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Business Intelligence in Logistics

Submitted to

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1. Introduction

In the logistics and supply chain sector, a significant amount of data is generated daily from various processes involving multiple players, including clients, freight forwarders, logistics operators, warehousing, transport, customs, ports, and administrations. This information overload can lead to crucial data loss that affects the organization's profitability due to:

- Difficulties in collecting data.
- Maintaining information on different platforms
- Reporting complexity and
- Manual data updating

For transport and logistics companies facing intense global competition, timely cost evaluations based on existing data are critical to managing financial pressure. Efficient resource management is also key to optimizing transportation and storage facilities. In any industry, accurate and up-to-date knowledge is essential for making informed business decisions quickly and safely. To address these challenges, business intelligence utilizes big data to provide up-to-date and credible information, enabling companies to monitor their progress and make informed decisions.

Investing in industry-specific Business Intelligence (BI) is crucial to provide relevant information on demand, and effective visualization is necessary to overcome challenges with confidence.

1.1 What is Business Intelligence?

Business intelligence (BI) refers to a wide range of technologies, tools, and processes that allow companies to collect, analyze, and interpret data to obtain valuable insights and make informed business decisions. BI is focused on converting unprocessed data into meaningful information that can be used to drive strategic planning, operational improvements, and competitive advantages.

1.2 History of business intelligence

The concept of business intelligence was coined by writer Richard Millar Devens in 1865 after he mentioned a banker who gathered intelligence on the market before his competitors. In 1958, Hans Peter Luhn, a computer scientist at IBM, delved into the possibilities of utilizing technology to obtain business intelligence. His findings led to the development of techniques for constructing IBM's initial analytics platforms.

During the 1960s and 70s, initial data management and decision support systems (DSS) were created to manage and arrange increasing data.

As per the IT education website DataVersity, the current form of business intelligence is believed by many historians to have originated from the DSS database. During that time, several tools were created to retrieve and analyze data and simplify data organization. Some of the tools developed to work with DSS included OLAP, executive information systems, and data warehouses.

During the 1990s, business intelligence gained popularity, but its technology was complex and required IT support. This often resulted in backlogs and delayed reports. Even without IT, business intelligence analysts and users had to undergo extensive training to effectively query and analyze their data.

Thankfully, recent developments have focused on self-service BI applications, making it possible for non-experts to benefit from reporting and analysis. Modern cloud-based platforms have further expanded the reach of BI across geographies. Many solutions now handle big data and real-time processing, allowing for decision-making based on up-to-date information.

2. Why Business Intelligence in Logistics?

Business Intelligence (BI) is an essential tool in the logistics industry. It helps optimize operations, improve efficiency, and enhance overall performance. Let's take a closer look at some critical aspects of BI in logistics:

2.1. Data Integration:

In the field of logistics, business intelligence entails gathering and merging information from different sources within the supply chain, including transportation systems, warehouse management systems, customer databases, and external data providers. Through the consolidation and centralization of data, companies can obtain a complete picture of their operations and make better-informed decisions.

2.2. Data Analysis and Reporting:

Logistics companies can utilize business intelligence tools to analyze and report on their data, leading to valuable insights. With the help of data visualization, dashboards, and reports, businesses can track KPIs, and identify trends, patterns, and areas for growth.

2.3. Performance Measurement:

The utilization of business intelligence aids in accurately measuring and monitoring the performance of logistics operations. By setting performance metrics and benchmarks, organizations can track their progress toward achieving their goals and objectives. With BI tools, both real-time and historical data are provided to evaluate key performance indicators including on-time delivery, order accuracy, inventory turnover, and cost per unit.

2.4. Predictive Analytics:

The use of predictive analytics in business intelligence allows for the forecasting of future outcomes based on historical data and statistical models. In logistics, this can be particularly useful for optimizing route planning, demand forecasting, inventory management, and resource allocation. By accurately predicting potential issues or changes in demand, organizations can proactively make decisions to improve efficiency and customer satisfaction.

2.5. Supply Chain Optimization:

Through the analysis of transportation routes, supplier performance, inventory levels, and demand patterns, business intelligence enables the identification of inefficiencies and

opportunities for optimization within the supply chain. This allows organizations to streamline processes, reduce costs, and enhance overall supply chain performance.

2.6. Decision Support:

Business intelligence is a crucial tool that offers decision-makers precise and timely information to facilitate strategic and tactical decision-making. By utilizing data-driven insights, organizations can analyze various scenarios, evaluate the potential impact of their decisions, and identify the most suitable course of action. This, in turn, helps align business strategies with market demands and stay ahead of the competition.

The logistics industry can benefit greatly from utilizing business intelligence, enabling organizations to make better decisions, measure performance, and optimize operations. By implementing BI tools and techniques, logistics companies can gain a competitive advantage, enhance operational efficiency, and provide better customer value. Business intelligence can provide insights into various issues such as transport routes, pick-ups and drop-offs, load factors, costs, turnover, orders, on-time performance, loading and unloading times per driver, and CO2 emissions. Data about customers, trips, vehicles, and driver levels can also be analyzed. Real-time dynamic interactive dashboards can visually display this information. Figure 1 shows the importance of utilizing business intelligence. Logistics companies have proven that implementing such technology results in a variety of benefits, including:

- Gaining more insightful knowledge of costs and profits
- Enhancing efficiency
- Increasing load factor
- Optimizing routes
- Better management and deployment of drivers and vehicles
- Achieving a comprehensive understanding of customers in various aspects.

Figure 1 : Benefits of Business Intelligence

3. Business Intelligence Tools

Business intelligence tools are utilized to implement business intelligence, but they do not make decisions on their own. It is crucial to combine the output of these tools with human judgment and intuition and to put the information into a wider context than any data warehouse or knowledge repository can handle. Business intelligence tools are software designed to help business users analyze large amounts of complex data. Figure 2 shows how the data flows in a Business Intelligence System. They vary widely in terms of cost, functionality, complexity, and number of users. The most popular business intelligence tools include:

3.1. Spreadsheets:

Business intelligence tools are widely used, and the most popular among them are spreadsheets, particularly Microsoft Excel files. The reasons for this are manifold: Excel is affordable, user-friendly, widely recognized in the business world, and comes equipped with almost all the necessary features for data display. Additionally, many other reporting tools can export data to Excel and import from it. Excel is often used for reporting and tracking goals.

3.2. Query, Reporting, and Data Visualization Tools:

A query tool is used to answer predetermined questions and provides users with a static view of information that can be analyzed, combined with data from other sources, or exported for use with other tools. The next set of tools is reporting tools, which can be either custom-built or commercial. Deciding whether to purchase or build a reporting tool depends on several factors, including the desired report distribution method and the need for ad hoc report creation. Reporting tools offer more flexibility than spreadsheets, allowing users to create, schedule, and run their reports. These tools enable users to ask ad hoc questions about patterns or details in the data. Visualization tools include graphical tools, dashboards, and scoreboards, which help interpret complex data relationships, facilitating decision-making.

3.3. OLAP tools:

OLAP (On-Line Analytical Processing) tools allow users to perform multidimensional analysis, commonly referred to as "slicing and dicing" of data. These tools provide the ability to view data from various dimensions and perspectives. Additionally, OLAP refers to the use of computers to support ongoing business operations.

3.4. Data mining tools:

Businesses can gain a competitive advantage with data mining tools that predict future trends and behaviors. These tools use advanced statistical and artificial intelligence techniques, such

as neural networks, machine learning, and decision trees, to automatically search for significant patterns or correlations in data. Unlike traditional business intelligence technology, which analyzes past events, data mining, and predictive analysis allow users to forecast future outcomes. This is particularly useful in today's uncertain economy and global crisis.

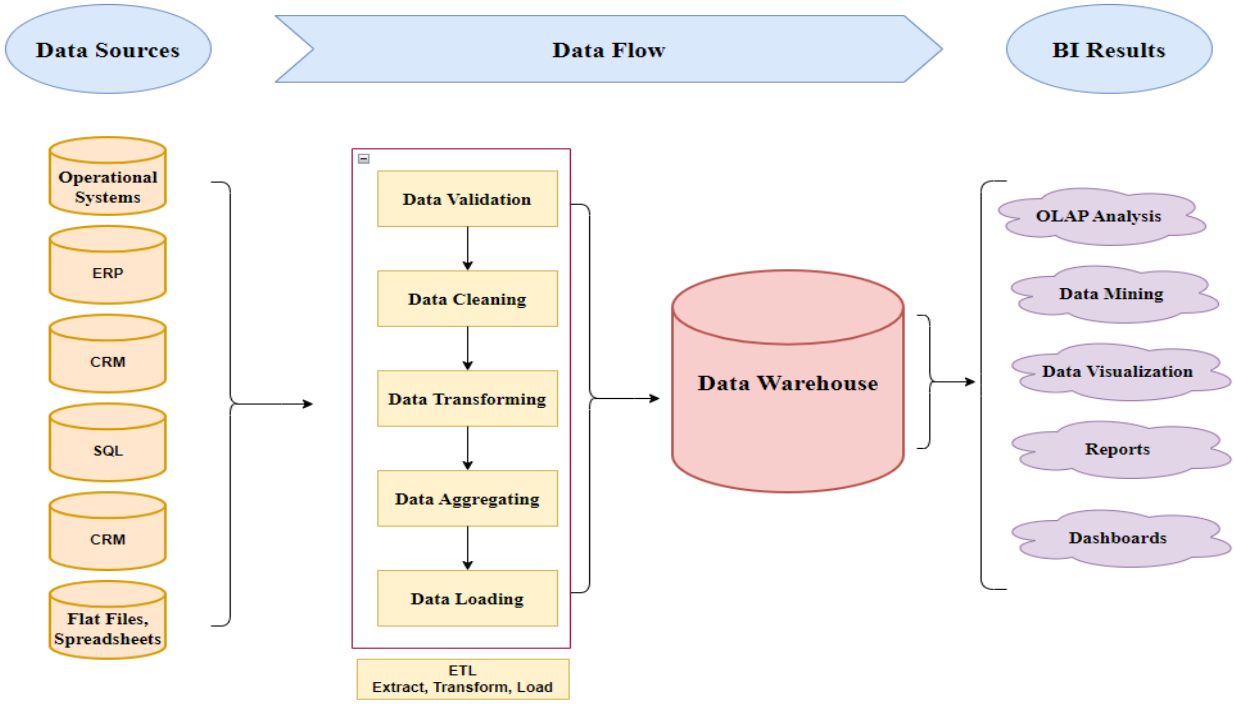

Figure 2 : Data Flow in a Business Intelligence system

3.5. The selection of appropriate business intelligence tools:

Before selecting the appropriate business intelligence tools for our company, it is essential to determine our specific needs. This involves identifying the types of tools we require, selecting the right vendor, and implementing the tools effectively. During the selection process, there are several crucial factors to consider, including product features, ease of use and implementation, scalability, user interface options, access to disparate data sources, search functionality, and integration with existing and future platforms. The implementation of business intelligence tools can be gradual or all at once, depending on our budget and the familiarity of our users with different software systems When choosing between building or buying business intelligence tools, we must consider our reporting requirements, distribution modes, and the need for ad hoc report creation. If we require numerous reports, it is better to purchase a reporting tool with a built-in management system. Similarly, if we need to access reports through various channels, buying a reporting tool with pre-packaged distribution modes is the right decision. If users can create their own ad hoc reports, buying a reporting tool is also advisable.

4. Applications of business intelligence (BI) in logistics

Business intelligence has various uses in logistics. Figure 3 depicts some of the uses discussed below.

4.1. Supply chain optimization: By analyzing data from various stages of the supply chain, Business Intelligence (BI) tools can help companies identify patterns, inefficiencies, and areas for improvement. This enables them to optimize their supply chain operations. With BI, businesses can determine the ideal inventory levels that balance costs and adequate stock availability. Furthermore, BI can point out areas where process automation or technology integration can streamline operations and reduce manual errors.

4.2. Demand forecasting*:* Forecasting future demand accurately is crucial for logistics planning, and BI achieves this by leveraging historical sales data, market trends, seasonality, and other factors. This information helps businesses determine the appropriate levels of inventory, anticipate transportation requirements, and allocate warehouse capacity, accordingly, reducing the risk of stockouts and overstocking and improving overall supply chain efficiency.

4.3. Route optimization: Business Intelligence (BI) plays a crucial role in optimizing transportation routes for businesses. This involves considering multiple factors such as distance, traffic patterns, fuel costs, and delivery time windows. Through analysis of historical data and real-time information, logistics teams can pinpoint the most efficient routes, thereby reducing transportation costs and improving delivery times. Besides enhancing operational efficiency, this approach also benefits the environment by minimizing fuel consumption and emissions.

4.4. Warehouse management: Real-time visibility into warehouse operations is provided by BI, enabling businesses to monitor inventory levels, track order fulfillment rates, and optimize resource allocation. Logistics teams can identify areas for improvement by analyzing data on order volume, picking accuracy, storage utilization, and labor productivity. Through BI, products with high demand can be identified and their placement in the warehouse optimized for faster picking and packing. BI can also help identify underutilized or overutilized storage areas, leading to better space optimization.

4.5. Supplier performance analysis: Business Intelligence (BI) empowers companies to evaluate supplier performance through multiple metrics such as delivery times, product quality, pricing, and responsiveness. By analyzing and consolidating this data, logistics experts can make well-informed choices regarding supplier selection, negotiation, and management. Using BI, it becomes possible to identify suppliers that consistently meet delivery deadlines

and maintain high-quality standards, leading to more efficient logistics operations and increased customer satisfaction.

4.6. Risk management: Business intelligence tools are capable of monitoring and analyzing data that pertains to potential risks and disruptions in the logistics process. This encompasses keeping an eye on weather conditions, geopolitical events, market volatility, and other factors that could affect the supply chain. By identifying possible risks before they occur, companies can create contingency plans, diversify supplier networks, and take proactive steps to reduce disruptions. For instance, if a business intelligence system detects unfavorable weather conditions in a particular region, logistics teams can modify transportation routes or secure alternative logistics providers to lessen the impact of potential delays.

4.7 Customer analytics: Business Intelligence (BI) empowers businesses to analyze customer data and gain valuable insights into their behavior, preferences, and buying patterns. Through the analysis of order history, customer feedback, and engagement metrics, logistics teams can personalize their offerings, tailor marketing campaigns, and ultimately improve customer satisfaction. For instance, BI can identify frequent customers who order specific products, enabling businesses to suggest related or complementary items and drive cross-selling opportunities proactively.

Logistics professionals can benefit greatly from utilizing business intelligence to make informed decisions, improve operations, elevate customer satisfaction, and remain competitive in an ever-changing industry. The logistics sector can take advantage of various BI tools to effectively analyze and optimize their operations.

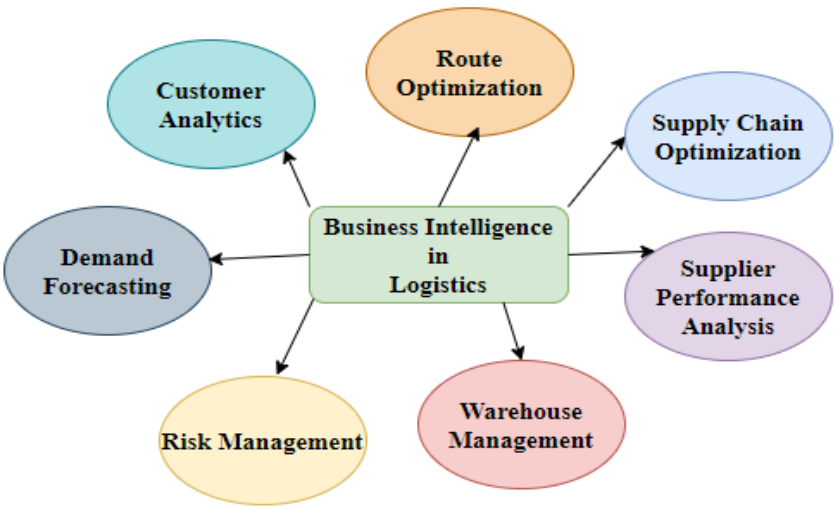

Figure 3 : Business Intelligence Applications in Logistics

5. Commonly used BI tools in logistics:

It is crucial for the logistics industry to use Business Intelligence (BI) tools since they provide valuable insights, data visualizations, and analytics to optimize operations, improve decision-making, and enhance overall efficiency. Figure 4 illustrates different tools that can be used in Logistics. Some of them are:

5.1. Power BI:

Microsoft's Power BI is a popular tool used in many industries, including logistics. Its powerful features for data integration, modeling, and visualization make it ideal for analyzing logistics data. Power BI can connect to various data sources, such as ERP, TMS, and WMS, enabling logistics professionals to monitor KPIs, track performance, and gain valuable insights into supply chain operations.

5.2. Tableau:

Tableau provides logistics teams with powerful data visualization capabilities that are highly valuable. It enables them to create interactive dashboards and reports, which offer real-time visibility into key metrics such as order fulfillment rates, transportation costs, and inventory levels. With its user-friendly interface and flexible customization options, Tableau is an effective tool for analyzing logistics data and identifying trends, patterns, and areas that require improvement.

5.3. QlikView/Qlik Sense:

QlikView and Qlik Sense, two BI tools developed by Qlik, are highly regarded for their user-friendly interfaces and associative data model. These tools are ideal for logistics professionals who want to delve into data relationships, investigate details, and gain a better understanding of supply chain performance. With their interactive visualizations and self-service capabilities, users can analyze logistics data independently and make informed decisions based on the insights gained.

5.4 SAP BusinessObjects:

SAP BusinessObjects is a top-tier business intelligence platform that seamlessly integrates with SAP's logistics and supply chain management solutions. It provides a comprehensive suite of reporting, dashboard, and analytics capabilities that enable logistics specialists to scrutinize data from multiple sources and derive valuable insights. Utilizing SAP BusinessObjects, logistics teams can keep a close eye on important metrics, measure progress toward goals, and pinpoint areas for improvement.

5.5 MicroStrategy:

MicroStrategy is a highly advanced business intelligence platform that offers a wide range of functionalities to its users, including reporting, analytics, and mobile BI. Its features are specifically designed to analyze logistics data, such as transportation costs, inventory levels, and order fulfillment. Additionally, MicroStrategy's data modeling, visualizations, and collaboration capabilities make it an invaluable tool for logistics professionals who wish to streamline their operations and achieve optimal efficiency.

Figure 4 : Business Intelligence Tools

These BI tools offer diverse features and capabilities that can be tailored to the specific needs of logistics operations. They enable businesses to gain actionable insights, make data-driven decisions, and improve overall supply chain efficiency. The choice of BI tool depends on factors such as data sources, integration requirements, user expertise, and specific analytics needs within the logistics context.

6. Power BI:

Microsoft's Power BI is a reliable business intelligence tool that enables users to analyze and visualize data from diverse sources, create interactive reports and dashboards, and gain valuable insights into their business operations (Figure 5). Its effectiveness is particularly valuable in logistics, offering a range of benefits, including:

6.1. Data integration:

As a logistics professional, you can make use of Power BI's ability to connect with a wide range of data sources such as databases, Excel files, cloud services, and APIs. This integration of data from multiple sources can provide a holistic understanding of your operations, including details about shipments, inventory, suppliers, and customers.

6.2. Real-time monitoring:

Logistics managers can utilize Power BI to keep track of vital metrics such as delivery performance in real-time through either live connections or scheduled refreshes. The feature enables accurate data monitoring for warehouse utilization, inventory levels, and transportation costs. Real-time insights provide the ability to pinpoint bottlenecks, resolve issues promptly, and make informed decisions.

6.3. Interactive dashboards and reports:

With Power BI, you can create visually appealing and interactive dashboards and reports. These visuals can provide logistics teams with a consolidated view of their performance indicators, such as on-time delivery rates, transit times, order volumes, and customer satisfaction. Interactive capabilities allow users to drill down into specific data points, apply filters, and explore trends or anomalies.

6.4. Data-driven decision-making:

With Power BI's analytics features, logistics experts can effectively analyze their data to identify patterns, trends, and correlations. By clearly presenting the data through visualizations, they can gain valuable insights into supply chain efficiency, inventory optimization, route optimization, demand forecasting, and overall operational performance. Armed with these insights, logistics professionals can make informed decisions and drive improvements throughout their operations.

6.5. Collaboration and sharing: With Power BI, users can easily share reports and dashboards with colleagues or stakeholders, promoting a collaborative environment. This

allows logistics teams to establish a data-driven culture, align stakeholders, and efficiently communicate performance. In addition, Power BI provides collaboration tools such as commenting, annotations, and subscription notifications.

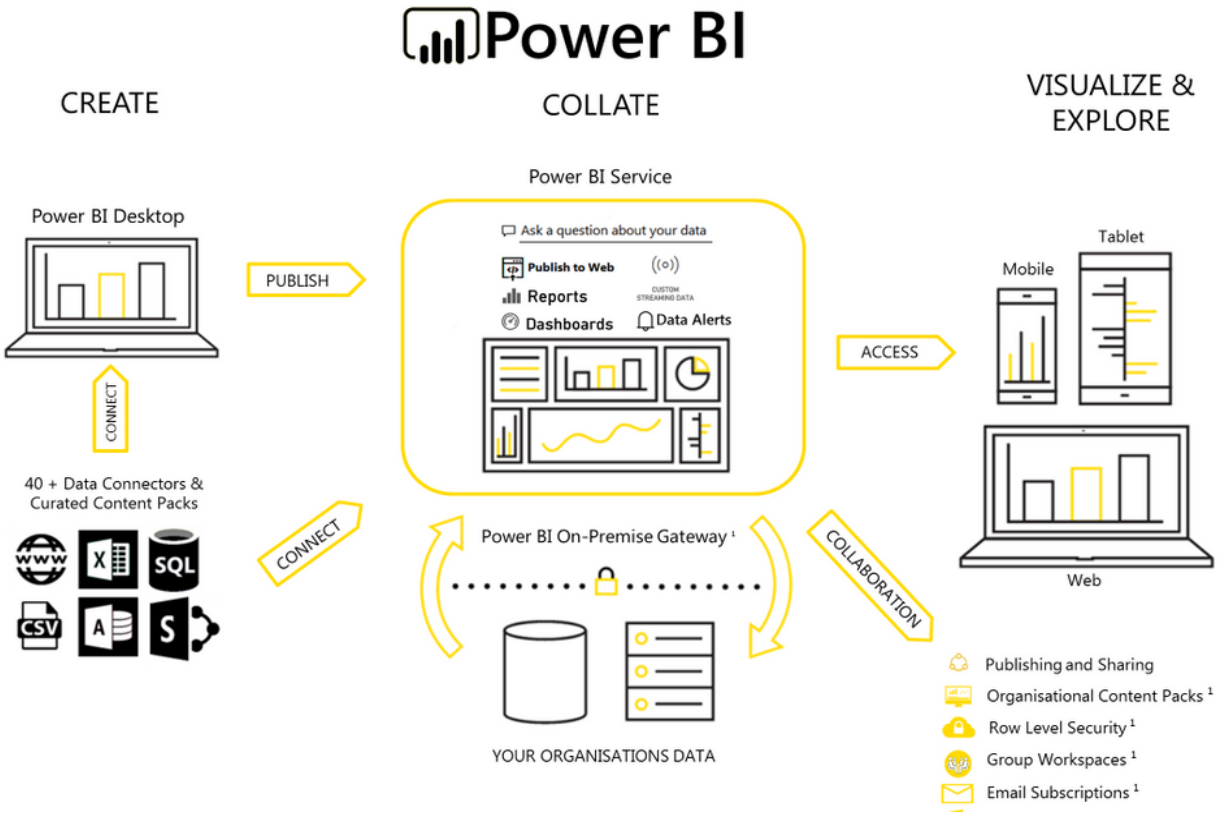

Figure 5 : Power BI Architecture

7.Step-by-Step guide: Utilizing Power BI for Data Analysis and Visualization

When it comes to utilizing Power BI in logistics, the usual course of action involves the following steps:

1. Connect to data sources: Import or establish connections to relevant data sources such as ERP systems, WMS (Warehouse Management Systems), TMS (Transportation Management Systems), or any other data repositories that hold logistics-related information.

2. Design reports and dashboards: Design visually appealing reports and dashboards that highlight critical metrics and KPIs using Power BI's simple drag-and-drop interface. Consider the specific needs and goals of your logistics operations when creating these visuals.

3. Add interactivity: Configure interactive elements like slicers, filters, or drill-through actions to enable users to explore the data and gain insights at various levels of detail.

4. Schedule data refresh: Ensure that your reports and dashboards are always updated with the latest information by setting up scheduled data refreshes or establishing live connections.

5. Share and collaborate: Share your Power BI reports and dashboards with others by publishing them to a shared workspace or distributing them to relevant stakeholders. Take advantage of Power BI's collaboration tools to facilitate discussions, gather feedback, and promote teamwork.

Logistics professionals can enhance their supply chain operations, optimize warehouse operations, and improve customer satisfaction by utilizing Power BI's capabilities. With the help of data modeling, calculation, and visualization, Power BI can provide valuable insights that can drive data-driven decisions.

8. Warehouse optimization

Whenever we think about Warehouse Optimization, two big questions arise at the beginning.

1) Why do we need Optimization?
2) How can we optimize a Warehouse?

Why it is necessary?

Warehouse optimization is nothing but doing the warehouse operations at the optimum time, and optimum cost with using all available resources without compromising Quality. For each company, customer satisfaction is an important aspect. In fulfilling the customer's demands and expectations, a warehouse plays a vital role. In short, a warehouse is the backbone of an organization or a company. For that warehouse optimization is important. A well-organized and optimized warehouse can lead to greater customer satisfaction, greater profit, and greater time-saving factor and vice versa.

There are several areas and operations which can be considered in the process of optimization.

For Example:

1) Picking
2) Inventory
3) Warehouse Management system
4) In-house material flow
5) Space and Resource Utilization etc.

How to optimize a Warehouse?

Above mentioned points can be improved with the following processes.

- Automation (Partially/Fully)
- With the implementation of the appropriate IT system i.e., WMS software.
- By using various analyses and methods. Like ABC/XYZ analysis, proper Picking strategy, and Demand Forecasting.
- Regular inventory audits and maintaining inventory accuracy.
- Functional area planning using the closeness rating method.
- Utilization of resources (i.e., Humans, Machines, Information Technology, etc.) at best.

For our case study, we utilized the Power BI tool a business intelligence tool to conduct ABC/XYZ analysis.

9. ABC – Analysis:

According to G. Wöhe, the ABC Analysis (Figure 6) is a straightforward way of categorizing materials based on their value and quantity.

When analyzing consumption dynamics, the XYZ analysis (Figure 7) calculates the variance coefficient of consumption or sales within a specific period. For instance, a planning object with the value BY may indicate a medium-volume planning object with a trend or seasonal demand.

The ABC/XYZ analysis categorizes planning objects (SKUs or characteristic value combinations) based on their value (revenue or sales volume) and consumption or sales dynamics. This method assigns each planning object to both an ABC and XYZ class during the analysis.

ABC classification	Value percentage	Proportion
A goods High value or sales percentage, low proportion	**approx. 80%** (70 – 80%)	**approx. 10%** (gering)
B goods Intermediate materials	**approx. 15%** (15 – 20%)	**approx. 20%** (10 – 40%)
C goods Low value or sales percentage, high proportion	**approx. 5%** (5 – 10%)	**approx. 70%** (> 40%)

Figure 6 : ABC Classification

Class	Consumption	Predictability
X	Constant, fluctuations are rather seldom	High
Y	Greater fluctuations, mostly for trend or seasonal reasons	Medium
Z	Completely irregular	Low

Figure 7 : XYZ Classification

9.1 Why Power BI in ABC analysis?

- Power BI helps to analyze data faster and easier.
- It requires less time compared to manual effort
- Accurate and simple representation.

9.2 To conduct ABC and XYZ analysis using Power BI, we followed the following steps:

1. Data preparation: To begin our data analysis in Power BI, it's essential to import the necessary data from your sources, including sales, inventory, or other datasets. It's crucial to ensure that the data is structured and related correctly for accurate analysis.

2. Define criteria: When deciding on the criteria for ABC and XYZ analysis, it's important to consider factors such as sales volume, revenue, and profitability for ABC analysis. For XYZ analysis, you may want to consider additional variables such as demand variability and frequency of sales.

3. Calculate metrics: Leverage Power BI's data modeling features and DAX formulas to determine metrics specific to your preferences. For instance, you can utilize SUM or other aggregation functions to compute sales volume or revenue for individual items.

4. Sort and rank: To organize and rank items based on calculated metrics, consider creating measures or calculated columns. Utilize DAX functions such as RANKX or TOPN to arrange the items within their respective categories.

5. Categorize items: To categorize items into ABC and XYZ categories, you can create additional calculated columns or measures. For ABC analysis, set thresholds based on the cumulative percentages of the calculated metrics. For XYZ analysis, determine appropriate thresholds based on items' characteristics and business requirements to categorize them into X, Y, and Z.

6. Visualize and analyze: To present the organized items and their measurements, one can generate visual aids like bar charts, pie charts, or tables. Additionally, interactive slicers or filters can be established to enable individuals to investigate the data through various dimensions or attributes.

7. Derive insights and actions: By analyzing the ABC and XYZ categories, you can identify significant patterns, trends, or outliers and use these insights to develop actionable strategies.

These strategies may include inventory management, pricing decisions, supplier prioritization, or customer segmentation, among others.

8. Share and collaborate: To share the Power BI report or dashboard, you can publish it to a shared workspace or distribute it to the relevant stakeholders. Promote collaboration and discussions among the team regarding the ABC and XYZ analysis findings, to agree on the necessary actions and drive progress.

By using Power BI to conduct ABC and XYZ analysis, you can develop a more comprehensive comprehension of your data, allocate resources strategically, and make informed decisions to enhance inventory management, supplier management, and overall operational efficiency.

10. ABC analysis utilizing Power BI

10.1 Task A: Improving Supply Chain Efficiency with Business Intelligence

Let us consider Computer AG and they want to optimize the stock carrying costs for its spare parts business. To dispose of parts properly, a material analysis must be performed.

The dataset is given for 12 months for 10 different with sales price per month and average price per piece.

Using past data and Power BI, we conducted an ABC analysis and obtained the following table (Figure 8), charts(Figure 9, Figure 10) and results.

ABC - Analysis Table

Ranking	Material Designation	Price [Euro/Piece]	Total Sales [pieces]	Consumption in Euros	Cum. Consm	Consumption %	Cum.Consm %	Item%	Sum of Cum.Item%	ABC-Classification
1	M10	750 €	38300	28.725.000 €	28725000	30 %	30 %	10 %	10 %	A
2	M2	300 €	81900	24.570.000 €	53295000	26 %	56 %	10 %	20 %	A
3	M4	650 €	34900	22.685.000 €	75980000	24 %	80 %	10 %	30 %	A
4	M9	450 €	16200	7.290.000 €	83270000	8 %	88 %	10 %	40 %	B
5	M1	15 €	226200	3.393.000 €	86663000	4 %	92 %	10 %	50 %	B
6	M6	25 €	94800	2.370.000 €	89033000	3 %	94 %	10 %	60 %	B
7	M8	20 €	118200	2.364.000 €	91397000	2 %	97 %	10 %	70 %	C
8	M3	10 €	181110	1.811.100 €	93208100	2 %	98 %	10 %	80 %	C
9	M7	45 €	23100	1.039.500 €	94247600	1 %	100 %	10 %	90 %	C
10	M5	35 €	11300	395.500 €	94643100	0 %	100 %	10 %	100 %	C

Figure 9 : Data Table for ABC Classification

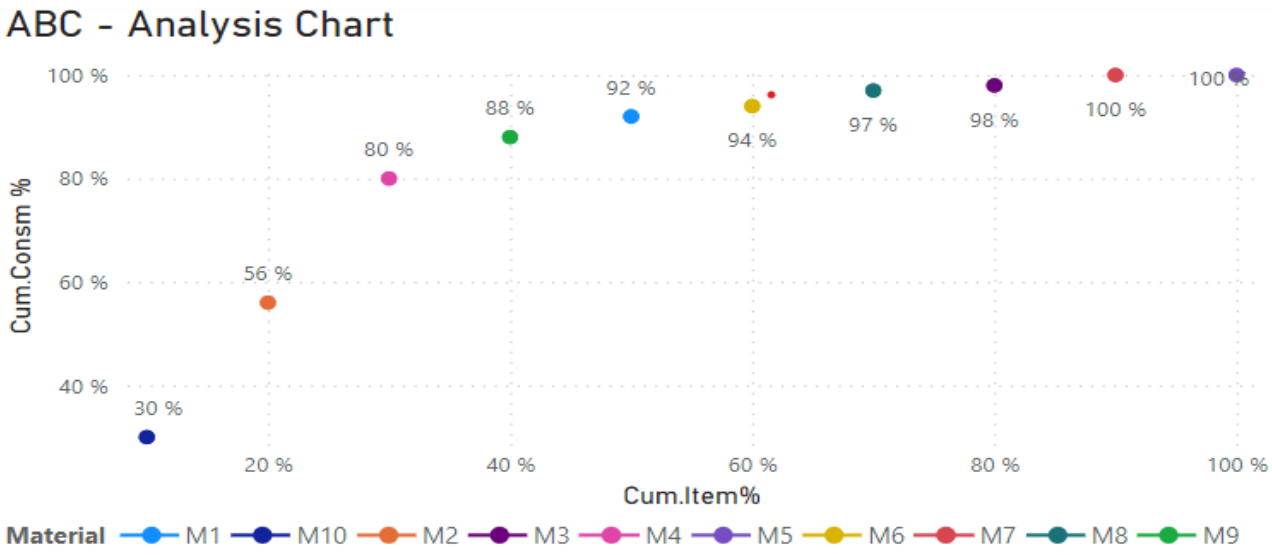

Figure 8 : ABC Analysis Chart (1)

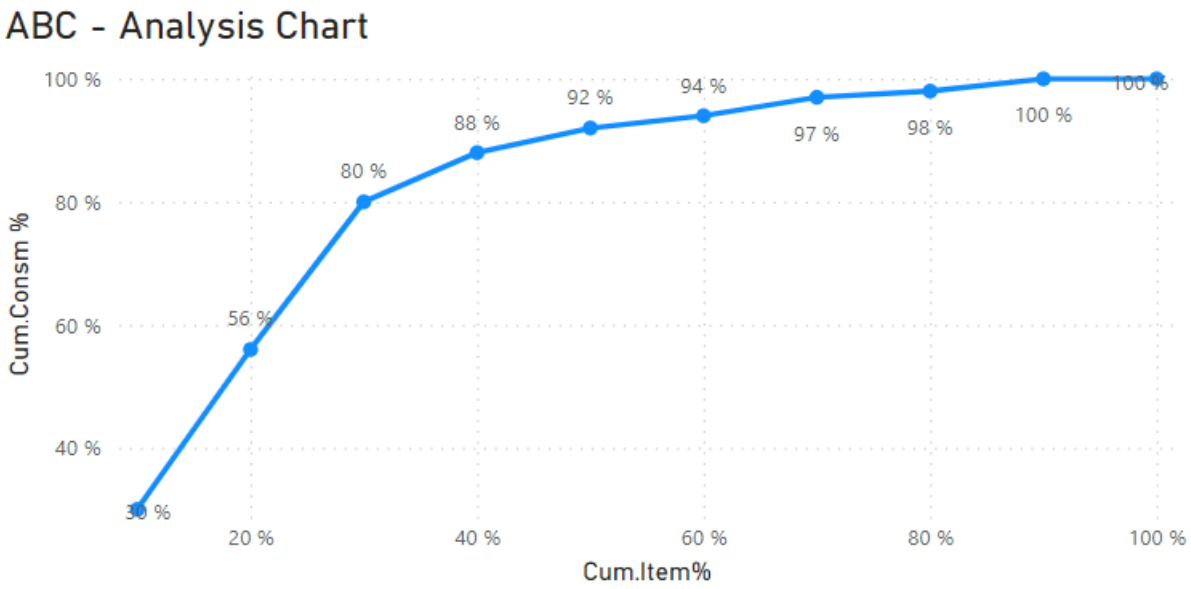

Figure 10 : ABC Analysis Chart (2)

If we compare our results to the standard ABC analysis, we can say that products M10, M2, and M4 are the A- articles which means we have 80% of the sales of these two items which share approx. 20% of the inventory. On the other side M8, M3, M7, and M5 are the C- Articles which means they have more proportion to the inventory than the sales.

So, with the help of ABC classification, one can get an easy idea of which items should be easy to reach in the warehouse and which not. Similarly, with the help of Past data, we perform XYZ analysis. (Figure 11) shows the results and (Figure 12, Figure 13) shows the charts.

XYZ - Analysis

Ranking	Material Designation	Price [Euro/Piece]	Total Sales [pieces]	V	s	VC%	Sum of Item%	Cum.Items %	XYZ-Classification
1	M6	25	94800	7.900,00	2.115,00	27 %	10 %	10 %	X
2	M1	15	226200	18.850,00	7.142,00	38 %	10 %	20 %	X
3	M3	10	181110	15.093,00	6.860,00	45 %	10 %	30 %	X
4	M4	650	34900	2.908,00	1.504,00	52 %	10 %	40 %	Y
5	M2	300	81900	6.825,00	3.616,00	53 %	10 %	50 %	Y
6	M7	45	23100	1.925,00	1.238,00	64 %	10 %	60 %	Y
7	M8	20	118200	9.850,00	6.579,00	67 %	10 %	70 %	Y
8	M9	450	16200	1.350,00	1.237,00	92 %	10 %	80 %	Z
9	M10	750	38300	3.192,00	3.283,00	103 %	10 %	90 %	Z
10	M5	35	11300	942,00	993,00	105 %	10 %	100 %	Z

Figure 11 : Data Table for XYZ Classification

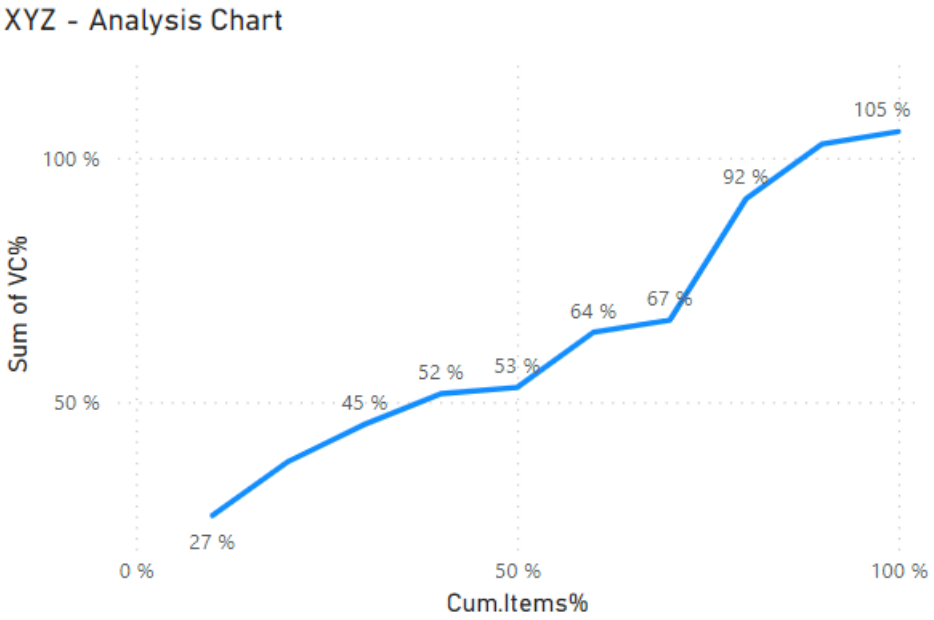

Figure 12 : XYZ Analysis Chart (1)

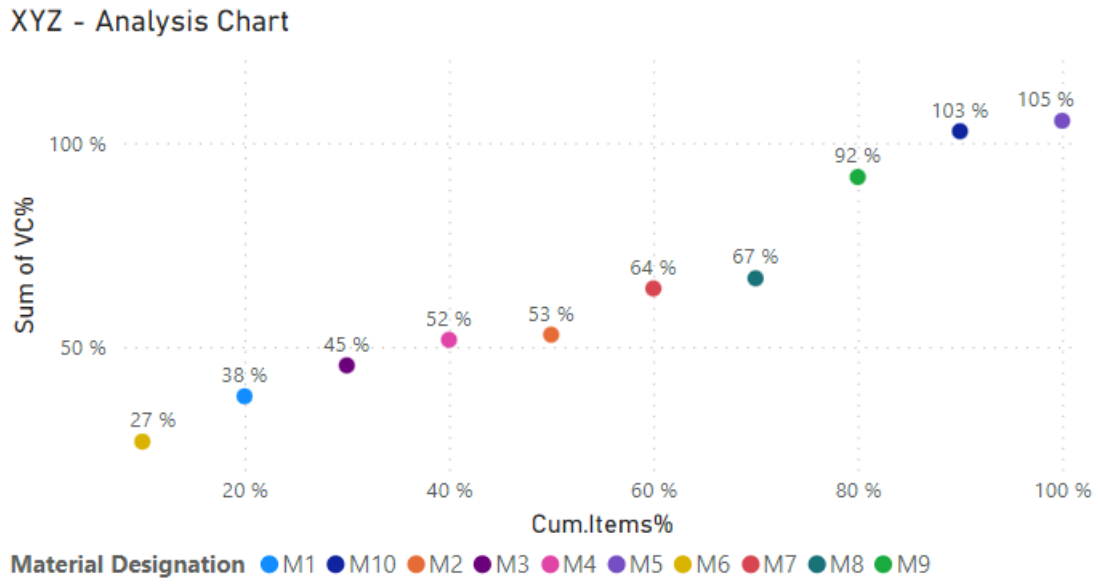

Figure 13 : XYZ Analysis Classification (2)

The XYZ analysis represents a method for the classification of the material according to the regularity of consumption.

In simple words with XYZ classification, it is easier to regularity or irregularity of the demand. For example, in our case the demand of M6, M1, and M3 is easy to predict because they

belong to X- articles which means the Variance Coefficient (VC=Standard deviation/Variance) of X- articles is lower than 30%.

So, we can say that as higher the coefficient of variance as higher the irregularity in the demand.

After performing both ABC and XYZ analysis we combined both (Figure 14) to get a clear idea about material provision (Figure 15).

If we compare our results (Figure 16) to the material provision principle, we can get a clear picture of the inventory.

ABC/XYZ Analysis Results

ABC/XYZ-Class	X	Y	Z	Total
A		2	1	**3**
B	2		1	**3**
C	1	2	1	**4**
Total	**3**	**4**	**3**	**10**

Figure 14 : Weightage according to ABC/XYZ Classification

Classification	X	Y	Z
A	-	M2, M4	M10
B	M1,M6	-	M9
C	M3	M7,M8	M5

Figure 15 : Assignment of Products

Results:

Material provision principles:

	X	Y	Z
A	JIT	JIT	Individual provisioning
B	JIT	stock	Individual provisioning
C	stock	stock	stock

Figure 16 : ABC/XYZ Matrix

BX, AY= M1, M2, M4, M6 = JIT

CX, BY, CY, CZ= M3, M5, M7, M8 = Stock

By performing ABC/XYZ analysis, we can get an idea about required space & stock, and demand realization, and ultimately it helps to optimize our warehouse by eliminating shortage of material, bottleneck, and excess inventory.

The use of the Power BI Tool in the optimization of a warehouse can be an advantage to analyzing, sorting, and removing unnecessary data accurately and more quickly with simple and easy-to-understand results.

10.2 Task B: Optimization of Distribution Costs using Power BI

For this, we utilized historical data.

The company Snack Deliveries wants to verify its distribution concept and wants to optimize the distribution costs respectively the costs of transportation.

Task

Several distribution variants are to be verified, at which the following configurations and combinations are imaginable:

a) Customer supply from four warehouses that are directly assigned to the respective factory

b) Building of one or more central warehouses for the supply of subareas

c) Building of one or more central warehouses for the supply of subareas

d) Additional installation of regional warehouses

The variants of a, b, and c can also arbitrarily be combined. Major customers can be directly supplied if the trucks can be filled sufficiently. For transport, there are semitrailers, which can load up to 33 pallets. Small trucks with a capacity of 500 cartons are used for delivery from the regional warehouses. It is assumed that each item is packed in a carton with sizes L = 60 cm, W = 40 cm, and H = 30 cm. Each loaded Euro pallet can be up to 2.4 m (loaded) high. For each regional warehouse location (for case c), fixed costs of € 10,000 per month are incurred, for a central warehouse and factory warehouse, fixed costs of € 50,000 are incurred. The movement of a pallet in the respective warehouse is set at 3 €. The transportation costs per truck are estimated at 1 € / km (the prices are given by a logistics service provider, therefore no return trips.

Data and general specifications:

Data & generalspecifications

Factory Location	Total Volume(Cartons)	Customers Served	No of Articles in Circulation
Lorsch	82678	1463	10334750
Mannheim	172159	1709	21519875
Mönchengladbach	276286	1702	34535750
Vechta	63154	1699	7894250
Total	**594277**	**1730**	**74284625**

Figure 17 : Customers Served and Carton Volume Distributed

Case A: Customers get direct supply from the factory warehouses (Figure 18).

Formula [1]: Distance between locations based on latitudes and longitudes in DAX (Power BI).

```
Distance b/w Factory & Customer =

var d = ACOS(SIN(Auftragsdatei[Werk Lat(radians)])*SIN(Auftragsdatei[Kunde
Lat(radians)])+COS(Auftragsdatei[Kunde Lat(radians)])*COS(Auftragsdatei[Werk
Lat(radians)])*COS(Auftragsdatei[Werk Lon(radians)]-Auftragsdatei[Kunde Lon(radians)]))
var distance = 6371*d
RETURN distance
```

Case A : Factory to Customers

Factory Location	No. of Cartons	No. of Pallets	Small Trucks	Distance b/w Factory & Customer	Total Costs
Vechta	63154	2256	126	284	135,369.53
Mönchengladbach	276286	9867	553	254	408,682.74
Lorsch	82678	2953	165	239	162,763.25
Mannheim	172159	6149	344	231	291,013.42
Total	**594277**	**21224**	**1189**	**250**	**881,956.12**

Figure 18 : Total Costs for Factory Warehouses to Customers (Case-A)

Case B: Customers served from factory warehouses to central warehouse and from central warehouse to customers (Figure 19).

Central Warehouse (Figure 20) is set up based on factory locations.

Center of Gravity- Geographic Midpoint:

The geographic midpoint is calculated by finding the center of gravity for the locations in the 'Your Places' list. The latitude and longitude for each location are converted into Cartesian (x, y, z) coordinates. The x, y, and z coordinates are then multiplied by the weighting factor and added together. A line can be drawn from the center of the earth out to this new x, y, z coordinate, and the point where the line intersects the surface of the earth is the geographic midpoint. This surface point is converted into the latitude and longitude for the midpoint.

Formula [2]: Center of Gravity Formula in DAX:

```
X = DIVIDE(SUM(NewData[Werk Lat]*NewData[Sum of BestellMenge]), SUM('NewData'[Sum of BestellMenge]))
```

```
Y = DIVIDE(SUM(NewData[Werk Lon] * NewData[Sum of BestellMenge]), SUM('NewData'[Sum of BestellMenge]))
```

Case B : 1. Factory to Central Warehouse

Factory	No. of Cartons	No. of Pallets	Big Trucks	Distance b/w Factory & CW	Total Costs
Lorsch	82678	2953	89	135.06	20,943.02
Mannheim	172159	6149	186	145.22	45,503.55
Mönchengladbach	276286	9867	299	96.86	58,562.88
Vechta	63154	2256	68	238.74	23,083.75
Total	**594277**	**21224**	**643**	**145.35**	**157,154.65**

Case B : 2. Central Warehouse to Customers

Factory	No. of Cartons	No. of Pallets	Big Trucks	Distance b/w CW & Customers	TotalCosts
Lorsch	82678	2953	89	228.77	29,328.76
Mannheim	172159	6149	186	215.01	58,506.14
Mönchengladbach	276286	9867	299	216.96	94,476.82
Vechta	63154	2256	68	222.05	21,943.12
Total	**594277**	**21224**	**643**	**219.84**	**205,064.80**

Figure 19:Total Costs for Factory Warehouses to Central Warehouses to Customers (Case-B)

Cental Warehouse based on Factories

Lat	Lon
50.65	7.51

Figure 20 : Location based on Factories.

Central Warehouse Location in Map (Flammersfeld)

Figure 21 : Location in Power BI Map

Case C: Customers served from factory warehouses to central warehouse and from central warehouse to customers (Figure 22).

Central Warehouse is set up based on customer locations.

Case C : 1. Factory to Central Warehouse

Factory	No of Cartons	No of Palllets	Big Trucks	Distance b/w Factory & CW	TotalCosts
Lorsch	82678	2953	89	129.16	20,414.97
Mannheim	172159	6149	186	145.84	45,618.53
Mönchengladbach	276286	9867	299	158.21	76,908.28
Vechta	63154	2256	68	216.93	21,593.49
Total	**594277**	**21224**	**643**	**159.32**	**166,137.84**

Case C : 2. Central Warehouse to Customers

Factory	No of Cartons	No of Pallets	Big Trucks	Distance b/w CW & Customers	TotalCosts
Mönchengladbach	276286	9867	299	205.52	91,055.66
Mannheim	172159	6149	186	202.36	56,148.59
Lorsch	82678	2953	89	215.48	28,138.92
Vechta	63154	2256	68	206.55	20,883.66
Total	**594277**	**21224**	**643**	**206.90**	**196,741.94**

Figure 22 : Total Costs for Factory Warehouses to Central Warehouse to Customers (Case-C)

Central Warehouse based on Customers

Lat	Lon
50.80	8.61

Figure 23 : Location-based on Customers

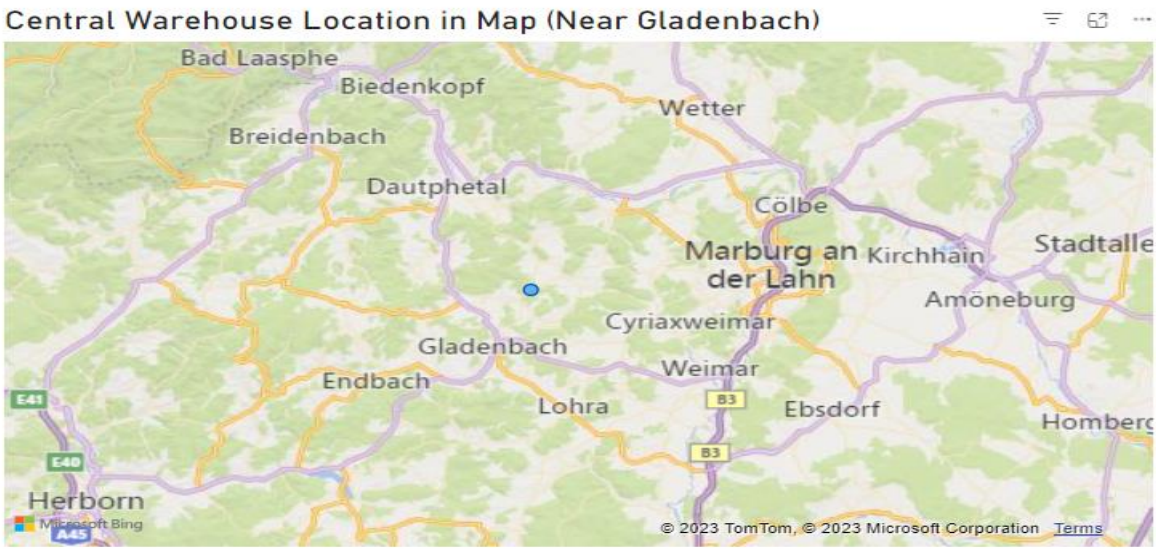

Figure 24 : Location near Gladenbach in Power BI Map

Case D: Customers served from factory warehouses to central warehouse and from central warehouse to regional warehouses and from regional warehouses to customers.

Case D : 1. Factory to Central Warehouse

Factroy	No of Cartons	No of Pallets	Big Trucks	Distance b/w Factory & CW(Case B)	Total Costs
Lorsch	82678	2953	89	135.06	20,943.02
Mannheim	172159	6149	186	145.22	45,503.55
Mönchengladbach	276286	9867	299	96.86	58,562.88
Vechta	63154	2256	68	238.74	23,083.75
Total	**594277**	**21224**	**643**	**145.35**	**157,154.65**

Case D : 2. C W to Regional Warehouse & R W to Customers

Type	No of Cartons	No of Pallets	Big Trucks	Small Trucks	Distance from RW to CW	Distance from RW to Customers	Total Costs
CW1 to RW1	112614	4022	122		323		51472
CW1 to RW2	173683	6202	188		235		62786
RW1 to Custm	112614	4022		226		136	42802
RW2 to Custm	173683	6202		348		117	59322
CW1 to Custm	307980	10999		616		149	124781

Figure 25 : Total Cost for Warehouses to Central Warehouses to Regional Warehouses to Customers (Case- D)

Figure 26: Locations of Regional Warehouses in Power BI Map

Regional Warehouse Locations

RW	Lat	Long
Bispingen	53,13	9,98
Flammersfeld	50,64	7,53
Remseck am Neckar	48,85	9,25

Figure 27 : Regional Warehouses

Result:

Total Transportation Costs

Case A	Case B	Case C	Case D
881,956.12	612,219.44	612,879.79	878,317.65

Figure 28 : Total Transportation Costs for all scenarios

After analyzing all four scenarios, it is recommended that a central warehouse be established at the Flammersfeld location which is Case B in our example. The goods can then be sorted based on the number of orders and transported to the customers via trucks. This approach will significantly reduce transportation costs, leading to a decrease in the overall expenditure.

Overall, by leveraging Power BI ‘s capabilities for optimizing distribution costs, businesses can gain comprehensive visibility, performed detailed analysis, identify cost–saving opportunities, and make informed decisions. This ultimately leads to improved cost efficiency, enhanced profitability, and a competitive advantage in the market.

11. Future Trends in Logistics

1. Internet of Things (IoT)

2. Artificial intelligence (AI) and Machine Learning (ML)

3. Blockchain

4. Autonomous Vehicles

5. Cloud Computing

6. Robotics and Automation

7. Augmented Reality (AR) and Virtual Reality (VR)

8. Predictive Analysis

9. Advanced GPS and Geolocation Services

10. Sustainability Solutions

11.1 Applications, Advantages, and Limitations:

1. Internet of Things (IoT):

Applications: IoT devices, such as sensors and RFID tags, can be used for real-time tracking of shipments, monitoring the condition of goods (e.g., temperature-sensitive products), tracking inventory levels, and managing fleet vehicles.

Advantages: Improved visibility and transparency in the supply chain, enabling better inventory management, reduced theft, enhanced asset utilization, and increased operational efficiency.

Limitations: Security concerns like data breaches and hacking, integration complexities with existing systems, and the need for reliable connectivity in remote areas.

2. Artificial Intelligence (AI) and Machine Learning (ML):

Applications: AI and ML can optimize route planning, demand forecasting, supply chain risk management, fraud detection, and customer service in logistics operations.

Advantages: Enhanced decision-making capabilities, reduced operational costs through automation, improved customer satisfaction through personalized services, and efficient resource allocation.

Limitations: Dependence on quality data for accurate predictions, potential bias in algorithms, and the need for skilled personnel to develop and maintain AI-based systems.

3. Blockchain:

Applications: Blockchain can be used for secure and tamper-resistant record-keeping in supply chains, tracking product provenance, facilitating smart contracts, and improving transparency in logistics processes.

Advantages: Enhanced traceability, reduced fraud, increased trust among stakeholders, and streamlined cross-border transactions.

Limitations: Scalability issues, high energy consumption, and the challenge of standardizing blockchain implementations across industries.

4. Autonomous Vehicles:

Applications: Autonomous trucks and drones can be used for last-mile delivery, long-haul transportation, and inventory management in warehouses.

Advantages: Increased efficiency and speed, reduced labor costs, improved safety, and the potential for 24/7 operations.

Limitations: Regulatory hurdles, public acceptance concerns, limitations in adverse weather conditions, and complex liability and insurance issues.

5. Cloud Computing:

Applications: Cloud-based logistics platforms facilitate real-time data sharing, collaboration, and scalability in supply chain operations.

Advantages: Accessibility from anywhere, cost savings due to reduced hardware requirements, seamless integration with other systems, and simplified maintenance and updates.

Limitations: Data security and privacy concerns, reliance on stable internet connectivity, and potential data transfer bottlenecks for large datasets.

6. Robotics and Automation:

Applications: Warehouse robots and automated picking systems optimize order fulfillment, reduce human error, and enhance warehouse productivity.

Advantages: Increased efficiency, reduced labor costs, improved order accuracy, and faster order processing times.

Limitations: High initial investment, complexity in integrating with existing systems, and potential job displacement concerns.

7. Augmented Reality (AR) and Virtual Reality (VR):

Applications: AR and VR can be used for training warehouse staff, maintenance and repair tasks, and remote assistance to field technicians.

Advantages: Enhanced workforce productivity, reduced training time, improved equipment maintenance, and better customer support experiences.

Limitations: Cost of implementing AR/VR technology, limited use cases in certain logistics operations, and potential discomfort or safety issues during usage.

8. Predictive Analytics:

Applications: Predictive analytics can be applied to demand forecasting, inventory optimization, route planning, and supply chain risk management.

Advantages: Better decision-making based on data-driven insights, reduced inventory holding costs, improved customer satisfaction, and efficient resource allocation.

Limitations: Accuracy of predictions depends on data quality and model complexity, and challenges in handling dynamic and uncertain market conditions.

9. Advanced GPS and Geolocation Services:

Applications: GPS technology combined with geolocation services enables real-time tracking of fleet vehicles, precise route optimization, and location-based analytics.

Advantages: Improved fleet management, on-time deliveries, reduced fuel consumption, and enhanced customer service through accurate delivery estimates.

Limitations: GPS signal disruptions in urban canyons or remote areas, potential inaccuracies in dense urban environments, and reliance on battery life for GPS devices.

10. Sustainability Solutions:

Applications: Sustainable practices, such as green logistics and eco-friendly packaging, promote environmental responsibility throughout the supply chain.

Advantages: Reduced carbon footprint, improved corporate social responsibility (CSR) image, and potential cost savings through optimized resource usage.

Limitations: Implementation costs, limited availability of eco-friendly alternatives, and challenges in balancing sustainability with cost-effectiveness.

12. LIMITATIONS

While Business Intelligence (BI) offers valuable insights and benefits in logistics, it also has certain limitations. Here are some limitations to consider when using BI in logistics:

1. To ensure accurate and reliable business intelligence (BI) in logistics, it is crucial to address various challenges. One significant challenge is data quality, as incomplete or inconsistent data, data entry errors, or outdated information can affect the reliability of BI analysis. Proper data governance and data cleansing processes can help ensure data quality.
2. Another challenge is integrating data from multiple systems and stakeholders, which can be complex and time-consuming. Effective data integration strategies and tools are essential to consolidate data from various sources.
3. Real-time data availability is also important for effective decision-making in logistics operations. However, integrating and accessing real-time data from external partners, suppliers, or logistics service providers can be challenging.
4. Analyzing complex logistics data requires advanced analytics techniques and expertise, as it comprises numerous variables such as transportation routes, inventory levels, carrier performance, and demand fluctuations.
5. While BI can provide historical and current data analysis, its predictive capabilities in logistics may be limited. Predictive analytics models and techniques beyond traditional BI may be necessary for forecasting future demand, optimizing supply chain operations, or predicting transportation disruptions.
6. User adoption and training are crucial for successful BI implementation in logistics. Overcoming resistance to change and ensuring proper training and support can be challenging. Implementing and maintaining a robust BI infrastructure can involve significant costs and resource allocation, which may limit small- and medium-sized logistics companies from fully leveraging BI.

Despite these challenges, the effective use of BI in logistics can enhance visibility, optimize operations, improve decision-making, and drive overall efficiency and competitiveness. Strategies, data management practices, and continuous improvement initiatives can help address these challenges and maximize the benefits of BI.

13. CONCLUSION

In today's competitive business world, companies face increasing demands regardless of their industry. They must strive to reduce costs in operations, products, and services while making informed decisions based on operational and historical data. To achieve these goals, users need to be able to explore and analyze data, create various reports, and predict the behavior of customers, products, and processes. Business intelligence tools are designed to assist users in these tasks by querying, reporting, analyzing, and visualizing data, while also revealing hidden patterns, correlations, and relationships. However, the true potential of these tools is unlocked by users who have a deep understanding of the business, the data, and the analytical methods involved, as well as familiarity with the software environment.

The use of Business Intelligence (BI) systems in logistics provides numerous benefits for companies. BI solutions can enhance the decision-making process related to supply chain logistics and improve performance across various areas of business activity. Furthermore, analytics solutions can provide high-quality information for decision-making, improving the logistics area as well as the entire enterprise's decision-making process. BI solutions can also lead to cost savings and optimization in reverse logistics, support third-party logistics providers, and improve transportation efficiency through route optimization and inventory management.

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