get the raw material used in production, the material cost % of finished goods and absolute value of production requirement for the month needs to be calculated.

The initial step involves determining the material cost as a percentage of the sales price, which is then converted to a percentage of the standard cost encompassing material and labour costs but excluding the margin. Inventory is valued at standard cost. Some of the sales are covered by existing inventory and do not require production. Consequently, by subtracting this inventory value from the standard cost of total sales for the month, one ascertains the production requirement for that month.

In the initial phase, Herrmans gathers raw material costs for each item, the summation of which is converted into a percentage of sales. Within Lean’s “Invoice Row Browser --All--105” report, the “Material Cost” column provides this data, as shown in FIGURE 9. Dividing the aggregated material cost per product group by the aggregated sales price at the product group level (found in the “Amount Curr” column) yields the material cost as a percentage of the sales price per product group. Material price increase potential is also factored in and added to the material cost % of sales, as shown in FIGURE 10. The material cost and unit price are confidential therefore, it is hidden in FIGURE 9.

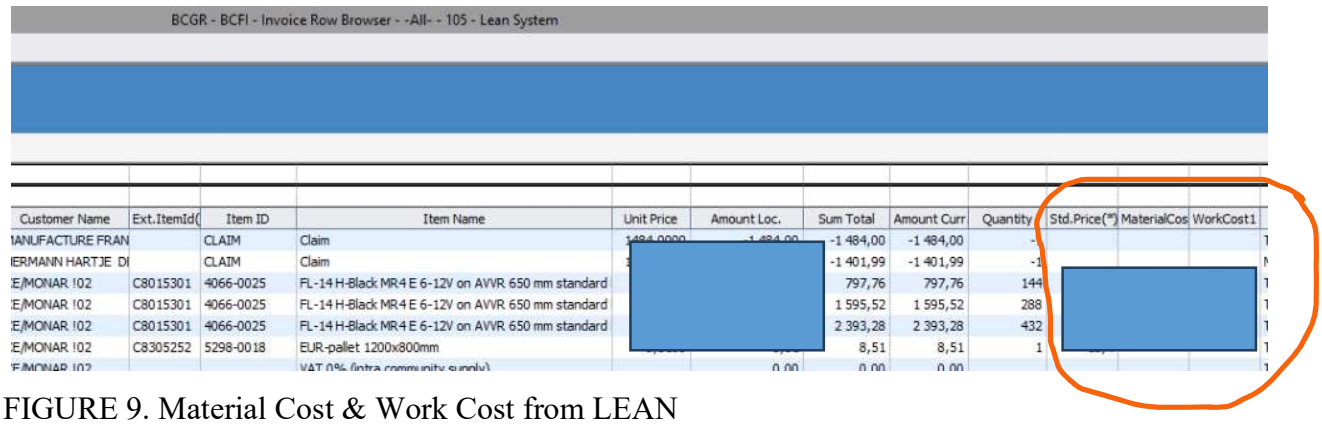


FIGURE 9. Material Cost & Work Cost from LEAN

Furthermore, the same report contains a “WorkCost1” column representing human and machine labour costs, also known as work cost or capacity cost. This is also shown in FIGURE 9. Calculating the work cost % of the sales price per product group involves dividing the aggregated work cost per product group by the aggregated sales price per product group (found in the “Amount Curr” column).

Multiplying the work cost % of sales and material cost % of sales (in FIGURE 11) for each product group by the aggregated sales of that product group gives us the absolute values of work cost and material cost per product group, respectively. The standard cost per product group for the month's sales is derived by combining the total aggregated absolute value of material cost and work cost per product group.

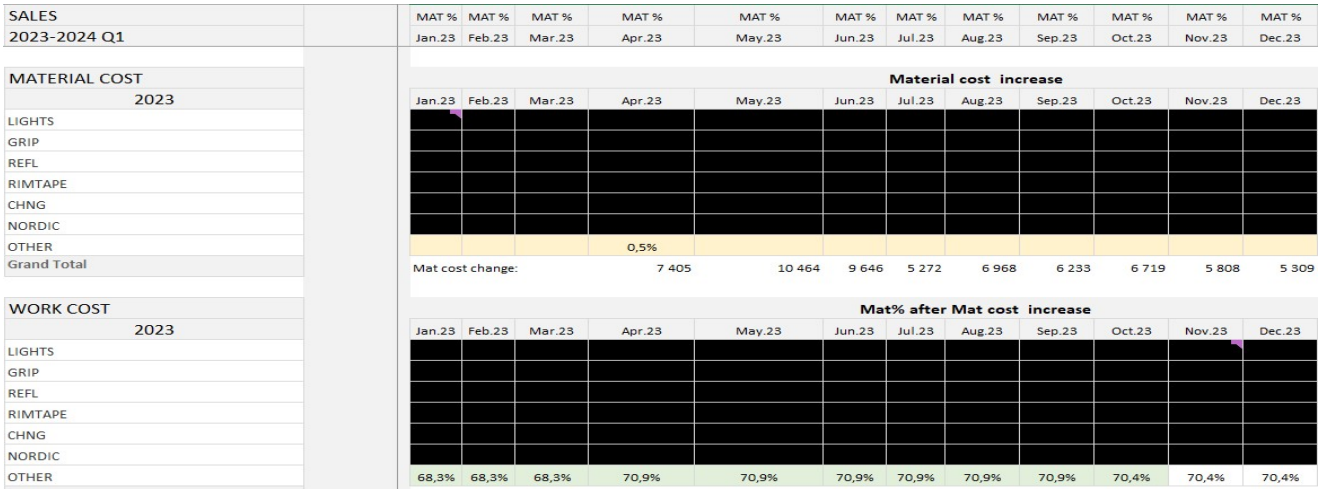


FIGURE 10. Price Increase Adaptation to Material Cost

Product Group	Sum of Material cost %	Sum of Wrk Cost %	
LIGHTS	[redacted]		Average fron
GRIP			Max from the
REFL			Max from the
NORDIC			Max from the
RIMTAPE			Max from the
CHNG	23,5%	3,7%	Max from the
OTHER	70,4%	5,6%	Cumulative f

FIGURE 11. Material Cost % & Work Cost % from LEAN

To determine the Material cost % of Finished Goods (at standard cost), divide the absolute value of material cost per product group by the standard cost of each product group for the month's sales. Similarly, dividing the absolute value of the work cost per product group by the standard cost per product group for the month's sales gives the Work cost % of Finished Goods, which is referred to as Capacity % of Finished Goods. This is presented in FIGURE 12.

This Material cost % of Finished Goods and Work cost % of Finished Goods is multiplied by the Total production needed to get the material needed and the capacity used in the production. At this point, the production requirement of the finished goods needs to be determined.

Sheet "Forecast"	SALES € Jan.23	SALES € Feb.23	SALES € Mar.23	SALES € Apr.23	SALES € May.23	SALES € Jun.23	SALES € Jul.23	SALES € Aug.23	SALES € Sep.23	SALES € Oct.23	SALES € Nov.23	SALES € Dec.23
OTHER	274 347	268 345	182 547	92 427	226 741	167 863	58 475	65 578	53 016	180 087	36 269	108 316

Sheet "Forecast"	MAT % Jan.23	MAT % Feb.23	MAT % Mar.23	MAT % Apr.23	MAT % May.23	MAT % Jun.23	MAT % Jul.23	MAT % Aug.23	MAT % Sep.23	MAT % Oct.23	MAT % Nov.23	MAT % Dec.23
OTHER	68,3%	68,3%	68,3%	70,9%	70,9%	70,9%	70,9%	70,9%	70,9%	70,4%	70,4%	70,4%

Sheet "Forecast"	WRK % Jan.23	WRK % Feb.23	WRK % Mar.23	WRK % Apr.23	WRK % May.23	WRK % Jun.23	WRK % Jul.23	WRK % Aug.23	WRK % Sep.23	WRK % Oct.23	WRK % Nov.23	WRK % Dec.23
OTHER	5,6%	5,6%	5,6%	5,6%	5,6%	5,6%	5,6%	5,6%	5,6%	5,6%	5,6%	5,6%

Sheet "Forecast"	MAT € Jan.23	MAT € Feb.23	MAT € Mar.23	MAT € Apr.23	MAT € May.23	MAT € Jun.23	MAT € Jul.23	MAT € Aug.23	MAT € Sep.23	MAT € Oct.23	MAT € Nov.23	MAT € Dec.23
OTHER	187 327	183 229	124 645	65 517	160 727	118 990	41 450	46 485	37 581	126 755	25 528	76 239

Sheet "Forecast"	WRK € Jan.23	WRK € Feb.23	WRK € Mar.23	WRK € Apr.23	WRK € May.23	WRK € Jun.23	WRK € Jul.23	WRK € Aug.23	WRK € Sep.23	WRK € Oct.23	WRK € Nov.23	WRK € Dec.23
OTHER	15 465	15 126	10 290	5 210	12 781	9 462	3 296	3 697	2 988	10 151	2 044	6 106

Sheet "Forecast"	STD € Jan.23	STD € Feb.23	STD € Mar.23	STD € Apr.23	STD € May.23	STD € Jun.23	STD € Jul.23	STD € Aug.23	STD € Sep.23	STD € Oct.23	STD € Nov.23	STD € Dec.23
OTHER	202 792	198 355	134 935	70 727	173 508	128 453	44 747	50 182	40 570	136 907	27 572	82 344

Sheet "Prod Sch OTHER"	MAT % STD Jan.23	MAT % STD Feb.23	MAT % STD Mar.23	MAT % STD Apr.23	MAT % STD May.23	MAT % STD Jun.23	MAT % STD Jul.23	MAT % STD Aug.23	MAT % STD Sep.23	MAT % STD Oct.23	MAT % STD Nov.23	MAT % STD Dec.23
OTHER	92,4%	92,4%	92,4%	92,6%	92,6%	92,6%	92,6%	92,6%	92,6%	92,6%	92,6%	92,6%

Sheet "Prod Sch OTHER"	WRK % STD Jan.23	WRK % STD Feb.23	WRK % STD Mar.23	WRK % STD Apr.23	WRK % STD May.23	WRK % STD Jun.23	WRK % STD Jul.23	WRK % STD Aug.23	WRK % STD Sep.23	WRK % STD Oct.23	WRK % STD Nov.23	WRK % STD Dec.23
OTHER	7,6%	7,6%	7,6%	7,4%	7,4%	7,4%	7,4%	7,4%	7,4%	7,4%	7,4%	7,4%

FIGURE 12. Converting % of Sales to % of Standard Cost

Not all sales orders for the current month automatically translate into production needs, as some sales are fulfilled from existing inventory. Hence, it is necessary to retrieve the latest inventory status from the LEAN/ERP systems. The same system also stores data on future confirmed orders and forecasted orders. Forecasted orders are an indication of probable incoming sales orders provided by customers but which have not yet been confirmed. Both sets of information are analyzed against the latest inventory available to determine the portion of future probable sales that will be fulfilled from existing inventory. If the inventory value exceeds the sum of the order book and forecasted orders, the total order and forecast value for the month are accounted for as sales from existing inventory. Otherwise, the

entire inventory value is allocated as sales from existing inventory. The formula for this can be found in FIGURE 8 as Sales from the inventory. Numeric calculation and an example are also shown in the FIGURE 13.

				Orderbook 2023				Forecast 2023				Balance 2023		Sales From INV 2023	
Item ID	Item Name (Long)	Produc	Average			Total	Balance			Total FOI	Balance FO	Bal M11	Bal M12	INV to SAL M1	INV to SAL M
1198-0101	Box Rimtape Decathlon Rockride HPM 20x559/26" vh 9mm 0,9 20mm 1620m	RIMTAPE	7 776	1248	156	1404	6 372	0	1248	1248	6 528	6 528	5 124	1248	1404
1209-0016	Rimtape HPM 16x507/24" vh 9mm 0,9 Rimtape HPM 16mm 1470mm/24" vh 9m	RIMTAPE	99	0	252	252	-153	0	0	0	99	99	-153		99
1211-0011	Rimtape HPM 18x622-635/28" vh 9mm 0,9 Rimtape HPM 18mm 1820mm/28" v	RIMTAPE	1446	0	3 765	3 765	-2 319	0	0	0	1446	1446	-2 319		1446
1213-0013	Rimtape HPM 20x584-622/26-28" vh 9mm 0,9 Rimtape HPM 20mm 1690mm/	RIMTAPE	1484	1028	248	1276	208	0	1904	1904	-420	456	-1696	1028	456
1213-0023	Rimtape HPM 20x406/20" vh 9mm 0,95 Decathlon Rimtape HPM 20mm 1180m	RIMTAPE	960	0	2 760	2 760	-1800	0	0	0	960	960	-1800		960
1216-0009	Rimtape HPM 23x622-635/28" vh 9mm 0,9 Rimtape HPM 23mm 1820mm/28"	RIMTAPE	4 543	0	816	816	3 727	0	0	0	4 543	4 543	3 727		816
1216-0016	Rimtape HPM 23x507/24" vh 9mm 0,9 Rimtape HPM 23mm 1470mm/24" vh 9m	RIMTAPE	132	0	279	279	-147	0	0	0	132	132	-147		132
1299-0058	Box Rimtape HPM 20x559/1610mm/26" vh 9mm 0,9	RIMTAPE	922	0	693	693	229	0	0	0	922	922	229		693
1613-0008	Rimtape HPA 27,5" 27x584/ 1690mm/ 1,15mm/ vhØ 7mm	RIMTAPE	156	0	504	504	-348	0	504	504	-348	156	-852		156
1709-0003	Rimtape HPP 16x622-635/28" vh 7mm 1,5 Rimtape HPP 16mm 1800mm/28" vh	RIMTAPE	238	0	0	0	238	0	376	376	-138	238	-138		238
1713-0001	Rimtape HPP 20x622-635/28" vh 9mm 1,5 Rimtape HPP 20mm 1800mm/28" v	RIMTAPE	3 044	1764	2 980	4 744	-1700	0	0	0	3 044	1280	-1700	1764	1280
1715-0001	Rimtape HPP 22x622-635/28" vh 9mm 1,5 Rimtape HPP 22mm 1800mm/28" v	RIMTAPE	128	0	220	220	-92	0	0	0	128	128	-92		128
1715-0004	Rimtape HPP 22x622-635/28" vh 7mm 1,5 Rimtape HPP 22mm 1800mm/28" v	RIMTAPE	1364	236	1200	1436	-72	0	0	0	1364	1128	-72	236	1128
2001-0006	Grip 2 110mm pvc70 black Ø22mm Classic	GRIP	163	0	140	140	24	0	0	0	163	163	24		140
2001-0008	Grip 4 pvc70 black Ø22mm	GRIP	64	0	172	172	-108	0	0	0	64	64	-108		64
2004-0003	Grip 45B 130mm tpe30 black Ø22mm Classic	GRIP	392	0	379	379	13	0	0	0	392	392	13		379
2004-0225	Grip 90A 90mm tpe45 darkbrown PMS4695 Ø22mm Comfort	GRIP	180	0	825	825	-645	0	0	0	180	180	-645		180

FIGURE 13. Sales from the Inventory

Deductions are made for inventory value at a standard cost, which is sold from the inventory, from the standard cost of the total sales of the month to determine the production need for the current and subsequent months. The cumulative standard cost of sales from inventory from the current month until year-end is then subtracted from the inventory/stock of the previous month to calculate the projected stock for future periods, aiding in predicting the company's stock levels moving forward.

After determining the production requirements, the next step is to plan the production schedule for these goods. Typically, 50% of the current month's production needs are manufactured within that same month, while 50% of the next month's production needs are also produced during the current month. These percentages may vary at times and are planned together with the production director. Combining two months' production needs, one derives the actual production need for the month. This process is shown in FIGURE 14.

While doing the production planning, extra care needs to be taken to make sure that the sales for any particular month are 100% covered by the production plan. This is found in the Grand Total row under each month in the table, which shows the percentual production number in FIGURE 14. Only the first and last month of the year will have a lower than 100% value.

The Stock Total row in FIGURE 14 gives the absolute value of Production of Finished Goods. The last row of FIGURE 14 also caters to the projected stock value in the future.

OTHER	INV €	INV €	INV €	INV €	INV €	INV €	INV €	INV €	INV €	INV €	INV €	INV €	INV €	INV €
	Jan.23	Feb.23	Mar.23	Apr.23	May.23	Jun.23	Jul.23	Aug.23	Sep.23	Oct.23	Nov.23	Dec.23	Jan.24	Feb.24	Mar.24
STOCK VALUE	372 191	329 096	290 896	307 357	268 069	271 371	263 118	271 090	297 657	270 920	0	0	0	0	0
From inv to sale €		43 095	38 200	-16 461	39 288	-3 302	8 253	-7 972	-26 566	26 736	3 327	1 400	0	0	0
Remining stock	**927 350**	**329 096**	**290 896**	**307 357**	**268 069**	**271 371**	**263 118**	**271 090**	**297 657**	**270 920**	**267 593**	**266 193**	**266 193**	**266 193**	**266 193**
Production Need		155 260	96 735	87 188	134 220	131 754	36 494	58 154	67 136	110 170	24 245	80 944	44 202	64 382	78 581
MAT COST FOR PRD	0	143 420	89 359	80 766	124 333	122 049	33 805	53 870	62 190	102 001	22 448	74 942	40 925	59 608	72 755
WRK COST FOR PRD	0	11 840	7 377	6 423	9 887	9 706	2 688	4 284	4 945	8 169	1 798	6 002	3 277	4 774	5 827

Sales Month →	PRD	PRD	PRD	PRD	PRD	PRD	PRD	PRD	PRD	PRD	PRD	PRD	PRD	TOTAL
Production month ↓	Jan.23	Feb.23	Mar.23	Apr.23	May.23	Jun.23	Jul.23	Aug.23	Sep.23	Oct.23	Nov.23	Dec.23	Jan.24	PER MONTH
Jan.23	50%	50%												100%
Feb.23		50%	50%											100%
Mar.23			50%	70%										120%
Apr.23				30%	50%									80%
May.23					50%	50%								100%
Jun.23						50%	50%							100%
Jul.23							50%	50%						100%
Aug.23								50%	50%					100%
Sep.23									50%	50%				100%
Oct.23										50%	50%			100%
Nov.23											50%	50%		100%
Dec.23												50%	50%	100%
Grand Total	**50%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**50%**	**1200%**

Sales Month →	MAT€	MAT€	MAT€	MAT€	MAT€	MAT€	MAT€	MAT€	MAT€	MAT€	MAT€	MAT€	MAT€	TOTAL	
Production month ↓	Jan.23	Feb.23	Mar.23	Apr.23	May.23	Jun.23	Jul.23	Aug.23	Sep.23	Oct.23	Nov.23	Dec.23	Jan.24	PER MONTH	
Jan.23	0	71 710	0	0	0	0	0	0	0	0	0	0	0	71 710	
Feb.23	0	71 710	44 679	0	0	0	0	0	0	0	0	0	0	116 389	
Mar.23	0	0	44 679	56 536	0	0	0	0	0	0	0	0	0	101 215	
Apr.23	0	0	0	24 230	62 166	0	0	0	0	0	0	0	0	86 396	
May.23	0	0	0	0	62 166	61 024	0	0	0	0	0	0	0	123 191	
Jun.23	0	0	0	0	0	61 024	16 903	0	0	0	0	0	0	77 927	
Jul.23	0	0	0	0	0	0	16 903	26 935	0	0	0	0	0	43 838	
Aug.23	0	0	0	0	0	0	0	26 935	31 095	0	0	0	0	58 030	
Sep.23	0	0	0	0	0	0	0	0	31 095	51 001	0	0	0	82 096	
Oct.23	0	0	0	0	0	0	0	0	0	51 001	11 224	0	0	62 225	
Nov.23	0	0	0	0	0	0	0	0	0	0	11 224	37 471	0	48 695	
Dec.23	0	0	0	0	0	0	0	0	0	0	0	37 471	20 462	57 933	
Grand Total	**0**	**143 420**	**89 359**	**80 766**	**124 333**	**122 049**	**33 805**	**53 870**	**62 190**	**102 001**	**22 448**	**74 942**	**20 462**	**929 646**	**-20 462**

Sales Month →	WRK€	WRK€	WRK€	WRK€	WRK€	WRK€	WRK€	WRK€	WRK€	WRK€	WRK€	WRK€	WRK€	TOTAL	
Production month ↓	Jan.23	Feb.23	Mar.23	Apr.23	May.23	Jun.23	Jul.23	Aug.23	Sep.23	Oct.23	Nov.23	Dec.23	Jan.24	PER MONTH	
Jan.23	0	5 920	0	0	0	0	0	0	0	0	0	0	0	5 920	
Feb.23	0	5 920	3 688	0	0	0	0	0	0	0	0	0	0	9 608	
Mar.23	0	0	3 688	4 496	0	0	0	0	0	0	0	0	0	8 184	
Apr.23	0	0	0	1 927	4 944	0	0	0	0	0	0	0	0	6 870	
May.23	0	0	0	0	4 944	4 853	0	0	0	0	0	0	0	9 796	
Jun.23	0	0	0	0	0	4 853	1 344	0	0	0	0	0	0	6 197	
Jul.23	0	0	0	0	0	0	1 344	2 142	0	0	0	0	0	3 486	
Aug.23	0	0	0	0	0	0	0	2 142	2 473	0	0	0	0	4 615	
Sep.23	0	0	0	0	0	0	0	0	2 473	4 084	0	0	0	6 557	
Oct.23	0	0	0	0	0	0	0	0	0	4 084	899	0	0	4 983	
Nov.23	0	0	0	0	0	0	0	0	0	0	899	3 001	0	3 900	
Dec.23	0	0	0	0	0	0	0	0	0	0	0	3 001	1 639	4 640	
Grand Total	**0**	**11 840**	**7 377**	**6 423**	**9 887**	**9 706**	**2 688**	**4 284**	**4 945**	**8 169**	**1 798**	**6 002**	**1 639**	**74 757**	**-1 639**

OTHER	LT MAT€	LT MAT€	LT MAT€	LT MAT€	LT MAT€	LT MAT€	LT MAT€	LT MAT€	LT MAT€	LT MAT€	LT MAT€	LT MAT€	TOTAL	
	Jan.23	Feb.23	Mar.23	Apr.23	May.23	Jun.23	Jul.23	Aug.23	Sep.23	Oct.23	Nov.23	Dec.23	YEAR	
Material cost	71 710	116 389	101 215	86 396	123 191	77 927	43 838	58 030	82 096	62 225	48 695	57 933	929 646	**0**
Work Cost	5 920	9 608	8 184	6 870	9 796	6 197	3 486	4 615	6 557	4 983	3 900	4 640	74 757	**0**
TO STOCK TOTAL	77 630	125 998	109 400	93 266	132 987	84 124	47 324	62 645	88 653	67 208	52 595	62 573	1 004 403	**1 004 403**

STOCK BALANCE	372 191	329 096	290 896	313 435	272 915	228 586	231 163	243 626	291 710	222 011	247 033	227 262		

FIGURE 14. Production of Finished Goods Forecast: Product Group Other

By multiplying the Material Cost % of Finished Goods with the Production of Finished Goods, raw material used in production is derived.

All previously available information can be summarized to determine the Change in raw material, as outlined in FIGURE 15. To the highest level, this month's end balance of raw material is subtracted from the previous month's end balance. To predict this month's end balance, one begins with the previous month's end balance and adjust it by adding the new purchases while subtracting the raw material consumed in production. The sourcing team provides the forecast for new purchases.

To forecast the raw material consumed in production, one first calculates the production requirements and then plans the production schedule for the current and upcoming months, eventually arriving at the actual production needs for the forecasted month. The material cost as a percentage of sales is derived from the previous month's sales report, which is also converted to a percentage of the standard cost. Applying the material cost percentage of the standard cost to the production requirements to estimate the potential raw material consumption.

TOTAL Inventory	MAT €	MAT €	MAT €	MAT €	MAT €	MAT €	MAT €	MAT €	MAT €	MAT €	MAT €	MAT €	TOTAL
2023	Jan.23	Feb.23	Mar.23	Apr.23	May.23	Jun.23	Jul.23	Aug.23	Sep.23	Oct.23	Nov.23	Dec.23	YEAR
PURCHASE INPUT	852 915	754 775	887 935	517 964	578 247	1 147 712	147 660	807 643	336 669	495 526	400 499	257 141	7 184 684
Purchases Raw Material	*624 795*	*667 126*	*322 010*	*997 380*	*595 042*	*197 378*	*660 094*	*577 804*	*374 930*	*313 044*	*346 688*	*570 193*	6 246 484
Used Raw material	-300 309	-624 795	-667 126	-322 010	-997 380	-595 042	-197 378	-660 094	-577 804	-374 930	-313 044	-346 688	-5 976 599
Raw Material BAL	**4 039 539**	***4 169 520***	***4 390 329***	**4 586 283**	**4 167 150**	**4 719 821**	**4 670 102**	**4 817 650**	**4 576 515**	**4 697 110**	**4 784 566**	**4 695 018**	**5 903 103**
CHANGE IN RAW MAT		129 981	220 809	195 953	-419 133	552 671	-49 719	147 548	-241 136	120 596	87 455	-89 547	

FIGURE 15. Changes in Raw Material

The third step of forecasting material cost includes predicting changes in finished goods, as outlined in FIGURE 6. This requires understanding the new finished goods sold from inventory, sold from new finished goods.

Goods that have been fully processed, completed all manufacturing stages, and ready to be sold to customers are called finished goods. These goods do not require further processing. (Ciuhureanu & Baltes 2012, 72.)

The current month-end value of finished goods is subtracted from the previous month-end balance to calculate the change in Finished Goods. As raw materials are transformed into finished goods during production, they consume raw materials, machine time, and labour hours. Increasing the production of finished goods raises inventory value, which decreases when items are sold. Throughout the month, sales can stem from either existing inventory (goods produced in previous months) or newly

manufactured items. Both must be subtracted from the previous month's inventory, and new finished goods produced during the month should be added to it to determine the new month-end value of finished goods. The formula for "This month-end balance of finished goods" can be found in FIGURE 16. "This month-end balance of finished goods" refers to the inventory value of finished goods at the end of the current month or the month for which Herrmans is doing the forecast in the future. All the calculations are done at standard cost.

FIGURE 16. Change in Finished Goods

The forecast for new finished goods, which is produced within a month, involves combining the raw material utilized in production with the capacity needed to transform the raw material into the finished product. To predict the new finished goods, the raw material used in production is summed up with the capacity used in production.

The methods for predicting the raw material used in production are detailed in the section where the forecast of Raw material used in Production is explained above. The cost of capacity used in production also needs to be predicted and added to determine the value of the new finished goods.

The calculation for capacity used in production involves multiplying the Production of Finished Goods by the capacity % of finished goods. The capacity % of finished goods is derived during the calculation of the material cost % of finished goods, which necessitates the computation of standard cost. Essentially, the data required for work cost as a percentage of sales, found in the LEAN ERP system's "Invoice Row Browser --All--105" report, is used to determine the work cost as a percentage of the standard cost. This metric, known as Capacity Cost % of Finished Goods, represents the work cost as a percentage of the standard cost.

Ultimately, the value of New Finished Goods is determined by adding both the raw material used in production and the capacity used in production. This sum is then combined with the Previous month-end balance of finished goods, as new finished goods contribute to the overall value of finished goods in the inventory. Throughout the month, the inventory decreases as some sold items are depleted from the inventory, which is deducted from the previous sum.

As items sold from inventory deplete the inventory value, they need to be deducted from the inventory. While calculating the Production of Finished Goods (FIGURE 13) as above, Sales from the inventory are derived, which is renamed as sold from inventory. It is deducted from the previous month's inventory value to get the month-end value of the inventory.

Essentially, sales from the inventory are computed by comparing each item's value in the inventory against the anticipated future sales from confirmed and forecasted orders, information that is accessible in the LEAN ERP system. If the sum of confirmed and forecasted orders for the month surpasses the value of items in the current inventory, the entire inventory value is assigned to sales for that month. Otherwise, the total value of the aggregated orders is designated as sales derived from inventory for that month, leading to a corresponding reduction in inventory.

Once the occurrence of sold from Inventory is established, calculating sold from newly finished Goods becomes straightforward. This involves a simple subtraction of "Sold from inventory" from the total standard cost of sales for the month. The total standard cost of the month is determined by multiplying the month's sales by the material cost percentage of sales and the work cost percentage of sales and then adding these two values together. The method for obtaining the material cost percentage of sales and work cost percentage of sales is detailed in forecasting the material cost % of finished goods above. The formula used in this process is outlined below:

Sold from new finished goods = Current month sales x (Material cost % of sales + Work cost% of sales) - Sold from inventory

After deriving the values for "New Finished Goods", "Sold from Inventory," and "Sold from New Finished Goods," the "This month-end balance of finished goods" can be calculated. This is achieved by adding "New Finished Goods" to the "Previous month-end balance of finished goods" and then subtracting both "Sold from Inventory" and "Sold from New Finished Goods" from this sum. Subsequently, the calculation for "Changes in Finished goods" is then obtained by subtracting the "This month-end balance" from the "Previous month-end balance". This is presented in FIGURE 17.

TOTAL Inventory	MAT €	MAT €	MAT €	MAT €	MAT €	MAT €
2023	Jan.23	Feb.23	Mar.23	Apr.23	May.23	Jun.23
PURCHASE INPUT	**852 915**	**754 775**	**887 935**	**517 964**		
Purchases Raw Material	*624 795*	*667 126*	*322 010*	*997 380*		
Used Raw material	-300 309	-624 795	-667 126	-322 010		
Raw Material BAL	**4 039 539**	***4 169 520***	***4 390 329***	**4 586 283**	**4 167 150**	**4 719 821**
CHANGE IN RAW MAT		**129 981**	**220 809**	**195 953**	**-419 133**	**552 671**
New Finished goods	1 461 352	827 313	890 474	407 918		
Sold from New Fin Goods		-779 654	-874 973	-647 125		
Sold from inventory		-395 623	-290 554	-149 788		
Finished goods BAL	**3 438 917**	**3 090 954**	**2 815 902**	**2 426 907**	**2 569 554**	**2 317 914**
CHANGE IN FINNISH GOODS		**-347 963**	**-275 052**	**-388 995**	**142 647**	**-251 640**

FIGURE 17. Change in Finnished Goods Summary

The last step in calculating material cost is to predict obsolete inventory, as outlined in FIGURE 6. Outdated stocks refer to goods that have lost their quality, properties, or relevance, making them difficult to sell at regular prices or at all. This type of inventory poses challenges as companies must either dispose of them properly or sell them at significantly reduced prices. They linger longer in the stock due to poor sales, inferior quality, low market value, seasonal fluctuations, or outdated technology. Poor forecasting, errors in judgment, mismanagement, or reckless buying of raw materials often result in excess and obsolete inventory. To operate successfully, companies need strategies to prevent overstocking and manage obsolete inventory effectively. It's crucial to have plans in place to either avoid creating excess stock or to handle it appropriately when it occurs. (Halilović 2022, 2.)

The process of assessing surplus inventory and evaluating the risk of obsolete items is carried out routinely monthly. Attempting to forecast obsolete items a year in advance involves a high degree of speculation. Many variables, such as the actual future sales of specific items, remain unknown until closer

to the month in question. Consequently, forecasting excess inventory and accounting for obsolete items occur at a broader level rather than on an individual item basis.

To estimate future obsolete inventory, an average of the past year's obsolete inventory as a percentage of the total inventory value at standard cost (before deducting obsolete items) is applied to the projected future inventory value at standard cost (before deducting obsolete items). This calculation yields the anticipated value of future obsolete inventory.

Increases in obsolete inventory have a direct impact on the Cost of Goods Sold (COGS). When the amount of obsolete inventory rises, it reduces the overall inventory value. As a result, this leads to an increase in material costs and a decrease in EBITDA.

TOTAL Inventory	MAT €	MAT €	MAT €	MAT €	MAT €	MAT €
2023	Jan.23	Feb.23	Mar.23	Apr.23	May.23	Jun.23
PURCHASE INPUT	852 915	754 775	887 935	517 964		
CHANGE IN RAW MAT		129 981	220 809	195 953		
CHANGE IN FINNISH GOODS		-347 963	-275 052	-388 995		
OBS INV 6~7%	-418 667	-359 431	-357 589	-403 899		
TOTAL INV BAL	7 059 790	6 901 043	6 848 642	6 609 290		
OBS as % of total Inv.	-5,6%	-5,0%	-5,0%	-5,8%	-6,8%	-6,6%

FIGURE 18. Obsolete Inventory Forecast

Resource utilization prediction is an outcome of the new model. Once "Capacity used in production" (New Finished Goods) is determined, it can be compared to the total available capacity to adjust operations and manage labour utilization efficiently. The unused capacity can be quantified by subtracting the "Capacity Used in Production" from the total capacity cost in the income statement (represented as IS Capacity). This hurts EBITDA. Addressing this issue can involve increasing production or reducing operational costs by laying off personnel temporarily or permanently.

An example from the new model is presented in FIGURE 19, where the Work Cost "Grand Total" is deducted from the "IS Capacity" row to derive the "Unused Capacity". This unused capacity is a crucial metric to control the performance of the business. The business aims to minimize the unused capacity so that EBITDA and gross margin can be improved.

WORK COST	MAT €	MAT €	MAT €	MAT €	MAT €	MAT €
2023	Jan.23	Feb.23	Mar.23	Apr.23	May.23	Jun.23
LIGHTS	[redacted]					
GRIP	[redacted]					
REFL	[redacted]					
RIMTAPE	[redacted]					
CHNG	[redacted]					
NORDIC	[redacted]					
OTHER	5 920	9 608	8 184	6 870	9 796	6 197
Grand Total	**89 518**	**202 519**	**223 348**	**85 908**	**303 319**	**226 866**
EFFICIENCY	CAP€	CAP€	CAP€	CAP€	CAP€	CAP€
2023	Jan.23	Feb.23	Mar.23	Apr.23	May.23	Jun.23
IS CAPCITY	577 962	529 649	429 429	380 820	425 397	438 877
UNUSED CAPACITY	0	-327 131	-206 081	-294 912	-122 078	-212 011

FIGURE 19. Capacity Utilization

The prediction of Material cost (excluding Freight, import duties, electricity, & currency difference) can be made by totalling the Purchase of material, Change in Raw Materials, Change in Finished Goods, and Change in Obsolete Inventory. Purchasing materials contributes to an increase in material cost. Conversely, an increase in the change of raw material and finished goods decreases the material cost, while a decrease in these factors increases the material cost. Additionally, an increase in obsolete inventory raises the material cost, whereas a decrease reduces it.

TOTAL Inventory	MAT €	MAT €	MAT €
2023	Jan.23	Feb.23	Mar.23
PURCHASE INPUT	**852 915**	**754 775**	**887 935**
Purchases Raw Material	*624 795*	*667 126*	*322 010*
Used Raw material	-300 309	-624 795	-667 126
Raw Material BAL	**4 039 539**	***4 169 520***	***4 390 329***
CHANGE IN RAW MAT		**129 981**	**220 809**
New Finished goods	1 461 352	827 313	890 474
Sold from New Fin Goods		-779 654	-874 973
Sold from inventory		-395 623	-290 554
Finished goods BAL	**3 438 917**	**3 090 954**	**2 815 902**
CHANGE IN FINNISH GOODS		**-347 963**	**-275 052**
OBS INV 6~7%	**-418 667**	**-359 431**	**-357 589**
TOTAL INV BAL	**7 059 790**	**6 901 043**	**6 848 642**
OBS as % of total Inv.	-5,6%	-5,0%	-5,0%
Capacity utilization	0	-327 131	-206 081
MATERIAL COST Excluding	**-1 271 582**	**-913 521**	**-940 336**
Material cost %		**-43,4%**	**-45,4%**

FIGURE 20. Material Cost (Excluding freight, imports, etc.) Summary

With these steps completed, pure material cost, which includes raw materials and finished goods, can be predicted. However, material cost includes other costs. These need to be predicted differently.

4.2.5 Other Variable Cost Excluding Direct Material Cost

A detailed flowchart for predicting additional material costs is endorsed in FIGURE 21. These expenses do not belong to the cost of materials or labour used to produce finished goods; rather, they are incurred to bring material into use. A variable expense is labelled as dependent when its value correlates to an independent variable. Dependent variables are analyzed based on the assumption or requirement that they are determined by some law or rule (such as a mathematical function) according to the values of other variables. On the contrary, independent variables are not considered to be correlated to any other variable within the context of the specific experiment being conducted. (Dependent and independent variables 2024.)

All these other variable expenses are recorded in the period when they occur. The most reliable approach discovered was to use a multiplier to estimate the cost. This multiplier is applied to an independent variable to determine the dependent variable. Each category of the dependent variable is associated with one of the four available independent variables. Like the percentage of sales technique, the sum of the dependent variable for the year-to-date period is divided by the sum of the independent variable for the same period to calculate the multiplier. This multiplier is then applied to the independent variable for the month to forecast the dependent variable. The four independent variables identified are the Sales, Purchase of Material, New Finished Goods, and Variable Salary total.

Furthermore, certain variable costs are intrinsic to the production process and are not influenced by other variables. These costs, including expenses like rent, leasing agreements, and testing for research and development, are indispensable to producing goods. Hence, they are categorized as variable costs. These costs are projected based on either the actual contracts associated with costs such as rent and leasing or from historical averages for research and development tests.

FIGURE 21 is a comprehensive flow chart that includes all the formulas. These formulas and connections aid in comprehending the interplay between dependent and independent variables.

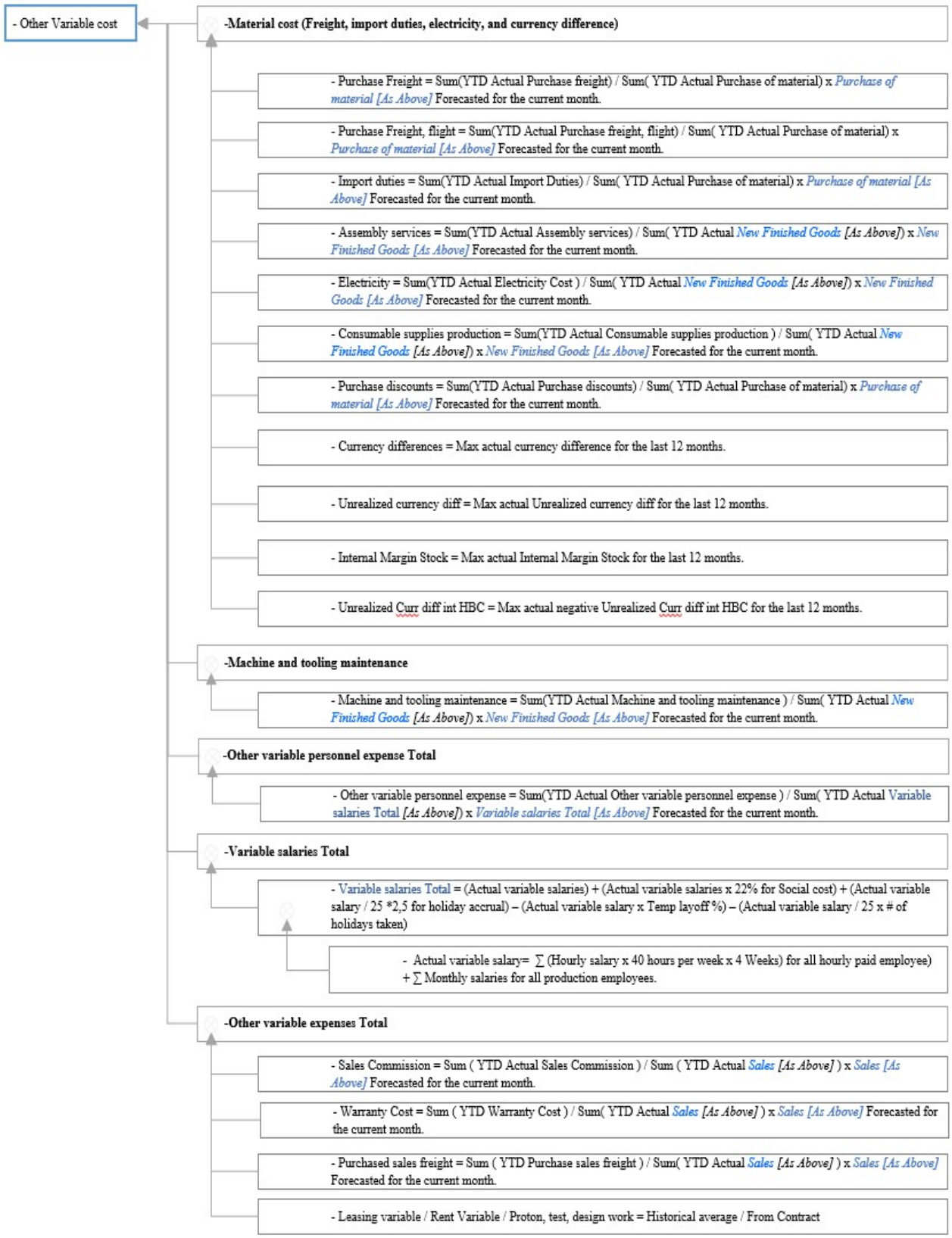
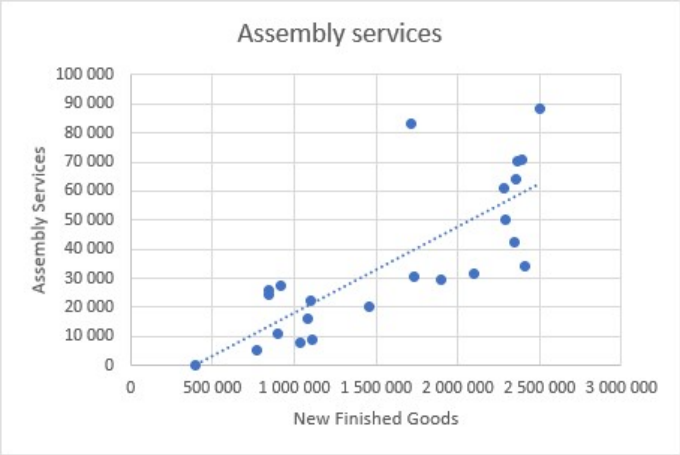


FIGURE 21. Other Variable Cost Prediction

Assembly Services, Electricity, Consumable Supplies Production, and Machine and Tooling Maintenance are the dependent variables. These depend on the independent variable New Finished Goods (from above).

The cost of assembly services refers to the expenses incurred from outsourcing assembly work. This cost rises with increased volume and when internal capacity is fully utilized. Due to a strong positive correlation between assembly service and new finished goods, assembly services are calculated as the ratio of the year-to-date actual assembly services to the year-to-date actual new finished goods, multiplied by the forecasted new finished goods for the current month.



	New Finished Goods	*Assembly services*
New Finished Goods	1	
Assembly services	0,79	1

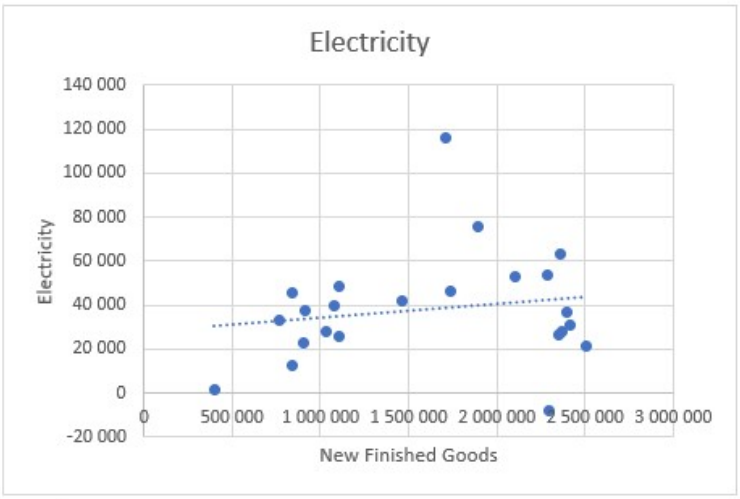
FIGURE 22. Assembly Service Correlation

The cost of assembly services refers to the expenses incurred from outsourcing assembly work. This cost rises with increased volume and when internal capacity is fully utilized. Due to a strong positive correlation between assembly service and new finished goods, assembly services are calculated as the ratio of the year-to-date actual assembly services to the year-to-date actual new finished goods, multiplied by the forecasted new finished goods for the current month. The correlation is presented in FIGURE 22.

Products are manufactured through the conversion of raw materials using injection molding machines, which consume electricity. Additionally, the factory requires a substantial base load for heating or cooling purposes. However, during the analysis, it was observed that there is a weaker correlation between electricity consumption and New Finished Goods when production volume is low. Conversely,

a strong negative correlation was found when the factory produced a high volume exceeding 1.8 million euros worth of finished goods at standard cost, which is presented in FIGURE 23.

This suggests that there is a baseline electricity requirement that remains consistent, resulting in constant electricity costs at lower production volumes. However, as production volume increases beyond 1.8 million euros, the following method becomes useful. The calculation for electricity cost involves dividing the year-to-date actual electricity cost by the year-to-date actual new finished goods and then multiplying it by the forecasted new finished goods for the current month. However, it is noted that this requires some change and needs to keep the cost to a fixed level until the volume reaches the 1,8 MEUR level.



	New Finished Goods	*Electricity*
New Finished Gooc	1	
Electricity	0,17	1

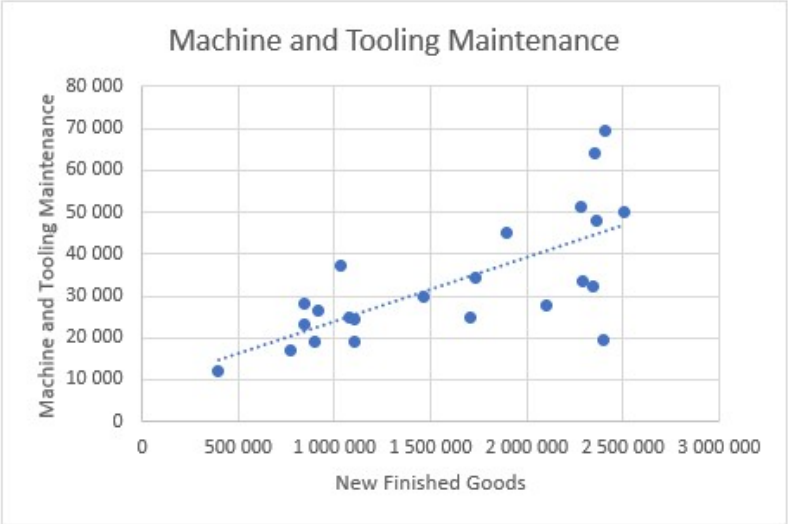
	Sales	*Electricity*
Sales	1	
Electricity	0,24	1

High volume	*New Finished Goods*	*Electricity*
New Finished Gooc	1	
Electricity	-0,78	1

FIGURE 23. Electricity Correlation

As production volume increases, the load on machines and tools increases, too. This results in higher wear and tear and requires higher maintenance. This hypothesis is also evident by a high degree of positive correlation, which is presented in FIGURE 24. Machine and tooling maintenance costs are calculated by dividing the year-to-date actual expenses for machine and tooling maintenance by the

year-to-date actual new finished goods and then multiplying this ratio by the forecasted new finished goods for the current month.

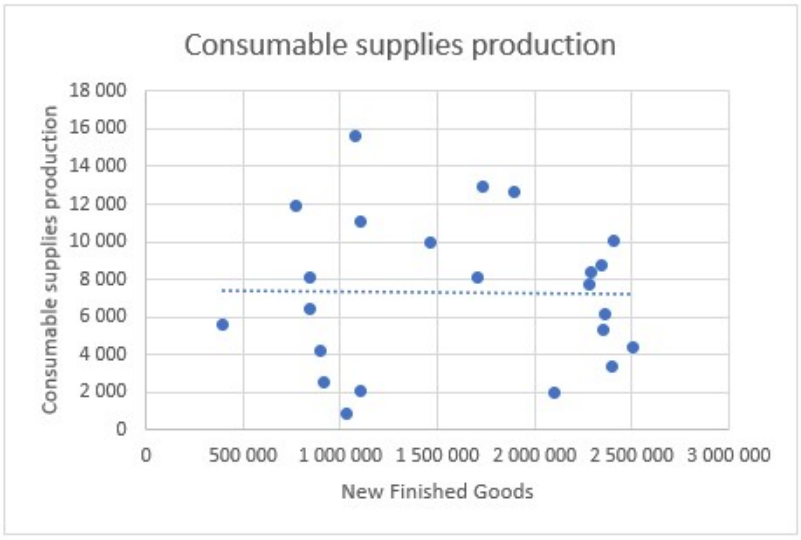


	New Finished Goods	*Machine and Tooling Maintenance*
New Finished Goods	1	
Machine and Tooling Maintenance	0,69	1

FIGURE 24. Machine and Tooling Maintenance Correlation

Consumables are supplies essential for production, such as machine oil in factories. Unlike raw materials, consumables are not integrated into the final product or service but are crucial for the production process. It can be challenging to precisely measure the quantity of consumables used in manufacturing each product. (Raw Materials and consumables (n.d.).)

As stated above, there is very little correlation between any other independent variable in forecasting for this variable, which is presented in FIGURE 25. The calculation for consumable supplies used in production is determined by dividing the year-to-date actual consumable supplies production by the year-to-date actual new finished goods, then multiplying this ratio by the forecasted new finished goods for the current month. This certainly requires an improvement as little correlation is found, and keeping the cost forecast fixed based on an average historical trend will be a better method of doing this cost forecast in the future.

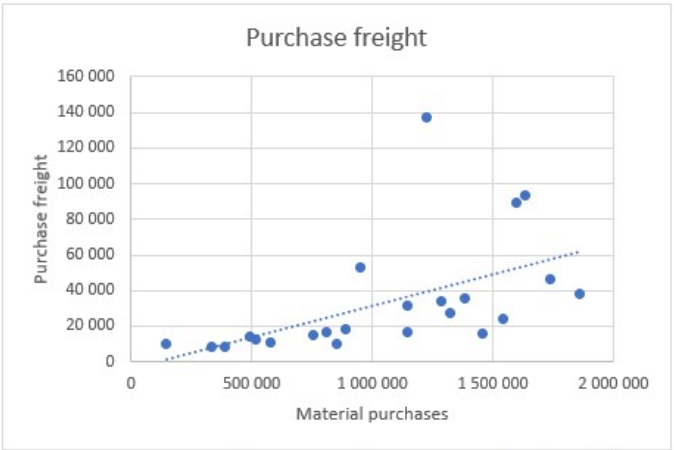


	New Finished Goods	*Consumable supplies production*
New Finished Gooc	1	
Consumable suppli	-0,0095	1

	Sales	*Consumable supplies production*
Sales	1	
Consumable suppli	0,055	1

FIGURE 25. Consumable Supplies Production Correlation

Purchase freight, purchase freight flights, import duties, and purchase discounts are expected to be dependent on the purchasing of raw materials. Purchase discounts have very little data available. Hence, this is considered insignificant for this new model.

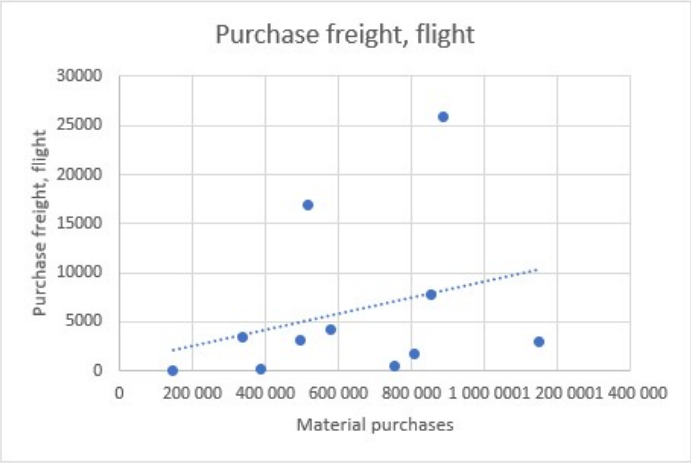


	Material purchases	*Purchase freight*
Material purchases	1	
Purchase freight	0,53	1

FIGURE 26. Purchase Freight Correlation

Freight expense is the cost charged by carriers for transporting cargo from the source to the destination. It is paid by the party requesting the transport and varies based on the mode of transportation, like a ship, airplane, train, or truck, as well as the cargo weight. Factors affecting freight costs include fuel prices, demand for shipping services, emerging events like piracy affecting routes and security costs, and government regulations impacting transport operations. Businesses record freight expenses in their financial books under general expenses, considering factors such as who pays the cost. (Freight expense 2024.)

A moderate level of positive correlation to the Material Purchased is presented in FIGURE 26. The calculation for purchase freight forecast is derived by dividing the year-to-date actual expenditure on purchase freight by the year-to-date actual purchase of material, then multiplying this ratio by the forecasted purchase of material for the current month.



	Material purchases	*Purchase freight, flight*
Material purchases	1	
Purchase freight, flight	0,292467607	1

FIGURE 27. Purchase Freight, Flight Correlation

Costs related to purchase freight and flights are incurred when materials are transported via air due to urgency. Although there are limited available data and minimal positive correlation is found, it is logical to consider these costs dependent on purchasing volume. Hence, Material Purchase is utilized as the independent variable. The correlation is presented in FIGURE 27. The calculation for purchase freight and flight involves dividing the year-to-date actual expenditure on these costs by the year-to-date actual purchase of material, then multiplying this ratio by the forecasted purchase of material for the current month.

There are two types of payment methods for salary. One is an hourly salary payment based on hourly rate and actual hours worked, and the other is a monthly fixed salary. Actual variable salary is the salary payable to the production employees before taking into consideration holidays and temporary lay-off. This cost is charged to the income statement as it occurs.

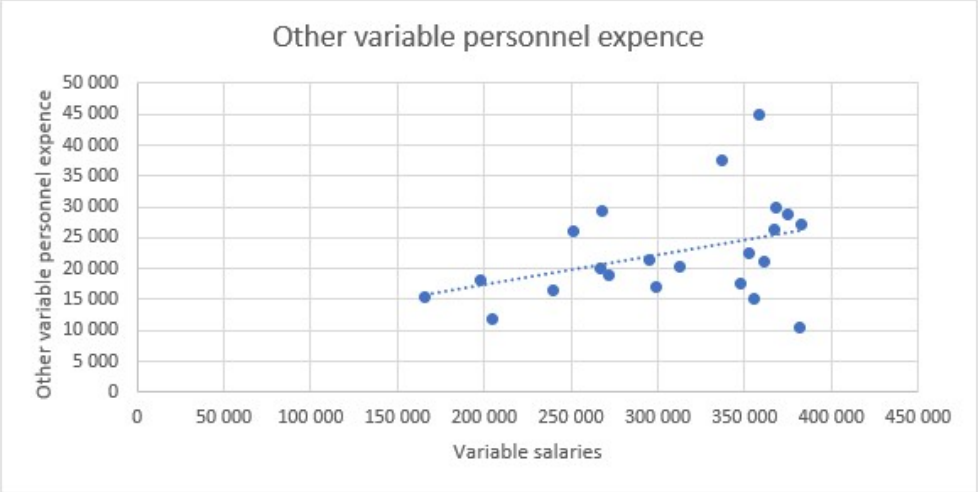
The actual variable salary is calculated as the sum of hourly salary multiplied by 40 hours per week multiplied by four weeks for all hourly-paid employees, plus the sum of monthly salaries for all production employees. This is the first step. All holidays, social costs, and lay-off costs need to be adjusted to this salary cost to derive the total cost to the company. 25 Days was considered the total number of holidays available to the production workers, and the social cost was 22%. Every month 2,5 days' worth of salary for the holiday is accrued for. The calculation for salary cost can be expressed as the formula below.

Variable salaries Total = (Actual variable salaries) + (Actual variable salaries x 22% for Social cost) + (Actual var-iable salary / 25 *2,5 for holiday accrual) – (Actual variable salary x Temp layoff %) – (Actual variable salary / 25 x # of holidays taken)

Actual variable salary= ∑ (Hourly salary x 40 hours per week x 4 Weeks) for all hourly paid employees) + ∑ Monthly salaries for all production employees.

Expenses such as workplace healthcare, cuisine expenses, personnel education, workwear and protection, personnel recreation, Tyky benefits, coffee expenses, and other related costs are expected to be dependent on variable salary costs. However, there is limited evidence from the data to support this hypothesis. These costs are forecasted collectively as "Other variable personnel expenses".

The calculation for these expenses involves dividing the year-to-date actual expenditure on them by the year-to-date actual total variable salaries, then multiplying this ratio by the forecasted total variable salaries for the current month. The result of the search to find an independent variable is presented in FIGURE 28, which shows very little correlation to variable salaries. A better method of forecasting these should be explored further.



	Variable salaries	*Other variable personnel expence*
Variable salaries	1	
Other variable pers	0,38	1

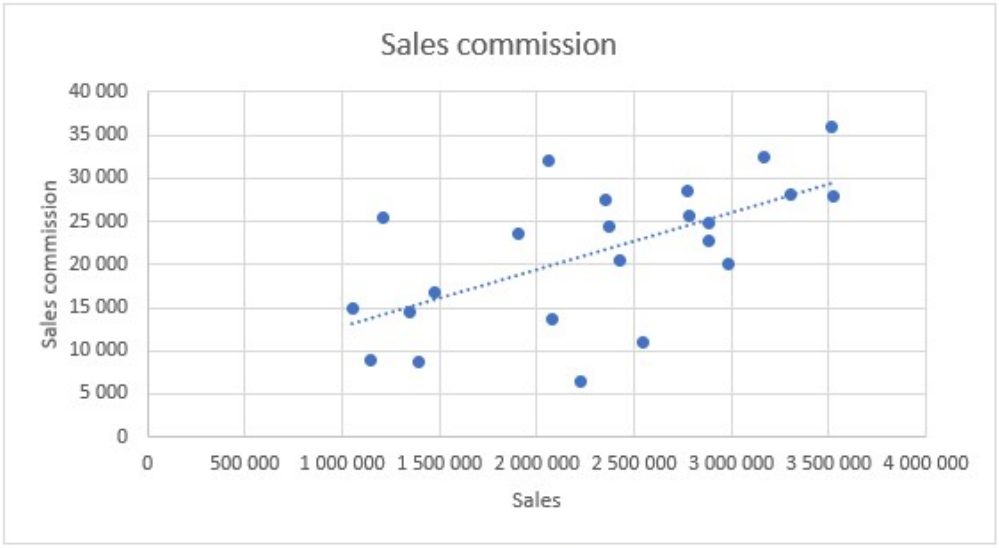
	Sales	*Other variable personnel expence*
Sales	1	
Other variable pers	0,16	1

FIGURE 28. Other Variable Personnel Expense Correlation

Three dependent variables are assumed to be correlated to the independent variable sales. Those are the Sales Commission, Purchase Sales Freight, and Warranty cost.

Sales commissions are disbursed to external sales agents either upon the actual invoicing or upon invoice payment. In both scenarios, a fixed percentage ranging from three to ten percent of the total sales is allocated to the respective agent responsible for generating the sales. Since the commission is based on sales figures, there exists a moderate level of positive correlation with sales performance. This is presented in FIGURE 29.

However, not all sales transactions are conducted through agents, and commission payouts do not always align with sales transactions but may be tied to invoice payment timelines. Hence, it is expected that the correlation may not be one-to-one. The calculation for Sales Commission in the current month involves dividing the total Year-to-Date (YTD) Actual Sales Commission by the total YTD Actual Sales and then multiplying this ratio by the forecasted Sales for the current month.



	Sales	*Sales commission*
Sales	1	
Sales commission	0,62	1

FIGURE 29. Sales Commission Correlation

Purchase Sales Freight represents the cost of transportation of goods to the customer. This is akin to the Purchase Freight Cost, but it is incurred when shipping goods to customers rather than when receiving goods from suppliers. If customers place orders higher than a certain volume at a time, according to company policy, they will be eligible for incoterm CIP.

Insurance in trading includes the practice of Carriage and Insurance Paid To (CIP), where the seller covers freight and insurance costs to deliver goods to a designated location. Risk transfers to the buyer upon delivery to the carrier or appointed party. CIP differs from cost, insurance, and freight (CIF), which are commonly used in maritime trade. CIP requires the seller to insure goods for 110% of the contract value, with buyers arranging additional insurance if needed. CIP is part of the Incoterms, a set of trade terms published by the International Chamber of Commerce (ICC) in 2020. (Kenton, 2023.)

This purchase freight cost should have a direct positive correlation to sales, and this is also found to be true, as presented in FIGURE 30. Therefore, the formula for Purchased Sales Freight is calculated by dividing the sum of Year-To-Date (YTD) Purchase Sales Freight by the sum of YTD Actual Sales (as mentioned earlier) and then multiplying it by the Sales Forecast for the current month.

	Sales	*Purchased sales freights*
Sales	1	
Purchased sales freights	0,86	1

FIGURE 30. Purchase Sales Freight Correlation

Warranty Costs refer to the expenses related to refunding, correcting, returning, or replacing defective products or services. These expenses may arise from warranty claims, contractual obligations, legal liabilities, or other sources. (Warranty costs definition (n.d.).)

	Sales	*Warranty cost*
Sales	1	
Warranty cost	0,18	1

FIGURE 31. Warranty Cost Correlation

While one would expect a correlation between sales and warranty, in reality, no such correlation was observed in FIGURE 31. Warranty costs are typically associated with product defects, which can stem from issues in product design, manufacturing, or processes. However, no distinct, independent variables were identified on which warranty costs depended. The formula for Warranty Cost is calculated by dividing the sum of Year-To-Date (YTD) Warranty Costs by the sum of YTD Actual Sales (as mentioned earlier) and then multiplying it by the Sales Forecast for the current month. There should be a further effort to find a more reliable way to predict the warranty cost.

Currency variances (both realized and unrealized) and internal margins for unsold stocks between two companies within the group are forecasted based on management's best knowledge. Additionally, rent, leasing costs, and research and development testing expenses are projected either from relevant contracts or historical averages.

4.2.6 Variable Cost Prediction Summary

The forecasts from "4.2.4 Material Cost (excluding Freight, import duties, electricity, and currency difference)" and "4.2.5 Other Variable Cost Excluding Direct Material Cost" are combined to determine the overall variable cost. The summary is outlined below in FIGURE 32.

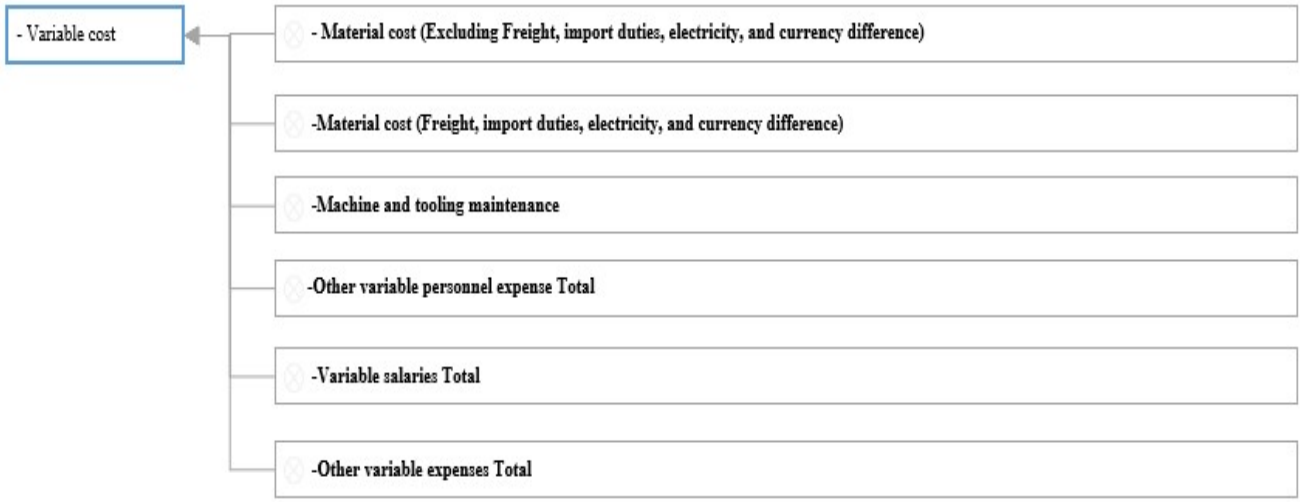


FIGURE 32. Variable Cost Summary

4.3 Fixed Cost Prediction

Fixed costs are business expenses that remain constant regardless of changes in production or sales volume. They typically include recurring expenses like rent. These costs are not directly tied to production. Alongside variable costs, which are directly linked to production, fixed costs make up a company's total expenses. They can impact profitability and are utilized in calculations such as breakeven analysis and operating leverage. (Hayes, 2024.)

The company's fixed costs encompass salaries for management, sales, marketing, R&D support, IT, HR, and finance personnel who are not directly involved in production. Additionally, it covers property-related expenses such as rent and maintenance, IT expenses, audit fees, insurance, and R&D expenditures. Salary calculations and forecasts are based on the number of employees and the relevant legislation in the country where they reside and receive their salaries. The other fixed cost is forecasted based on the budget prepared by each department head. FIGURE 33 describes the formula used and the steps taken to forecast the fixed cost.

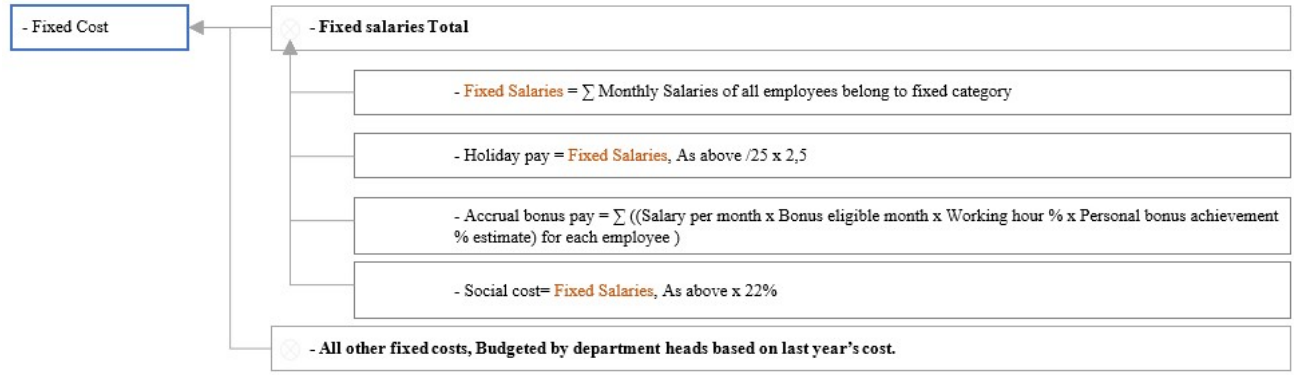


FIGURE 33. Fixed Salary Forecast

4.3.1 Fixed Salary Cost Predictions

Total fixed salaries comprise fixed salaries, holiday pay, accrual bonus pay, and social costs. Fixed salaries are the sum of the monthly salaries of all employees categorized as fixed. Holiday pay is calculated as fixed salaries divided by 25(there are approximately four weeks in a month; six days are considered to be working days in Finland), then multiplied by 2.5. Accrual bonus pay is calculated as the sum of (monthly salary × bonus eligible months × working hour percentage × estimated personal bonus achievement percentage) for each employee. Social costs are calculated as fixed salaries multiplied by 22%. All these are added together to forecast the fixed salary for the month in question.

4.3.2 Other Fixed Cost Predictions

Sum of Amount						Months					
Year	Group	Account	Account Name	CTR #	CTR Name	1	2	3	4	5	6
2023	500 Fixed salaries	500010	Salaries	7050	Bike Sales & Operations support	14 390	15 547	15 701	14 932	10 944	16 186
2023	500 Fixed salaries	500015	Paid bonuses	7050	Bike Sales & Operations support				4 731		
2023	500 Fixed salaries	500020	Holiday pay	7050	Bike Sales & Operations support	2 685	-1 242	3 884	-5 626	1 814	-4 072
2023	500 Fixed salaries	500025	Accrual bonus pay	7050	Bike Sales & Operations support		1 608	-5 693	-3 792		
2023	500 Fixed salaries	505040	Health insurance fees	7050	Bike Sales & Operations support	221	238	241	301	168	248
2023	500 Fixed salaries	505050	Pension insurance employer	7050	Bike Sales & Operations support	3 593	3 881	3 920	4 906	2 735	4 040
2023	500 Fixed salaries	505055	Pension insurance employee	7050	Bike Sales & Operations support	-1 164	-1 258	-1 269	-1 595	-860	-1 275
2023	500 Fixed salaries	505060	Unemployment ins. employer	7050	Bike Sales & Operations support	433	468	472	591	330	487
2023	500 Fixed salaries	505061	Unemployment ins. employee	7050	Bike Sales & Operations support	-216	-234	-236	-296	-165	-243
2023	500 Fixed salaries	505065	Indirect costs, accrued salary	7050	Bike Sales & Operations support	454	618	-634	-2 033	393	-881
2023	500 Fixed salaries	505070	Accident insurance	7050	Bike Sales & Operations support	110	118	42	52	29	43
2023	610 Other fixed personnel expenses	507020	Personnel education	7050	Bike Sales & Operations support			144			
2023	610 Other fixed personnel expenses	507090	Other personnel expenses	7050	Bike Sales & Operations support			50		52	
2023	640 Sales & Marketing	640030	Other selling costs	7050	Bike Sales & Operations support		107	73	73		39
2023	640 Sales & Marketing	640090	Other marketing expenses	7050	Bike Sales & Operations support				63	115	
2023	650 Travel expenses	650000	Travel costs	7050	Bike Sales & Operations support	676		74	3 229		-1 225
2023	650 Travel expenses	650010	Travelling allowance, km allow	7050	Bike Sales & Operations support			167		450	
2023	650 Travel expenses	650090	MasterCard	7050	Bike Sales & Operations support	-746		-138	-3 300	-176	-2 157
2023	660 Administration	660020	Internal meeting expenses	7050	Bike Sales & Operations support	102	342				
2023	660 Administration	660030	IT Leasing and small purchases	7050	Bike Sales & Operations support		296			380	-380
2023	660 Administration	660031	IT Maintenance and annual fees	7050	Bike Sales & Operations support	500	120	500	615	120	-1 735
2023	660 Administration	660032	IT Consultation&ext. services	7050	Bike Sales & Operations support	710		150	1 095		-960
2023 Total						21 747	20 611	17 447	13 948	16 328	8 116
2024	500 Fixed salaries	500010	Salaries	7050	Bike Sales & Operations support	12 536	12 536	12 700	12 700	12 700	12 700
2024	500 Fixed salaries	500015	Paid bonuses	7050	Bike Sales & Operations support	731	731	731	731	731	731
2024	500 Fixed salaries	500020	Holiday pay	7050	Bike Sales & Operations support	1 045	1 045	-1 495	1 045	1 045	1 045
2024	500 Fixed salaries	505050	Pension insurance employer	7050	Bike Sales & Operations support	2 919	2 919	2 919	2 919	2 919	2 919
2024	500 Fixed salaries	505065	Indirect costs, accrued salary	7050	Bike Sales & Operations support						
2024	500 Fixed salaries	505070	Accident insurance	7050	Bike Sales & Operations support	55	55	55	55	55	55
2024	610 Other fixed personnel expenses	507020	Personnel education	7050	Bike Sales & Operations support				300		
2024	610 Other fixed personnel expenses	507090	Other personnel expenses	7050	Bike Sales & Operations support					50	
2024	640 Sales & Marketing	640030	Other selling costs	7050	Bike Sales & Operations support			40			40
2024	640 Sales & Marketing	640090	Other marketing expenses	7050	Bike Sales & Operations support				100		
2024	650 Travel expenses	650000	Travel costs	7050	Bike Sales & Operations support						
2024	650 Travel expenses	650010	Travelling allowance, km allow	7050	Bike Sales & Operations support						
2024	650 Travel expenses	650090	MasterCard	7050	Bike Sales & Operations support						
2024	660 Administration	660020	Internal meeting expenses	7050	Bike Sales & Operations support		200				
2024	660 Administration	660030	IT Leasing and small purchases	7050	Bike Sales & Operations support			150			150
2024	660 Administration	660031	IT Maintenance and annual fees	7050	Bike Sales & Operations support	300	300	300	300	300	300
2024	660 Administration	660032	IT Consultation&ext. services	7050	Bike Sales & Operations support				500		
2024 Total						17 586	17 786	15 400	18 650	17 800	17 940

FIGURE 34. Example and Template for Fixed Cost Budget

The forecasting of all remaining fixed costs follows the budgetary process. At the outset of the year, the budget is formulated using the previous year's expenses as a reference. Department heads receive a fixed-cost budget template, as in FIGURE 34. They subsequently develop a yearly plan, which is integrated into the new forecasting model. Throughout the year, these expenses are closely monitored, and if it becomes apparent that costs will exceed the budgeted amount, corrective actions are implemented to align costs with the budget.

The fixed cost comprises approximately 20% of total sales, divided equally into 10% for salary expenses and 10% covering other expenditures such as property-related costs, sales and marketing expenses, travel costs, leasing, rent, financial audits, IT expenses, R&D outlays, and other non-recurring items. These costs are meticulously planned and understood solely by department heads. Thus, the most dependable method for forecasting these expenses is to extract information directly from them.

FIXED COST	Jan.23	Feb.23
Salaries	[redacted]	[redacted]
Holiday pay	[redacted]	[redacted]
Accrual bonus pay	[redacted]	[redacted]
Activated salary expenses	[redacted]	[redacted]
Daily allow health ins. comp.	[redacted]	[redacted]
Health insurance fees	[redacted]	[redacted]
Pension insurance employer	[redacted]	[redacted]
Pension insurance employee	[redacted]	[redacted]
Unemployment ins. employer	[redacted]	[redacted]
Indirect costs, accrued salary	[redacted]	[redacted]
Unemployment ins. employee	[redacted]	[redacted]
Accident insurance	[redacted]	[redacted]
500 Fixed salaries Total	**-241 306**	**-220 621**
Workplace healthcare	[redacted]	[redacted]
Personnel education	[redacted]	[redacted]
Courtship of personnel	[redacted]	[redacted]
Recruit expenses	[redacted]	[redacted]
Other personnel expenses	[redacted]	[redacted]
610 Other fixed personnel expenses Total	**-2 475**	**-2 243**
Real estate tax	[redacted]	[redacted]
Waste expenses	[redacted]	[redacted]
Property insurances	[redacted]	[redacted]
Water	[redacted]	[redacted]
Real estate maintenance	[redacted]	[redacted]
Inventory, various	[redacted]	[redacted]
630 Property Total	**-15 743**	**-20 572**
Representation	[redacted]	[redacted]
Sales external services	[redacted]	[redacted]
Sponsoring and support	[redacted]	[redacted]
Other selling costs	[redacted]	[redacted]
Fair expenses	[redacted]	[redacted]
Advertising agency services	[redacted]	[redacted]
Advertisement	[redacted]	[redacted]
Marketing materials	[redacted]	[redacted]
Other marketing expenses	[redacted]	[redacted]
640 Sales & Marketing Total	**-1 227**	**-9 621**
Travel costs	[redacted]	[redacted]
Travelling allowance, km allow	[redacted]	[redacted]
MasterCard	[redacted]	[redacted]
650 Travel expenses Total	**-10 050**	**-10 807**
Leasing rent, other	[redacted]	[redacted]
Postage	[redacted]	[redacted]
Office supplies	[redacted]	[redacted]
Newspapers and literature	[redacted]	[redacted]
Internal meeting expenses	[redacted]	[redacted]
IT Leasing and small purchases	[redacted]	[redacted]
IT Maintenance and annual fees	[redacted]	[redacted]
IT Consultation&ext. services	[redacted]	[redacted]
Tele- and datacommunication	[redacted]	[redacted]
Vehicle expenses	[redacted]	[redacted]
Insurances	[redacted]	[redacted]
Financial audit	[redacted]	[redacted]
Legal services	[redacted]	[redacted]
Consultant services	[redacted]	[redacted]
Economic administration servic	[redacted]	[redacted]
Membership fee	[redacted]	[redacted]
Other administrative expenses	[redacted]	[redacted]
Banking expenses	[redacted]	[redacted]
Quality certifications	[redacted]	[redacted]
Yle-tax	[redacted]	[redacted]
660 Administration Total	**-125 063**	**-148 840**
Purchased designer services	[redacted]	[redacted]
IPR Rights	[redacted]	[redacted]
R&D expenses	[redacted]	[redacted]
Other fixed expenses internal	[redacted]	[redacted]
Salaries exp Taiwan	[redacted]	[redacted]
670 Other fixed expenses Total	**-10 064**	**-28 159**
Non-Recurring Items	[redacted]	[redacted]
Total fixed cost	**-405 927**	**-440 865**

FIGURE 35. Fixed Cost Inside New Forecast Model

4.4 EBITDA Forecast

The sales forecast is obtained from section “4.1 Sales Forecasting”, while the variable cost forecast comes from section “4.2 Variable Cost Prediction”, and the fixed cost forecast is derived from section “4.3 Fixed Cost Prediction”. EBITDA can be calculated by subtracting the total variable costs forecast and fixed costs forecast from the sales forecast. The EBITDA percentage is determined by dividing EBITDA by sales and then multiplying by 100. This is the chosen key performance indicator (KPI) for the business, and the targeted EBITDA% is 20%.

Gross margin is also calculated as the difference between sales and variable costs. The gross margin percentage is calculated by dividing the gross margin by sales and then multiplying by 100. To reach 20% EBITDA, approximately 40% Gross margin is required, and this is the most important KPI.

4.5 Efficiency, Inventory value, and Cash flow predictions

In the EBITDA forecasting process, predictions for capacity utilization, efficiency, inventory value, and cash flow are also generated as by-products of the new model. Efficiency is calculated as the difference between the capacity stated in the income statement and the capacity utilized in production. Inventory value is determined by subtracting the current month’s obsolete goods from the sum of this month’s ending balances of finished goods and raw materials, as previously mentioned. All this information is available in the new model.

Cash flow is calculated as the sum of EBITDA, changes in inventory, changes in operating payables, and changes in payables minus capital expenditures. EBITDA and changes in inventory are outcomes derived from this new model, which is used in predicting cash flow.

5 ASSESSMENT

Testing both inputs and outputs appears justified. Testing inputs helps refine a model and, in causal models, provides insights into the impacts of policy changes. On the other hand, testing outputs aids in model selection and assessing uncertainty. However, input tests may also reveal one model's inferiority to another, while output tests may also offer suggestions for model improvement. (Armstrong 2001, 2.)

Given that the primary focus of this study is on crafting an alternative forecasting model, the assessment of only output errors was conducted. The examination of inputs may be deferred to a later stage to enhance specific aspects of the new model's performance.

Based on the earlier discussion, it is apparent that the forecast of EBITDA % relies heavily on sales, given the strong correlation between the two. However, upon scrutinizing the sales forecast in FIGURE 36, it became clear that accurate predictions are only achievable a few months before the actual sales month. While there has been a notable improvement in sales forecasting at the outset of 2024 due to process enhancements, this was not the case in 2023. Since 2023 data is the focus, the EBITDA forecast from one month before the actual month will be utilized as the forecasted value for this assessment against the actual value of the month.

FIGURE 36. Sales Forecast Accuracy

5.1 Performance Assessment

Exhibit 8
Ratings of Error Measures

Error measure	Reliability	Construct validity	Outlier protection	Control for difficulty?
Root Mean Square Error	poor	fair	poor	no
Percent Better	good	fair	good	yes
Mean Absolute Percentage Error	fair	good	poor	no
Median Absolute Percentage Error	fair	good	good	no
Geometric Mean Relative Absolute Error	fair	good	fair	yes
Median Relative Absolute Error	fair	good	good	yes

FIGURE 37. Rating of Error Measures (Armstrong 2001, 14)

Armstrong (2001) outlines six error measures for evaluating output errors (FIGURE 37), with "Percent better" deemed the most reliable and "Median Relative Absolute Error" as the second preferred method. However, both required either the deployment of the random walk method or a forecast from the old model for the same period, which is missing. Therefore, absolute errors and absolute percentage error methods are employed to compare with the previous model's output.

EBITDA, %	31.1.22	28.2.22	31.3.22	30.4.22	31.5.22	30.6.22	31.7.22	31.8.22	30.9.22	31.10.22	30.11.22	31.12.22	2022
Jan	18,1%	22,6%	22,6%	22,6%	22,6%	22,6%	22,6%	22,6%	24,4%	23,0%	24,5%	23,1%	22,5%
Feb	18,1%	27,6%	22,6%	22,6%	22,6%	22,9%	23,0%	23,2%	21,1%	23,3%	21,2%	23,2%	22,6%
Mar	18,1%	27,6%	21,9%	22,6%	22,6%	22,9%	23,0%	22,4%	22,7%	21,9%	22,5%	23,2%	22,5%
Apr	18,1%	27,6%	21,9%	11,6%	22,6%	22,9%	23,0%	22,9%	23,2%	22,4%	22,8%	23,2%	21,8%
May	18,1%	27,6%	21,9%	11,6%	14,3%	22,9%	23,0%	22,9%	23,2%	22,4%	22,8%	23,2%	21,1%
Jun	18,1%	27,6%	21,9%	11,6%	14,3%	14,8%	23,0%	23,7%	23,8%	23,8%	23,8%	20,4%	20,5%
Jul	18,1%	27,6%	21,9%	11,6%	14,3%	14,8%	-4,4%	18,1%	20,3%	20,2%	17,9%	23,5%	17,4%
Aug	18,1%	27,6%	21,9%	11,6%	14,3%	14,8%	-4,4%	25,2%	16,0%	15,7%	15,3%	14,7%	16,4%
Sep	18,1%	27,6%	21,9%	11,6%	14,3%	14,8%	-4,4%	20,9%	17,5%	15,7%	14,7%	13,5%	16,0%
Oct	18,1%	27,6%	21,9%	11,6%	14,3%	14,8%	-4,4%	20,9%	17,5%	8,5%	16,5%	20,6%	16,2%
Nov	18,1%	27,6%	21,9%	11,6%	14,3%	14,8%	-4,4%	20,9%	17,5%	8,5%	14,8%	19,9%	16,0%
Dec	18,1%	27,6%	21,9%	11,6%	14,3%	14,8%	-4,4%	20,9%	17,5%	8,5%	16,8%	11,9%	15,6%

FIGURE 38. EBITDA % from the OLD Model

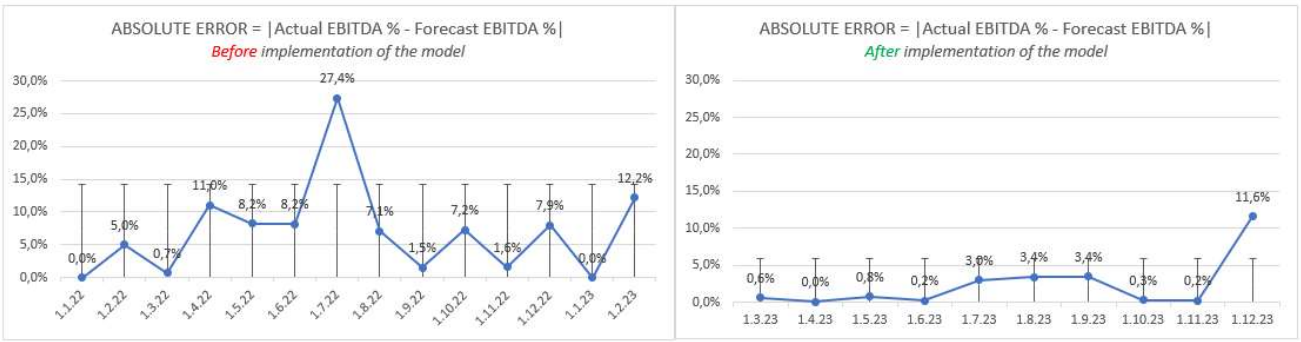
EBITDA, %	31.1.23	28.2.23	31.3.23	30.4.23	31.5.23	30.6.23	31.7.23	31.8.23	30.9.23	31.10.23	30.11.23	31.12.23	2023
Jan	16,9%	10,7%	9,1%	21,8%	26,1%	21,5%	14,3%	12,7%	17,9%	11,4%	10,4%	7,2%	15,4%
Feb	16,9%	-1,5%	9,1%	21,8%	26,1%	21,5%	14,3%	12,7%	20,8%	14,3%	13,6%	10,6%	15,4%
Mar	16,9%	-1,5%	8,6%	-11,0%	11,2%	7,7%	23,4%	20,6%	19,9%	18,4%	19,0%	23,1%	14,1%
Apr	16,9%	-1,5%	6,0%	-10,9%	8,1%	6,0%	-0,3%	19,0%	17,5%	18,6%	18,0%	20,4%	10,8%
May	16,9%	-1,5%	6,0%	-10,9%	7,3%	6,9%	-16,6%	-7,5%	18,2%	19,6%	20,0%	19,2%	8,6%
Jun	16,9%	-1,5%	6,0%	-10,9%	7,3%	6,7%	-26,8%	-1,4%	18,2%	19,6%	20,0%	19,2%	8,8%
Jul	16,9%	-1,5%	6,0%	-10,9%	7,3%	1,1%	-23,8%	9,3%	13,1%	15,8%	15,1%	16,9%	7,3%
Aug	16,9%	-1,5%	6,0%	-10,9%	7,3%	1,1%	-23,8%	12,7%	4,3%	-17,1%	4,5%	8,8%	2,7%
Sep	16,9%	-1,5%	6,0%	-10,9%	7,3%	1,1%	-23,8%	12,7%	0,9%	-8,2%	-15,7%	-9,0%	0,4%
Oct	16,9%	-1,5%	6,0%	-10,9%	7,2%	1,1%	-23,8%	12,7%	0,9%	-7,9%	-16,9%	-8,9%	0,3%
Nov	16,9%	-1,5%	6,0%	-10,9%	7,2%	1,1%	-23,8%	12,7%	0,9%	-9,0%	-16,7%	-15,2%	0,1%
Dec	16,9%	-1,5%	6,0%	-10,9%	7,2%	1,1%	-23,8%	12,7%	0,9%	-9,0%	-21,9%	-3,6%	0,4%

FIGURE 39. EBITDA % from the New Model, Jan & Feb are from the OLD Model.

The EBITDA% forecast and actual outcomes for 2022 and 2023 are utilized to evaluate the model, which can be seen in FIGURE 38 and FIGURE 39. Darker cells indicate actual EBITDA%, while white cells represent forecasts.

FIGURE 40 represents a comparison for absolute error. A reduction in the mean error (7,0% to +2,3%) indicates that, on average, the predicted values are closer to the actual values, reflecting improved accuracy across all data points. The median error percentage is less influenced by extreme values than the mean, and it serves as a central tendency measure. A decrease (7,1% to 0,7%) in the median error percentage signals a substantial reduction in errors. When the standard deviation of error percentages decreases (6,9% to 3,3%), it signifies reduced variability in errors around the mean, indicating greater consistency in the forecasting model's performance. This implies enhanced stability and reliability, with predictions becoming consistently more accurate.

Absolute errors are computed by subtracting the forecasted value from the actual value. Analysis indicates significant improvements in median, mean, and standard deviation. Additionally, while the previous model exhibited negative biases in error mean and median, the new model demonstrates more positive biases, suggesting a conservative forecasting approach and enhanced forecast performance. As the standard deviation is also reduced, forecast consistency and volatility are improved.



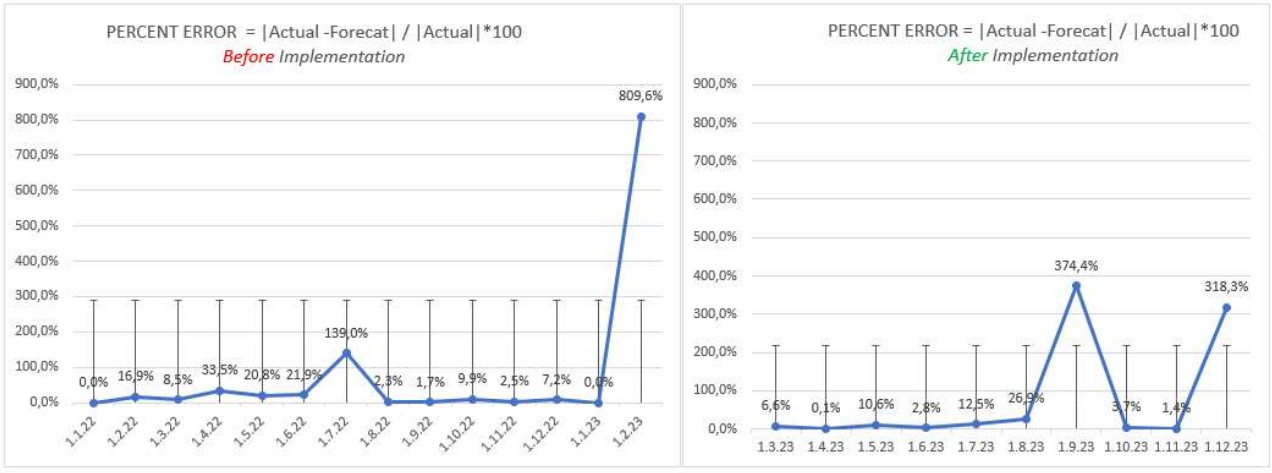
Median	7,1%
Mean	7,0%
STD DIV	6,9%

Median	0,7%
Mean	2,3%
STD DIV	3,3%

FIGURE 40. Result of EBITDA % Forecast Before and After Implementation, Absolute Error

Percent error is a percentage that indicates the difference between the expected and actual values of the actual value itself. To calculate the discrepancy between expected and actual values, use the absolute percent error formula. It involves subtracting the true value from the approximate value, taking the abolute value, dividing by the true value, and multiplying by 100. (Tasha 2022.)

This perent error method is the same as an absolute percentage error. The analysis in FIGURE 41 indicates that the new model has notably reduced both the mean (82,6% to 75,7%) and median (9,9% to 8,6%) error percentages. Decreased mean and median error percentages indicate improved prediction accuracy, with predictions closer to actual values and reduced impact of extreme errors. Additionally, the standard deviation has decreased (212,8 to 136,7%), indicating a reduction in volatility. Hence, it can be confirmed that the new model has effectively minimized errors.



Median	9,9%
Mean	82,6%
STD DIV	212,8%

Median	8,6%
Mean	75,7%
STD DIV	136,1%

FIGURE 41. Absolute Percent Errors

5.2 Impact Assessment

EFFICIENCY	CAP€	CAP€	CAP€	CAP€	CAP€	CAP€	CAP€	CAP€	CAP€
2023	Jan.23	Feb.23	Mar.23	Apr.23	May.23	Jun.23	Jul.23	Aug.23	Sep.23
IS CAPCITY	577 962	529 649	429 429	380 820	425 397	438 877	248 023	324 736	275 152
UNUSED CAPACITY	0	-327 131	-206 081	-294 912	-122 078	-212 011	-196 500	-109 226	-82 707

FIGURE 42. Unused Capacity

By calculating production capacity, the new model facilitated an understanding of overcapacity and enabled adjustments, resulting in a reduction of approximately three million euros in capacity cost. Comparing raw material purchases to overall needs for production led to decreased raw material procurement, reduced inventory, and improved cash flow. Enhanced accuracy of EBITDA and cash flow prediction also enabled the renegotiation of bank loan covenants for businesses.

5.3 Limitations and Improvements

The new model currently bases standard cost calculation solely on product group profitability. However, as the weighted average of customer profitability shifts, so will overall profitability. If the weighted average volume of customers remains constant, the cost forecast based on product profitability will suffice. Nonetheless, further improvement of the new model is warranted by incorporating customer profitability into product group profitability.

The new model currently overlooks production costs and products sourced from multiple production sites, such as Finland or China. Cost disparities primarily stem from differences in labour costs across locations. Hence, integrating standard cost calculations for production across multiple locations is essential. At present, production in China has a negligible effect on the new model's outcome.

Some of the independent variables used for predicting dependent variables exhibit low values of correlation coefficient, as indicated in the table below. No superior independent variables have been identified to predict these dependent variables. Further investigation is needed to enhance the predictability of these variables.

TABLE 3. Low Value of Correlation Coefficient

Dependent Variable	**Independent Variable**	**Correlation Coefficient**
Electricity	New Finished Goods	0,17
Electricity	Sales	0,24
Electricity	New Finished Goods, Sales > 1,8 M€	-0,78
Purchase freight, flight	Material purchases	0,29
Consumable supplies production	New Finished Goods	-0,0095
Consumable supplies production	Sales	0,055
Other variable personnel expense	Variable salaries	0,38
Other variable personnel expense	Sales	0,16

The Excel FORECAST function offers predictive analysis based on historical data points and supports three primary types of forecasting: linear, single exponential smoothing, and double exponential smoothing. Linear forecasting assumes a consistent rate of change between data points, while single exponential smoothing emphasizes recent data points to capture short-term trends. Double exponential smoothing incorporates both the level and trend of data, making it suitable for consistent trends over

time. While Excel can provide accurate forecasts for straightforward scenarios with linear trends, its accuracy diminishes with complex data, outliers, or seasonal fluctuations. (Richardson, 2023.)

Presently, the Excel FORECAST function is not utilized, but its implementation could enhance the new model's performance. As data and operations become more complex and seasonal, a basic linear trend-based forecast may lack accuracy. Exploring modern technologies rooted in data science and advanced forecasting methods could further enhance performance.

Another notable limitation is the absence of market or macroeconomic data in the current forecasting system for integrating into future cost forecasts. For instance, if there is a substantial material cost increase anticipated in six months, it will not be accounted for in the forecast system. This deficiency requires immediate improvement.

The new forecasting model does not consider slow-moving items or adjust the percentage of obsolete materials accordingly. However, there is an opportunity for enhancement by integrating this aspect directly into the new forecasting model. The sourcing team could analyze slow-moving inventory items and advise the accounting team on how this might affect the future proportion of obsolete inventory relative to sales.

6 CONCLUSION

In February 2023, the old EBITDA forecasting model resulted in significant errors. A closer investigation discovered several reasons. A percent of sales method was used to predict the gross margin. As sales were forecasted at an aggregated total level, the old model did not account for product mix changes. Therefore, forecasting based on the percentage of sales method did not produce reliable output. Material cost was also connected only to the aggregated sales, which is far from reality. Different product groups had different material cost percentages. Aggregated sales-based material cost did not reflect the correct material cost. Changes in obsolete items were not considered separately, which also caused a significant margin of error. Some other variable cost was forecasted as a percentage of sales, whereas other independent variables were found to be more correlated to those costs. Capacity cost utilization was ignored in the old model. During the decrease in production volume, the old model did not account for unused capacity, which, in reality, reduced the gross margin. Salary cost was also forecasted as a percentage of sales. But actually, it was related to the actual number of people, their salary, and temporary lay-off and holiday payment. The fixed cost was simply copied over from the most recent actual month to the other months, which did not account for organizational change and planned cost increase or decrease.

The new model strived to consider all the shortcomings of the old model. A detailed sales forecast was developed for each of the seven product groups separately. Data from CRM systems, ERP systems, and Tableau management reports were combined. The current order book from the Tableau report, future sales forecast provided by customers from the ERP system, and order pipeline from the CRM system were collected and processed to improve the sales forecast performance.

Direct material cost forecast was improved by separately forecasting changes in raw materials, changes in finished goods, changes in obsolete inventories, and new row material purchases. To calculate the changes in raw materials and finished goods, the Bill of Materials (BOM) and Bill of Operations (BOO) from the ERP system were used. The standard costing principle was deployed to predict the material cost. New purchases were also forecasted in great detail by considering the production need and raw material demand. Obsolete cost was forecasted based on the inventory value at standard cost and historical trend. Higher inventory value caused higher obsolete value forecasts, which increased the material cost and decreased the margin. These actions have increased the accuracy of the materials cost forecast.

Production requirements for each month were forecasted utilizing data from the inventory balance report, order book report, and order forecast report of the ERP systems. If the combined value of the order book and order forecast was greater than the inventory balance, then the entire inventory value was considered to be sold, reducing the inventory value. Otherwise, the combined value of the order book and the order forecast was considered to be sold from inventory, and a consequent reduction of inventory was recorded. By deducting what is sold from inventory from the standard cost of the product sold for a month, the production requirement was calculated.

Based on the production requirement, capacity utilization was forecasted by utilizing BOO. If the total capacity cost booked in the income statement was not fully utilized by the production need, it required to reduce the margin forecast by the unused capacity. This also increased the accuracy of the gross margin forecast.

The salary cost forecast was improved by directly calculating the actual salary of the people for the planned number of employees. Social costs, bonuses, temporary lay-off, and holiday costs were all calculated based on an actual number of employees and their respective salaries and contracts.

An independent variable was used to forecast a few types of variable costs as some degree of correlation was established with the dependent variables. For these types of variable costs, the year-to-date cost of the dependent variable was divided by the year-to-date cost of the independent variable to get a ratio. This ratio was multiplied by the independent variable forecast for the month to derive a forecast of the dependent variable for that month. Four such dependent variables were sales, purchasing, new finished goods, and salary. However, there were some variable costs where no dependent variable was established. Management judgment, based on either contracts or historical trends, was applied in those cases. Therefore, these variable costs had a much more robust forecast.

A detailed budget for fixed costs was prepared by the relevant head of each department. This budget was plugged in for the fixed cost forecasting. If the actual cost starts to deviate from the budget, the head of the department will adjust the action plan to match the budget.

The output of the new model was tested using absolute error and absolute percentage error methods. All mean, median and standard deviation of the new model for both error measures showed improvement compared to the old model. Therefore, it can be concluded that by combining data from various

data sources such as ERP, ERM, and Tableau reporting software, as well as utilizing the interdependencies among the various cost elements and sales, the EBITDA forecast can be significantly improved.

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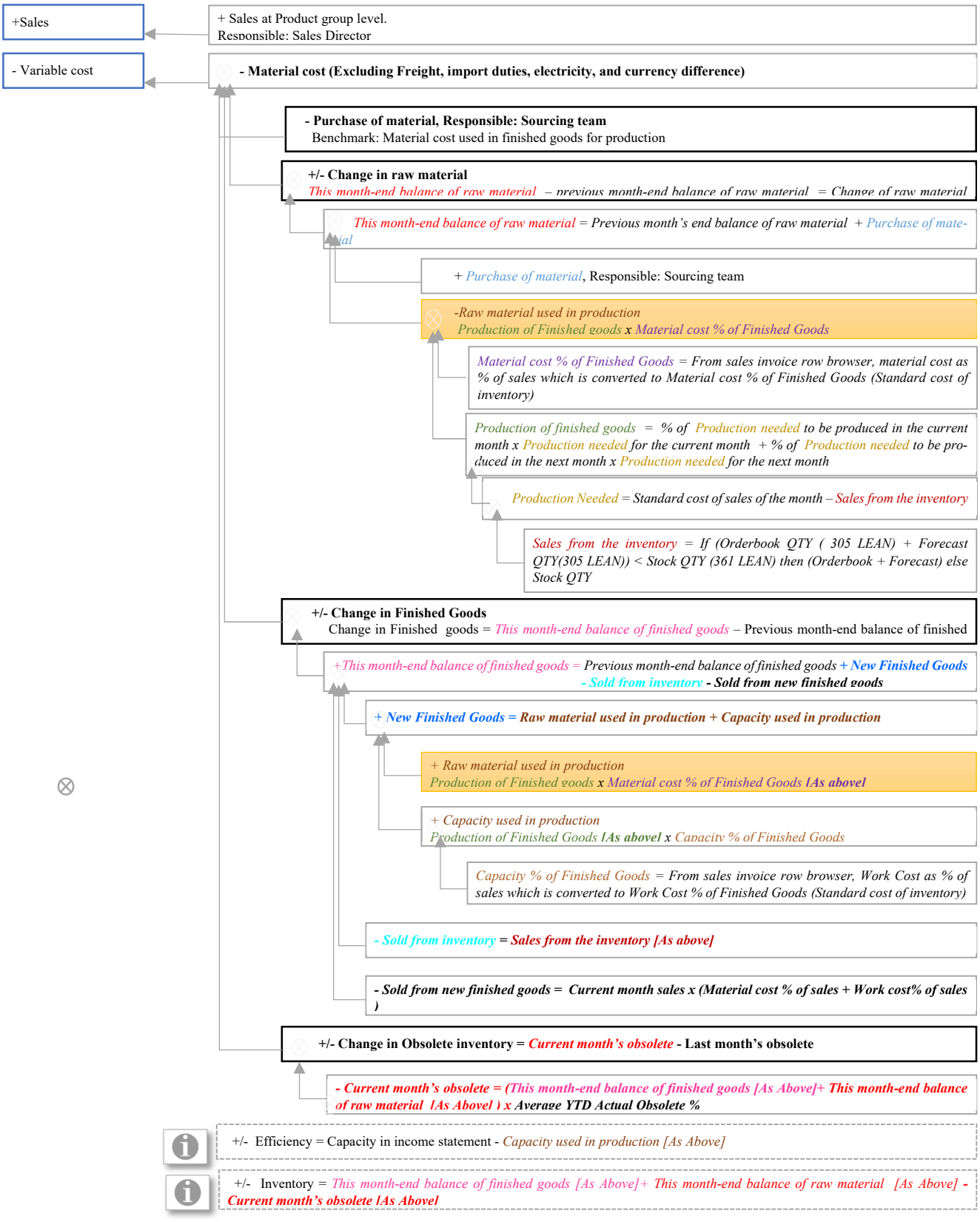
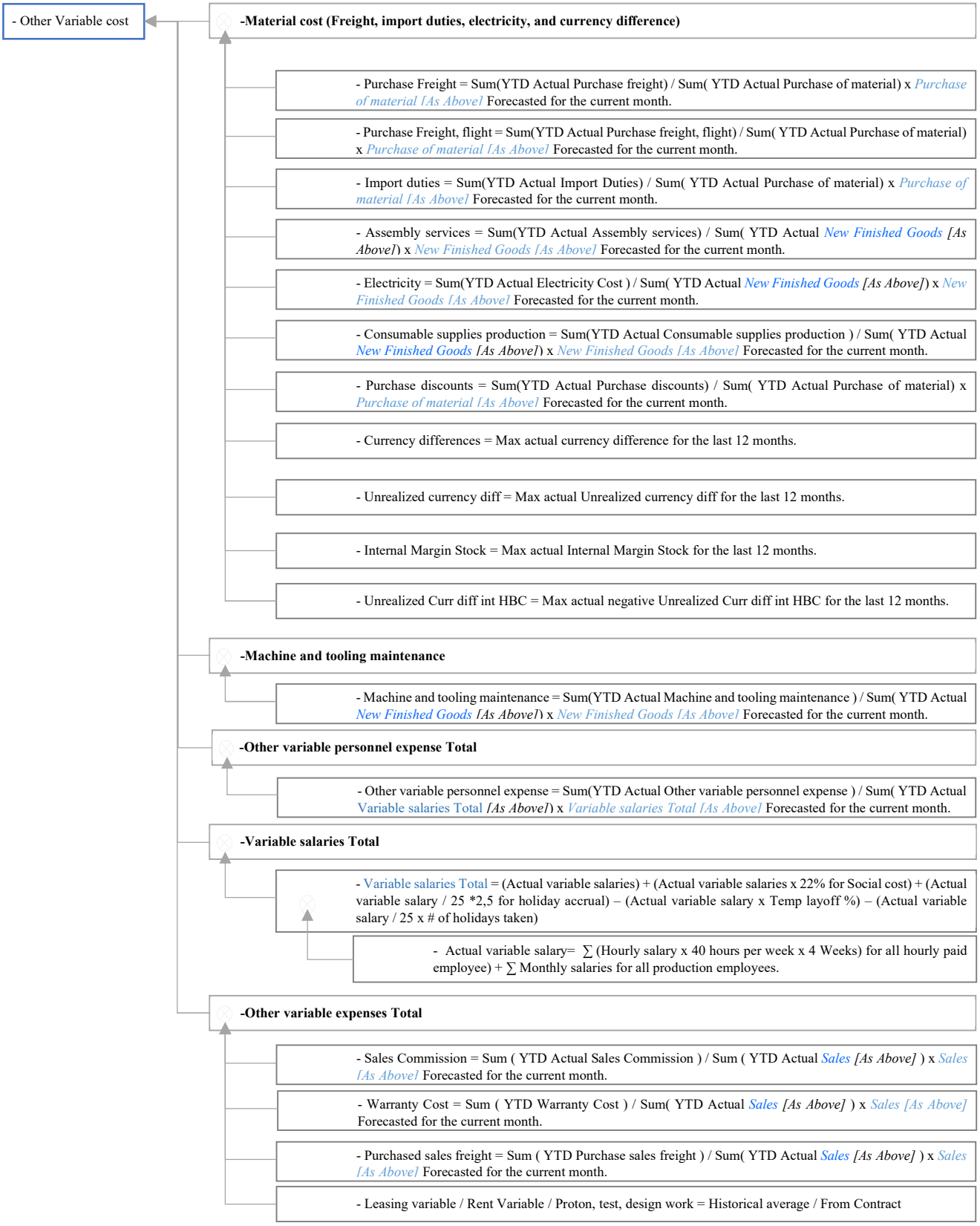
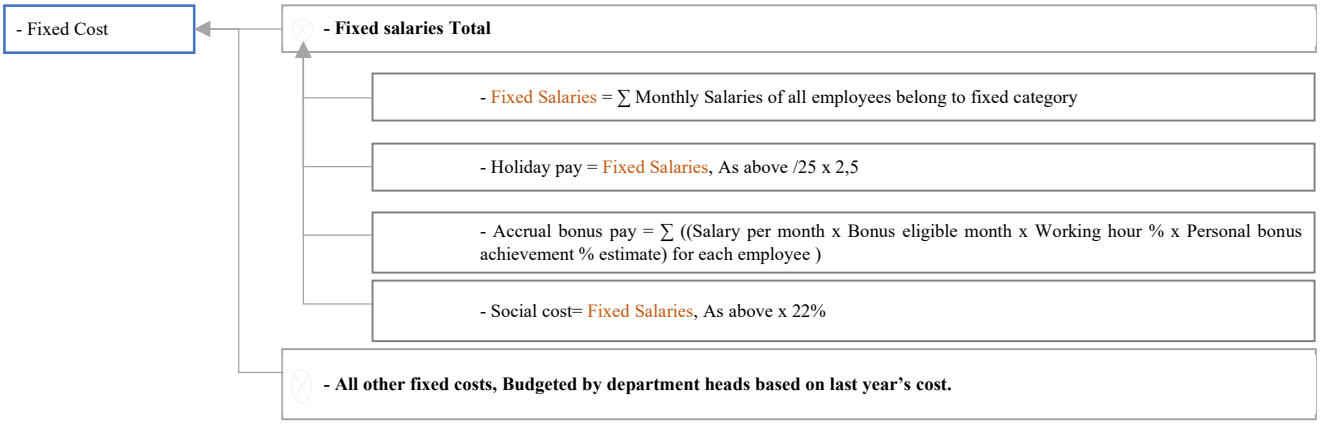
APPENDIX 1 /1


+Sales
+ Sales at Product group level.
Responsible: Sales Director
- Variable cost
- Material cost (Excluding Freight, import duties, electricity, and currency difference)
- Purchase of material, Responsible: Sourcing team
Benchmark: Material cost used in finished goods for production
+/- Change in raw material
This month-end balance of raw material – previous month-end balance of raw material = Change of raw material
This month-end balance of raw material = Previous month's end balance of raw material + Purchase of material
+ Purchase of material, Responsible: Sourcing team
-Raw material used in production
Production of Finished goods x Material cost % of Finished Goods
Material cost % of Finished Goods = From sales invoice row browser, material cost as % of sales which is converted to Material cost % of Finished Goods (Standard cost of inventory)
Production of finished goods = % of Production needed to be produced in the current month x Production needed for the current month + % of Production needed to be produced in the next month x Production needed for the next month
Production Needed = Standard cost of sales of the month – Sales from the inventory
Sales from the inventory = If (Orderbook QTY (305 LEAN) + Forecast QTY(305 LEAN)) < Stock QTY (361 LEAN) then (Orderbook + Forecast) else Stock QTY
+/- Change in Finished Goods
Change in Finished goods = This month-end balance of finished goods – Previous month-end balance of finished
+This month-end balance of finished goods = Previous month-end balance of finished goods + New Finished Goods - Sold from inventory - Sold from new finished goods
+ New Finished Goods = Raw material used in production + Capacity used in production
+ Raw material used in production
Production of Finished goods x Material cost % of Finished Goods [As above]
+ Capacity used in production
Production of Finished Goods [As above] x Capacity % of Finished Goods
Capacity % of Finished Goods = From sales invoice row browser, Work Cost as % of sales which is converted to Work Cost % of Finished Goods (Standard cost of inventory)
- Sold from inventory = Sales from the inventory [As above]
- Sold from new finished goods = Current month sales x (Material cost % of sales + Work cost% of sales)
+/- Change in Obsolete inventory = Current month's obsolete - Last month's obsolete
- Current month's obsolete = (This month-end balance of finished goods [As Above]+ This month-end balance of raw material [As Above]) x Average YTD Actual Obsolete %
+/- Efficiency = Capacity in income statement - Capacity used in production [As Above]
+/- Inventory = This month-end balance of finished goods [As Above]+ This month-end balance of raw material [As Above] - Current month's obsolete [As Above]

APPENDIX 1 /2


- Other Variable cost
-Material cost (Freight, import duties, electricity, and currency difference)
- Purchase Freight = Sum(YTD Actual Purchase freight) / Sum(YTD Actual Purchase of material) x Purchase of material [As Above] Forecasted for the current month.
- Purchase Freight, flight = Sum(YTD Actual Purchase freight, flight) / Sum(YTD Actual Purchase of material) x Purchase of material [As Above] Forecasted for the current month.
- Import duties = Sum(YTD Actual Import Duties) / Sum(YTD Actual Purchase of material) x Purchase of material [As Above] Forecasted for the current month.
- Assembly services = Sum(YTD Actual Assembly services) / Sum(YTD Actual New Finished Goods [As Above]) x New Finished Goods [As Above] Forecasted for the current month.
- Electricity = Sum(YTD Actual Electricity Cost) / Sum(YTD Actual New Finished Goods [As Above]) x New Finished Goods [As Above] Forecasted for the current month.
- Consumable supplies production = Sum(YTD Actual Consumable supplies production) / Sum(YTD Actual New Finished Goods [As Above]) x New Finished Goods [As Above] Forecasted for the current month.
- Purchase discounts = Sum(YTD Actual Purchase discounts) / Sum(YTD Actual Purchase of material) x Purchase of material [As Above] Forecasted for the current month.
- Currency differences = Max actual currency difference for the last 12 months.
- Unrealized currency diff = Max actual Unrealized currency diff for the last 12 months.
- Internal Margin Stock = Max actual Internal Margin Stock for the last 12 months.
- Unrealized Curr diff int HBC = Max actual negative Unrealized Curr diff int HBC for the last 12 months.
-Machine and tooling maintenance
- Machine and tooling maintenance = Sum(YTD Actual Machine and tooling maintenance) / Sum(YTD Actual New Finished Goods [As Above]) x New Finished Goods [As Above] Forecasted for the current month.
-Other variable personnel expense Total
- Other variable personnel expense = Sum(YTD Actual Other variable personnel expense) / Sum(YTD Actual Variable salaries Total [As Above]) x Variable salaries Total [As Above] Forecasted for the current month.
-Variable salaries Total
- Variable salaries Total = (Actual variable salaries) + (Actual variable salaries x 22% for Social cost) + (Actual variable salary / 25 *2,5 for holiday accrual) – (Actual variable salary x Temp layoff %) – (Actual variable salary / 25 x # of holidays taken)
- Actual variable salary= ∑ (Hourly salary x 40 hours per week x 4 Weeks) for all hourly paid employee) + ∑ Monthly salaries for all production employees.
-Other variable expenses Total
- Sales Commission = Sum (YTD Actual Sales Commission) / Sum (YTD Actual Sales [As Above]) x Sales [As Above] Forecasted for the current month.
- Warranty Cost = Sum (YTD Warranty Cost) / Sum(YTD Actual Sales [As Above]) x Sales [As Above] Forecasted for the current month.
- Purchased sales freight = Sum (YTD Purchase sales freight) / Sum(YTD Actual Sales [As Above]) x Sales [As Above] Forecasted for the current month.
- Leasing variable / Rent Variable / Proton, test, design work = Historical average / From Contract

APPENDIX 1 /3


- Fixed Cost
- Fixed salaries Total
- Fixed Salaries = ∑ Monthly Salaries of all employees belong to fixed category
- Holiday pay = Fixed Salaries, As above /25 x 2,5
- Accrual bonus pay = ∑ ((Salary per month x Bonus eligible month x Working hour % x Personal bonus achievement % estimate) for each employee)
- Social cost= Fixed Salaries, As above x 22%
- All other fixed costs, Budgeted by department heads based on last year's cost.