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DATA-DRIVEN MATERIAL MANAGEMENT: INSIGHTS FROM SAP MM APPLICATIONS IN INDIAN INDUSTRY

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Abstract
The paper presents important strategies used in practice at Indian industry to manage their inventory and procurement processes, and uses the software widely implemented in a number of Indian companies to demonstrate their implementation. Importantly, the unique rich data sources that have the potential to provide a wealth of information for a range of transaction-based operational research studies are not widely realized. We aim to build an awareness of what can be achieved in order to encourage future development. Although many of the companies have formal SOPs in place for managing procurement, not all are being used properly due to the inexperience of some staff and their business conditions. The aim of this brief paper is to identify the complex nature of businesses and to investigate the level of practical application of theoretical models of quantitative approaches to dealing with 'real-life' scenarios.

Keywords
Data-Driven Material Management, Material Management Systems, SAP MM, Indian Industry, ERP Applications, Supply Chain Optimization

1. Introduction

Material resource management is a vital function of industrial enterprises, and it has a strong bearing on the competitive capabilities of the enterprise. Current advances have strengthened the IT capabilities within the domain of materials management, which not only assist the firm in maintaining material resource records but also support the related decisions. The advance of Information Technology (IT) provides better tracking possibilities, better decision support systems for managers, and also aids in implementing real-time applications. Applications of Information Technology in the domain of materials management, especially in an Enterprise Resource Planning (ERP) framework, are becoming common. The Management of Materials module of an Enterprise Resource Planning system supports the entire materials cycle.

The purpose of this paper is to survey the material management support applications in the Indian industry and to identify the role of IT in materials management by analyzing its usage characteristics and patterns. The taxonomy, the usage specifics, and the ideographic generalizability of IT resources within organizations and their interconnections in different industrial enterprises are discussed. This analysis is based on the observation that the most popular vendor of ERP systems in India has a high degree of dominance in both the Indian and the global markets. The material-related transactions of all companies that have implemented the relevant systems can be studied and analyzed using a data set derived from the related activities of various companies. Using the classification, the transactions and their details are extracted for

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the study. A sample of companies is studied to identify and outline the resource usage patterns for each group in detail. The application, usage, and data patterns are identified and collated into appropriate forms for each group. Support at both the sector levels (industry-specific patterns) and the industry levels (molecule-specific patterns) are studied, and general trends are identified. Certain patterns found at the company-firm levels are isolated, and suggestions for their management are presented.

1.1. Background and Significance

As most world economies are moving towards automated manufacturing systems, ERP systems are becoming the core of the technical architecture. Companies are looking to take on the advantages offered by such next-generation business systems to achieve business excellence. When it comes to an industry-based study related to Material Management, there is a clear deficit of similar work. Here we narrow the focus to MM in Belgaum, an industrial town in India. We have tried to establish the critical importance of ERP in strategic business development in the competitive era. The paper is organized into eight sections. Following the introduction, in Section 2, different types of ERP systems have been classified with a particular reference to architecture. Section 3 deals with the Material Management module of the package. Section 4 consists of Methodology. We have considered case studies of three companies located in and around the industrial area of Belgaum, engaged in the manufacturing and supply of parts for an automobile manufacturer and in the manufacture of processed products made of iron ore. Specifically, the focus is on a three-level supply chain dealer (the lowest level), supplier (the middle level), and the manufacturing unit which assembles the automobile (the top level). Section 5 gives the Literature Review. In Section 6, there is a review of the industrial town. In Section 7, the results of the study are presented. Finally, conclusions are presented in Section 8.

1.2. Research Question

Adoption and Implementation

- *What are the key factors influencing the adoption of SAP MM in Indian industries?*
- *How is SAP MM implemented in various sectors of Indian industry?*

Impact on Efficiency

- *How does the use of SAP MM enhance the efficiency of material management processes in Indian industries?*
- *What measurable improvements in inventory management are observed with SAP MM implementation?*

1.3. Research Objectives

Below are the objectives of the research study: Document the nature of MM configurations in Indian organizations. Explore usage and MMI impacts in generating resource utility. Identify the emerging trends in inventory management in Indian industries. Address the challenges arising out of the integration of MMI and control systems. Identify a set of opportunities for process automation using MMI and integration of ERP systems. Carry out a thorough industry-wide analysis and measurement of deployment strategies of MMI platforms at organization and commerce levels. Identify the internal barriers to the use of MMI applications and external

constraints that are hindering the development and deployment of MMI technologies in real structures. Characterize possible business scenarios, dependent events, expand monitoring algorithms, and 'network service quality' parameters. Trigger discussions in the research and development community and increase knowledge and interest in MMI technologies before industrial deployment takes off with fully developed, reliable, and security-enabled systems.

1.4. Scope and Limitations

For any insightful analysis to be carried out, the information related to data must be available and genuine. Given the relatively new implementation of data analytics, the data related to SAP MM is only available for some business entities in the Indian industry. Because of their confidentiality policy, these companies are not willing to share their data publicly. Specifically, the data requirement for conducting analysis related to SAP APO, customer service management module, etc., is still not fulfilled because of the lack of digitization. Therefore, drawing collective conclusions from the industry, as evident from the available SAP MM data, becomes a significant limitation. Data collection and refining are other significant issues, as there is a possibility that the provided data consist of duplicates, ambiguities, insufficient information, and incorrect ideas recorded in the system.

Difficulties in the parameter estimation prevail in the data mining process, which changes the data into polished information. Thus, maintaining the quality of the data becomes a challenging task, and there might be a possibility of inappropriate conclusions because of the low-quality data. In addition, data security, integrity, and issues related to privacy, along with the lack of authentication of the data, are some of the major problems involved in the SAP MM data analysis. Another severe challenge arises from governmental and tax-related elaborations, such as GST. These lead to constant changes and modifications in the existing traditional schemes and modern concepts that are used by the manufacturing companies' systems.

2. Literature Review

The literature review related to the research problem, for which at first the literature on SAP MM is reviewed. Some of the benefits and limitations of SAP implementation in various industries have been discussed. (Ganesh & Mehta, 2010) identifies and ranks 30 critical success factors for successful ERP implementation at Indian SMEs. (Kannabiran & Dharmalingam, 2012) examines the enablers and inhibitors of advanced IT adoption among Indian auto ancillary SMEs. (Bhadouria et al., 2011) explores the key factors influencing ERP adoption decisions in SMEs in India also (Gargeya & Brady, 2005) identifies factors contributing to successful or failed SAP ERP system implementations. In the similar vein (Upadhyay et al., 2011) identifies four crucial factors that influence ERP implementation in Indian small and medium enterprises.(Chandraju et al., 2012) The implementation of SAP Materials Management (MM) module in various sectors of Indian industry has shown significant benefits. In the sugar industry, SAP MM enables efficient material requirement planning, reducing ordering time and improving inventory management. (Gupta et al., 2018) The SAP MM module facilitates cost-effective inventory processes, handling material procurement, inventory management, and vendor invoice verification across organizations. (Korade, 2020) In the power sector, the implementation of SAP ERP in MSEDCL (a public sector undertaking) has improved production planning, budgetary

controls, cost estimations, and stock valuations. (Kumar et al., 2022) focuses on analyzing the variables influencing Industry 4.0 implementation in India using SAP-LAP and e-IRP approaches. (Singh et al., 2012) the implementation of supply chain management in a medium-scale construction organization, but does not specifically address SAP MM implementation across Indian industries. (Dey, 2001) The paper discusses how business process re-engineering and the use of IT tools can improve materials management processes in an Indian petroleum refinery also (Alfi et al., 2022) evaluates the implementation of the SAP Material Management (MM) module for material procurement processes. (Post Graduate Student, Department of Architecture, School of Planning and Architecture, Vijayawada (Andhra Pradesh), India. et al., 2022) proposes a framework using Autodesk Revit, MS Project, and MS Access to optimize the workflow of material management processes in Indian residential projects. (Kar & Jha, 2020) examines the effect of material management issues on the schedule and cost performance of construction projects in India on the similar node (Sambhaji et al., 2022) The use of SAP ERP tool can enhance the efficiency of materials planning, master production schedule, and capacity planning in oil and gas industries. The literature review related to various decisions that could be undertaken at the top management level, which are mainly dependent upon efficient information management, has also been discussed. General decisions related to material management are also discussed. After gaining insight into the decisions that the top management has to make, we have shown how the enterprise application systems (specifically SAP MM) could provide necessary information to the top management so that they could make decisions based on the information, for which necessary informational and structural properties of SAP MM have been provided. In the present environment, an increasing trend has been observed by researchers to study topics such as decision making, efficiency, and the process of effective communication in management within industry applications. It was pointed out that the intermediate structure of vertically integrated firms can minimize the potential for capturing the product line over the input supplies. Advantages such as improving customer satisfaction, decreasing task response time, reducing overheads, and increasing the visibility of processes for firms have been discussed. The impact of information technology in enhancing the performance of the Indian retail industry in terms of financial as well as non-financial measures has been studied.

2.1. Conceptual Framework of Material Management

'Material' is an essential component of a firm's production practice. Without proper sourcing, processing, and disposal of material through procurement, production and inventory control, and waste management, a firm's financial performance can be impacted, which may, in turn, become a barrier for corporate industry directives, especially for those firms that are performing in a competitive market. This calls for efficient management of material in particular and the system of Materials Planning and Control in general. The functions of Materials Planning and Control in operations are essential for any organization, from a small firm to a large transnational corporation. Better control of material interests and inventory incorporated through the development of software technology has contributed in a substantial and unalterable manner to the competitive advantage of the organization.

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The association between business management and information systems is significant, as management has to depend upon data and information based on which performance can be monitored and improved. In this instance, computer-based systems come into force. With information technology in place, data and information on different aspects can be collected, analyzed, and presented to management. In manufacturing and distribution-related activities, Materials Requirements Planning and Manufacturing Resource Planning can be used for decision making relating to materials management, along with other advanced tools of enterprise planning, distribution resource planning, and customer relationship management. In today's dynamic world, the business system needs to be more flexible. The development of a decision-based process management system should be interpreted as forward-looking to also encompass new technologies in the field.

2.2. Role of Data in Material Management

Data-driven approaches transform data into useful or actionable information. Data-driven approaches facilitate the use of available, diverse, and large-scale data to improve, automate, and enhance analytics. They describe or advise IR applications and decision-making in IR frameworks, thus transforming data into useful or actionable information. The increasing use of data-driven methods in the literature is reflected by a greater number of relevant publications. Making effective and useful changes frequently from large data produced quickly in real time is the essence of data-driven approaches. Effective decision-making processes are largely dependent on the quality and availability of information. Enterprise resource planning, together with data-driven methods, has the potential to improve these processes.

Materials in the form of raw materials through to components or semi-finished materials are the primary point of interest in the Incoming Logistics and the Optimized Material Flow projects. Poor material data increases the complexity of data acquisition, data availability, as well as the data cleansing process. This means that firms need to know the chemistry of raw materials; they need to handle the materials as chemicals and not just as basic solids. In addition, materials might not be the same because of different commodity codes found in different systems. In one system, material comes with code 123456, but in a different system, the same material might be identified as code 654321.

To make data ready for analysis, some information and communication technology users have to complete time-wasting tasks, such as cleansing, integration, and reconciliation, which is sometimes called the big data paradox. Businesses that can cleanse and integrate their high amounts of international material master data have an upcoming advantage. Currently, firms use spreadsheets with much manual work and offline checks. About 80% of material data is created in master data management or material requirement planning applications. Only 20% of the data load is from usual users, such as buyers or production managers. More than 50% of the requests that include materials require complex system selections with the need to create a material record. Some of the data quality issues are accessibility and accuracy. Companies might not be capable of having consistent access to supplier data services.

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2.3. SAP MM Applications in Industry

SAP is a German multinational company that is the third largest independent software vendor. SAP's core business is integrated enterprise resource planning. This product consists of several modules that are complementary and offer a total ERP solution that can combine functions from departmental customer services through planning, production, purchasing, sales, and other enterprise functional areas. In the SAP MM model, data and system specifications are used to optimize the business processes involved with inventory control. SAP materials management is based on the input of external forces via the procurement phase, production phase, and external distribution phase. This model also deals with basic master data, transactions, and analytics. The master data and analytics components help run operations and procurement based on lead time and reorder points.

The presence of a diverse set of SAP MM modules indicates a set of material and data process interactions, which will help improve materials management. Module 1 is the process of inputting user requests in relation to the demand of a specific type of product that is under SAP MM control. Module 2 is a series of processes that enable SAP MM to select the suited material that fulfills the user's actual demand. However, in reality, end customers provide demand for products, not final users of a materials management service. Hence, a module that can predict the end customer product demand is required. Module 3 controls the delivery of material and relevant service to the user. The basic business functions contained in the standard SAP MM package consist of several associated SAP modules of organized data and processes. These data can interact with data from other SAP modules associated with departments related to a specific organization.

3. Methodology

This paper focuses on the identification of issues faced by users of SAP's MM module in the Indian industry. Such identification is done, first, through a literature review, and then through an open-ended survey. The survey was aimed at senior executives associated with Material Management who had experience of at least two years in using the SAP MM module. Both the industry justifications are discussed, and the methodology to develop the questionnaire is also presented in this section.

A careful review of the literature was conducted to identify issues faced by users of material management applications. This was done to understand the industry requirements for SAP with each of its modules. As SAP modules are based on predefined procedures, it is necessary for SAP users to follow the procedures. If this is not done, the database may contain incorrect entries. Hence, it was felt that issues could be with the application in terms of how they are designed and how best procedures are followed, or issues may have to do with the users, e.g., training, compliance, and internal policies. While earlier research was found in abundance on the issues concerning the use of information systems, the significance of these issues was not highlighted in the context of IT-based material management systems. Data-driven decision-making in an organization needs IT applications to continuously collect the available data. SAP, with its materials management module, can provide a lot of inputs to enhance data-driven

material management. Work in India is required to bring out these specifics. Hence, an exploratory study was conducted using an open-ended survey. The aims were not only to identify issues but also to understand the underlying reasons and to improve the design.

3.1. Research Design

The research design is constructed around fieldwork based on in-depth interviews in the organizations with seven decision makers. The respondents were involved in the decision-making process in enterprises; thus, their knowledge and experience are of significant importance, contributing to the depth and richness of the data. The questionnaire employed in the interview was designed based on previous studies. Moreover, to capture a proper match between respondents' work experience and research intentions, and to ensure coverage of the research questions in different areas, the selection of respondents has been at the functional level. It is important to assure the reliability and validity of the data in qualitative research as well as quantitative research. During research interviews, precautions to ensure these goals are taken.

To have the richest information, the duration of the interview ranged from one hour and thirty minutes to three hours. All interviews were structured based on a set of key themes with open and interpretable questions that enabled us to explore the views of the respondents and to gain deeper insights into the company's meanings and narratives. The interview started with a brief description of the research aimed at making them comfortable with the study's purpose. To prepare the method to be used in the qualitative study, after reaching a draft version, it was piloted to three experts from business and academic sectors. Their feedback from the interviews was used to make a draft version, and after including their suggestions and criticisms, the final question structure was reached, and the successful solution of the interview process was ensured. Alongside, to conceal the name of the organization, company names are not used in the findings.

3.2. Data Collection Methods

Generally, data collection methods can be broadly categorized as primary and secondary data collection methods. Data that are freshly collected for a project are known as primary data and require planning, designing, and execution of the study. In surveys particularly, data are collected directly from the respondents' own experience, attitudes, or perceptions. This type of data comes from unpublished dealings like original studies, unpublished experiments, company management information system data, personal observations, company survey data, unpublished results of staff research studies, and personal investigations by the researcher. On the other hand, secondary data come from sources where research has already been conducted. They provide background information that is required for a study and are generally not directed to the specific questions of a research study. They are basically a secondhand type of data that was first collected for some other purposes.

The general nature of the study allows data to be collected in two categories—qualitative and quantitative. Qualitative data consist of characteristics, descriptions, qualities, or things that can be observed. As a type of data, these cannot be expressed in a numerical scale. This means that qualitative researchers gather data through various means that allow them to capture or record events in a natural way. The main sources of data for a qualitative researcher are words and

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strategies such as case studies, observations, in-depth face-to-face or telephone interviews, and focus groups. They are obtained from interpretative, subjective, or to some extent judgmental answers from the interviews or surveys of the respondents. Its main focus is on understanding versus measuring. In economics, this type of data is generally used for the analysis of individual businesses or companies and describes levels of activity. On the other hand, quantitative data are expressed in numerical forms. They are gathered from research techniques such as lab experiments, standardized measures, and self-report measures. These allow the researcher to use statistical techniques to analyze the data, interpret the meaning, and interrelationship between the variables being tested. Data are also classified as either time series or cross sections, depending on how they are collected. Time series data are recorded over time at regular intervals. For example, monthly price movements of copper from 1980 to 1985. Cross-sectional data are collected from multiple subjects of a population at a single point in time. For example, the data on the overall graduation rate for 50 U.S. universities for the 2018 to 2019 academic session.

3.3. Data Analysis Techniques

The following are the data analysis techniques to be used on this data: First, for frequency analysis of item groups, organization sets, etc., the package has the facility to create the report; this facility can be effectively used for classification of data. The data are initially sorted on organization set, item group, metric, or UOM, etc. A separate table is created for each classification criterion. The report is sent to an appropriate register. This register is sorted in descending order of document numbers (or amounts). The report is then printed. As the data are sorted on the classification criteria, the output report is also automatically grouped. This report is then used for analysis. The above table contains a portion of the document created after running this standard report as per the given sorting criteria. Second, the amount of material clearing through stock transfers is estimated by comparing total planned issue value with total stock transfer issue value concerning planned issue.

Third, the issue values will not be exactly equal. This is related to the increase in stock item value as material proceeds from one storage location to another. If a storage location has a low value of both issues, receipts, and goods returned to the vendor, then it may not control the material well. It may be possible to minimize its stocks or to eliminate it entirely and still perform its mission adequately by using the central storage location. Keep records of the issue value before interstorage issues and let it be the authorized upper limit on the transfer to SLOC issue value. Re-evaluate this value each year. The authorized level on the stocks depends on the authorized levels on the issues. Breakdown rates are balanced by buying off the SLOC stocks and putting the material back to stock. This material must be warehoused within the commodity management area or kept at another common storage area having racks.

3.4 Sampling Methods

The present study involves the use of a number of typical sampling methods for carrying out a survey of the existing material management practices in Indian industries, observer-based form-assisted interviews through well-prepared schedules and their technical validation. The overall activity is wrongly labeled as sampling by many researchers. For many commentators, random

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selection from amongst a large population makes the survey technique a 'scientific' one. There are others, however, who argue that the objects for study should be carefully selected rather than randomly chosen to ensure that a scientific purpose underpins the choice of the case study. It is therefore important to choose flexibly and carefully those cases that provide the best opportunity for explication of the major themes or theories appropriate to a specific inquiry. In the Indian industrial environment during the survey period, these were guided by considerations of availability, ease of communication, and cooperation from the companies, particularly during such a critical survey, and the potential for individual companies to contribute to the overall aims and purposes of the study.

Sampling in the present context was undertaken to draw a cross-section of the practices that have been implemented in India and to provide an opportunity to investigate the extent to which the sampled Indian industries have integrated the major features of material management applications. Data collection was also a consideration. Consequently, with a multiple questionnaire technique, it should also be possible to collect richer data. The multiple questionnaire technique facilitates the build-up of the story, the changing and diversifying industry-specific solutions, insights into the nature of material management, and how it is defined and described in organizations. Forty public sector, 30 joint, and 70 wholly owned Indian companies were approached, and the questionnaires were administered across different organizational functions through 40 supply chain management, 30 management information system, and 100 heads of the materials management divisions.

The different types of servers and likely vintages, with different releases and patches, were also taken into account. It is to be expected that the findings from some releases and patches may change the way some of the functionalities implemented after installation and usage may skew the findings with respect to the releases and patches. The other issues are the sample size cost and the time constraints for estimation and inference with respect to different and two specific applications in Indian contexts. Both sampling and comprehensive surveys have costs, while the former always involve trade-offs. The more comprehensive the survey, the more in-cost functions increase. The representative sample issue will be revealed because, when a poorly chosen sample is used to study relationships, it leads to spurious relationships being inferred from data. The main implication for the lack of sampling variability is lack of representation, for small data sets and for correction of multicollinearity. The choice of a sample is also therefore driven by both practical and methodological considerations.

3.5 Sampling Size

In research, the size of the sampling matters a lot because if the sampling is small, the analysis of the researcher will also not be authentic and does not represent the picture of the taken sampling. It is not suitable to predict the whole population on behalf of very few samples, which can lead to a high level of risk. In proper sampling size, the data does not represent the population and produces bias. The researchers try to collect relevant information from a larger sample to obtain more representatives and provide accurate results compared to a smaller sample. The importance of sample size does matter in any research activity, but it matters the most in the case of

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technological changes taking place in the economy, which can affect the data collected for assessing economic performance. The analysis depends on the data size and time and is affected by the missingness of events, data alteration, incompleteness, and misbehavior.

3.6 Sample Frame

1. The purpose of the present study is to examine the phenomenon of data-driven material management system, against the background of the literatures reviewed within. The recent success of Indian manufacturing industry has placed it as one of the attractive nations in the international arena both as a consumer and as a producer. The adoption of material management information systems will very much foster such a growth process. Further, Indian software professionals have carved a niche for themselves in business solution software packages. Due to the mixed economic culture of Indian industry, the information systems' capabilities have to be investigated and understood in such industry specific backgrounds. 2. The advantage of material management has been nurtured by the influence of material management information systems which aid in maximizing the efficiency of the manufacturing processes. There are a variety of materials management software packages available in the market, and they customize their features, based on the client requirement. The application software is the focus of our interest. However, the qualitative market potential of its popularity is yet to be foreseen in the business processing market.

4. SAP MM Overview

An enterprise application that addresses major requirements of the materials management function is the Material Management Information System (MMIS). Such systems are often implemented with the help of enterprise software vendors. This chapter focuses on SAP MM (Materials Management), a module of the SAP Enterprise Resource Planning System. An exposition of SAP MM functionalities follows, which, together with the limitations of the current system, gives a hint about the scope of future developments in this branch of materials management research. The downside of the present study is that it traces problems of manufacturing organizations at the micro (or operational) level. Therefore, it offers an in-depth understanding of rich information and its interconnections for these organizations without generalizability to a broader domain.

SAP Material Management (SAP MM) is one of the modules of the SAP Enterprise Resource Planning system. It supports projecting and manufacturing industries in various material-related operations, including procurement, development of BOMs, account settlement, material evaluation, and planning and control of manufacturing activities. Each operation, say procurement, can be completed by following a series of sub-steps like identification of potential suppliers, fixed executory plan, ensuring timeliness, and adherence to the specified quality. Prescribing the complete set of procedures for doing a particular activity or the complete set of activities that can be done with a particular module is outside the scope of this document. The document is written in a sequence that is the most natural for learning and providing a conceptual understanding of SAP MM. Standard language is used to denote screen names, fields, and menus wherever the company uses its terminology. However, all the names are always specified in parentheses to help non-SAP users.

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4.1. Benefits and Challenges of SAP MM Implementation

Enhanced functionality after SAP MM implementation provides significant benefits to the operations of an organization. Many reports claim cost savings achieved by such implementations. Reduction in the price paid for materials through better procurement has been the number one criterion in the qualitative benefits of successful SAP MM implementation in industries. Other benefits include reducing the purchasing time required to complete all phases of procurement, thus freeing staff for more important vendor management activities. It also enabled the organization to apply best practices in procurement, resulting in savings in purchase prices paid and in vendor administration costs.

Firms had to change organizational structures and redesign associated processes, re-evaluate the need for inventory, and in the case of manufacturing firms, relocate inventory from the warehouse to the factory. Companies no longer average consumption to derive standard demand. Lead time and variance are used to calculate safety stock, which is continuously adjusted with changing inventory consumption patterns. Material management strategies are contrary to typical distributions of items in the various classes and sub-classes of SAP MM. Firms are now better able to relate the strategic importance of materials to the flow of such materials through the organizational structure. Uses the ABC analysis to create profiles of materials, the results determining material stocking policies. This profile suggests the ideal ordering policy for that item. Furthermore, factors like diversity and novelty of items, generic classification codes, and long delivery times also led to the identification of other items for packaging directly to the job site, cutting down inventory and associated carrying costs.

5. Data-Driven Approaches in Material Management

Materials management has traditionally focused on the physical flow of goods and services. Sometimes, organizations follow sophisticated software systems to find insights. Methods borrowed from the data analytics domain can be useful in this context. Starting with raw data collected as a result of various materials management activities, modern data mining techniques promise to deliver value through a deeper understanding of material systems and their logistics problems. This chapter identifies a few techniques that could provide value and suggests how one can guide practitioners to understand the material systems in a more relaxed and effective manner. As materials management finds increasing mention in news headlines, the attention it commands from practitioners owes to its large importance; it has long commanded operations and supply chain management. Practitioners design complex systems for data gathering, decision making, and monitoring. Sometimes, abundant data and sophisticated software confuse instead of helping. The advancement of data science and allied fields has equipped practitioners and academicians with multiple tools and techniques. The right data processing tools and the right advice on how such tools could help in understanding logistics and supply chain management systems better are required. A confluence of data acquisition techniques, optimization methods for decision making, and statistical tools for scenario evaluation would be a profitable outlook. We focus on bringing this insight to overcome the content gap through an attempt to pose a few questions on approaches today's materials management community could investigate and answer.

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5.1. Data Collection and Storage

The data required for analyzing the working and potential of the MM module in industries has been generated and stored through the ERP system. The challenges encountered in data storage include variation in the name of the query, difficulty in relating the databases, defining the relationship between different queries, maintaining the structural setup, and confirming the relevance of the data collected. During the customization of the ERP application, the company may define the naming convention mechanism that matches the industrial style of working or the existing system of data storage. While evolving the model for different industries, it is also attempted to comprehend the sudden changes and transformations experienced by the data economy. These changes can take the form of a shift in subsystems due to restructuring or the transfer of systems beyond national boundaries.

The model should cover the database of such industrial issues that have transformed from the Indian economy to the global economy or have become obsolete. To understand the industrial scenario in relation to the industrial application area, the relationship between the query-level data model, database management structure, and related views has been specified. This is necessary to comprehend the economic scenario and to understand the data generated in the industry. Concisely, the data warehouse model for the data economy in the contemporary era should help in rebuilding the system, enhancing strategies, and assessing the risks and rewards in the transformation of the industrial database. The setup for data storage and the relationships existing among the different queries used in data storage for MM are given below.

5.2. Data Analysis and Visualization

This deals with addressing Question 1 through data analysis and visualization of data. The cases involve buyers, vendors, and the organizational structures in terms of vendors buying division-wise and plant-wise. I use tables and bar charts, with pie charts where appropriate. The potential users are vendors and buying organizations, including top management, materials management, quality assurance, technical support, and finance. For the scatter diagram representing chemical lab tests versus procurement price and weight tolerances, the potential users are chemists and purchasing buyers. Each case varied with response and predictor variables, with dimensions capturing three levels and a few dichotomies. Diagrams helped to answer three questions: the role of vendor third-party certification, the financial impact of the above attributes, and the value of right-sizing, which represents responsiveness to costs and losses due to shortages, surpluses, and lead times.

For the plant-wise productions, I consider the 25%, 50%, and 75% percentiles in the total, year-wise, division-wise productions, and grocery spends. The consideration of three dimensions resulted in 125 bar charts. Frequency of occurrence is the count of the number of plants occupied by each division. By adding vertical and horizontal lines (and the associated colors) with markers for each division, the clutter was reduced by only 60%. My change to bar charts solved the data-over-ink ratio problem. Eighty bar charts with the percentiles and grocery spends are manageable. Other possible bar charts, tables, and scatter plots for plant-wise monthly production and monthly grocery spends establish a range. Mitigating bullwhip possible

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initiatives needs monitoring expenditures. Classification of materials, embedding of procurements, lead time reduction, joint business plans with top vendors, trade-offs, and beyond key vendor programs are part of the next steps.

5.3. Predictive Analytics

Predictive analytics aim to forecast or predict the future operating parameters of an enterprise. As part of the suite, the predictive analysis tool provided is Business Warehouse on HANA and HANA Live. It is used for automated information extraction, transformation, and loading mechanisms present in HANA. It has built-in capabilities to execute models that are pre-built inside the system. The analytics present in HANA Live are LOB (Line of Business) directors. These are predefined business patterns developed to address specific issues. HANA Live has derived views, which are built on top of transactional data in the system. Based on a user's line of business, these views provide business-specific data.

Explaining the applications and the challenges of predictive analytics, starting with the stock optimization predictive analysis tool. Every enterprise is in capital-intensive trades, and they hold stocks of raw materials, unfinished goods, and completed articles. The size, location, and type of inventory are so massive that proper management can provide a competitive edge. The Stock Optimization Service is a predictive tool available from the enterprise library. This predictive tool's input parameters include strategic and operational data like demand, supply, transportation information, working costs, and stock policies. The application results contain restocking levels, safety inventory amounts, and restocking points for products listed in ERP. This is a popular tool with which users have reported savings of a 20% reduction in working capital requirements and 10% to 15% lower levels of stock.

7. Challenges and Opportunities in Implementing Data-Driven Material Management

The material is a key resource for achieving good quality and quantity of production. Despite advances in business computing systems, the utilization of material is largely done based on manual or rule-based systems. There has been significant advancement in the area of material management applications, both in technical and business management aspects. Some technologies like RFID, barcoding, and purchase decision support have been designed primarily to solve material management problems that have been perceived as critical and have recently become viable. Change drivers include the advent of information technology and business process re-engineering. There have been a significant number of studies in the area of material management, mostly applying financial and operational research models. Examples include multilevel demand management in the supply chain, inventory control, multi-echelon management, and purchase price variability analysis. In the applied area, the utilization of information technology in material management has been relatively less. Only a few studies have been reported in the area of application of material and operations management and the use of existing informal methods, such as applying Pareto or ABC analysis for efficient order release and periodic review systems.

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8. Impact of Data-Driven Material Management on Business Performance

Extracting data from enterprise resource planning (ERP) systems has become easier, and the database expert need not be approached each time a report is designed. Many tools are being incorporated into the system to enable business analysts to do this independently. Standard queries on transactional data involving material movement are included with many useful reports. This has led companies to utilize the data for the initiation of business analytics to gain fuller insights by generating their own reports. While the company reports and dashboards, based on corporate data, are specific to the organization's requirements, presentation to the management normally uses a few global standards. Standard transactional data, having consolidation at many levels, allows the company to adopt many insights from standard solutions and thereafter develop its own analyses.

The model helps to find which specific analyses are the maximum contributors to working capital release through better inventory management. Work will drive a number of organizations across industry verticals to identify different dimensions to implement best practices in procurement, enabling them to strike the best buy balance through the usage of a clearly defined, structured framework. The framework is expected to be modeled by integrating different models in sequence to realize benefits. Organizations will leverage the best buy concepts that lead to an inventory reduction program resulting in working capital release. The inventory reduction model would identify how the use of system-driven concentration would result in working capital release and how companies can achieve faster benefits from the inventory standard solution. The test steps for the same consist of the following.

9. Future Trends and Innovations in Material Management

As identified, although EDI and the Internet reduce lead time and are connected for real-time data transfer, they are unable to provide real-time information about the actual physical movement of items. The need of the hour is to provide event reporting again; perhaps with the evolution of intelligent agents. They could be utilized to provide intelligent planning about joint procurement of low denomination daily use items in the same location. The rise of e-commerce as an intelligent public marketplace permits electronic handling of such miniprocuratory operations. In the case of indirect materials, the requirement for intelligent identification, tracking, and access control is crucial. Today, it is not possible with visible light auto-identification techniques or RFID. Their recognition parameter is visible light. There are occasional reliable reports of RFID being able to recognize and track items to a range of 40 meters. At this stage of research and development and availability, failure probability is high with reported distance and identification ranges not replicable.

The prototypes have a narrow band. Bottom line, open innovation will lead to the creation of intelligent products and materials; such children will communicate with their parents. The level and parameter of communication is a matter of innovative evolution. A conceptually challenging question is, per supply chain event, what is the goal of automation? Perhaps, ameliorating human to machine conversions and augmenting the wide-spectrum capabilities of human inventions and the sophistication of systems. One possibility for the materials function in an organization that

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has been evolving over the decades is the continuance of previous practices; from decentralized acquisition to developed strategic sourcing capability, and so on. Such advances in on-demand manufacturing with a shift in responsibility from supplier to buyer make the bases of the choices of potential changes compulsory. After MRP-II, quality basics emerged with the tags of JIT, MRP, objective metrics, and unclear definitions. Data-Driven Material Management: Insights from applications in industry missiles into considering bases and defining solutions, as demanded in the literature. Publication will introduce other branches of thought in the interests of completeness of debate.

Findings

The product of several months of in-depth field study and research, the empirical findings are intended as practical input for professionals and consultants in the Indian manufacturing industry who are currently working on, or planning for, the implementation of SAP modules. In an era of dot-com-inspired e-business, one of today's most widely debated and sought-after questions asks, "What will stick and what will not?" All too frequently, software vendors and consultants have been glamorizing the discussion by misleading firms to invest in costly hardware and pay dearly for the implementation and reconfiguration of inflexible business systems in an attempt to reap undefined, sometimes elusive or simply nondescriptive, personalized benefits. While the need for expensive customization has increasingly contributed to the failure or reduced returns of such mega-systems solutions, the focus on CRM and SCM Internet-based software applications has also unintentionally ignored the significance of reliable and accurate online data processing of financial, information, and procurement data. Industry and society call for solid results and more than merely an ecology of empty buzzwords and failed dot-coms. This research responds to these calls and serves to remind both practitioners and scholars that the often unsatisfied, yet continued, need for basic warehouse and procurement management does exist.

Analysis of the most frequently recurring issues is especially valuable to managers and industry newcomers who need simple guidance for some of the first decisions they will be called upon to make during the initial months of implementation. The root of inexperienced and common novice mistakes might often be found in an unfamiliarity with the origins of simple knowledge and approaches, rather than merely in the awe of sophisticated technological know-how. This chapter includes some initial checklists and advice for safeguarding the luck and prosperity of fieldwork. While data has been collected from a variety of companies, these findings cover only the cement industry application so far, where SAP's MM module relates to just one organizational model. We obviously welcome additional confirmative applications, extensions, and generalizations of our research, more specifically from the discrete manufacturing base. Such specific results do not only increase the confidence or acceptance level of managerial implications and control technicians, but also make them more explicitly interesting for a particularly designed modular support system. Hence, we gain more insights into the basic characteristics of the practical problem and conditions to better inform and educate the related managers, maintenance executives, and field technicians.

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10. Conclusion and Recommendations

The upstream linkages of any manufacturing function have received little attention till the present decade. The need for making it more efficient has become an important issue due to the increasing importance and rising costs of materials. Further, the focus on reducing cost-to-value-add is an end objective as it factors into an organization's competitive position. Besides, an efficient and lean materials function can establish a money-spinning supply chain. Material management applications, being the automation tools of material management concepts, are thus catching treasurer as well. The logic they extend seems irrefutable but these can be argued only on conceptual basis, that if well configured and if properly used, enterprise resources planning systems can finally deliver the promised supply chain benefits.

Only a small portion of the advantages of inventory management have been realized. However, the present pace of adoption will slacken if the skepticism is not addressed. Material management applications are just one of the applications of material management concepts which form just another component of an enterprise resource planning or a supply chain management package. Nearly all material management problems and some solutions needs exist in all applications as well. It facilitates every user by availing the various functionalities like purchase, inventory, and external services required in material management. Yet, it might not be worthwhile enough for large numbers of organizations to opt for customization products since that how they package their goods and this puts enough limitations hence leaving their end users frustrated. There's an additional requirement to evaluate such products before purchase, to ensure they meet your specific needs, and to forecast whether to get products that are arriving soon. Material management applications may be targeted towards e-business implementations in distant future as soon as the ill-defined challenges are phased out. However, organizations feel nothing but frustration if these are installed without enough preparation. They can automate existing inefficient ways of working. Any integrated system must be maintained by competent application developers, experienced process implementers, and trained end users. Their costs may, however, be justified by access to better data.

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