Product LifeCycle Management Systém as part of an effective information management system for an industrial enterprise

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--*ABSTRACT*---

The steady increase in design and technology requirements for efficient and incredibly rapid new product development in the pre-production stages and subsequent production and service presentsevery engineering company with the challenging task of managing the emerginginflux and updatingunstructured data and information. The inevitable collaboration of all pre-production and production stages components in the innovation orlaunchof a new product has increased the need for enterprise data management and governance and online access to design, process and production data. Increasingly, this collaboration is taking place in an environment that uses concurrent engineering. In such an environment, document and business process management must be more thoroughly ensured in synergy with quality management. By analogy, the secure protection and control of corporate data and information is one of the main concernsoftoday's industrial manufacturing companies.

Key words:*Product LifeCycle Management, effectively, Information Management, industrial enterprise,*

1. Introduction

The definition of Product Lifecycle Management (PLM) is based on the concept of product lifecycle management and the requirements of the entity for this system. Since the requirements of companies from different areas are similar, the available definitions differ only in terms of form and style, but are essentially the same in terms of content.

PLM is an acronym for a technology solution that enables a company to achievecompetitiveness through product lifecycle management. Product development is carried out through a sequenceoflifecycle processes, including marketing, design, process planning, manufacturing, assembly etc. For customers, developers, manufacturers and suppliers, a PLM system provides an integrated environment for managing processes throughout the product lifecycle. It integrates people, processes, and technology and supports collaboration in managing product data at the virtual enterprise level. The PLM system enables the management of a portfolio of products, processes and services from initial conception to final disposal in an efficient yet integrated manner.[4]

A PLM system is a set of software tools interlinked into one coherent solution tailored to the specific needs of a given company and its products. A company can use a PLM solution to cover its entire portfolio of product-related activities or choose only the important part. PLM software efficiently enables information management across the entire product lifecycle, from initial idea through design to product removal from the market. Mastery of PLM techniques and PLM systems is a fundamental prerequisite for the successful operation of modern digital enterprises and decentralized manufacturing businesses.[4]

PLM (Product Life Cycle Management) [1] is a strategic approach applied through enterprise-wide solutions supporting collaboration in creating, managing, redistributing, and using product information. PLM forms a product information backbone for internal needs and the extended enterprise. In doing so, CIM Data emphasizes that it is [2]:

- access to information within the extended enterprise (employees, suppliers, customers and partners);
- integrates people, processes, business systems and information;
- manages product data from conceptual design to end-of-life.

PLM consistsof many elements, including [2]:

- unified technologies and standards (e.g., exchangeable data formats, visualizations, collaboration and integration with other enterprise subsystems);
- graphical and text editors and engineering systems (e.g. CAD, CAE and other editors);
- data corefunctions (e.g. data and documentation storage and management, workflow and process management);
- functional applications (e.g. generation ofBOMs, changeprocedures);
- enterprise solutions extending the functionalityof the previous elements (e.g. superstructures on top of CAD systems, componentcatalogues).

Integration of PLM and ERP

Due to larger enterprises' better availability of financial resources, PLM and ERP integration were more widely used in these enterprises in the beginning. Nowadays, all small, medium and large enterprises face similar problems and have the same need for PLM and ERP integration. PLM manages the innovation process, enabling companies to create products quickly and bring them to market. It focuses on digital, context-driven information, activities and business processes – thevalues associated with the product and the characteristics of the business. Manages the lifecycle and relationship between product information and processes.[3]

ERP ensures that a quality product is produced on time while controlling costs based on customer requirements. It focuses on physical business activities, transactions, and return on investment and deals with production planning, asset management, cost and other physical aspects of production. It is optimized to manage a large number oftransactions and associated data.[5]

Benefits of PLM and ERP integration

PLM enhances the benefits of ERP by enabling the unified management of technical data. ERP, therefore, relies on the product and environmental knowledge provided by PLM to optimise flow control for production and logistics. Benefits include [6]:

- *Efficiency gains*

PLM and ERP integration automates real-time updating, transferring and accessing data. With this real-time data, it'seasy to uncover areas for improvement and increase your team's efficiency. Manual workarounds are minimized, and data is entered only once – improvingaccuracy and eliminatinginconsistencies.

- *Cost savings*

With increased data accuracy from automated ERP and PLM processes, the procurement team can place orderssafely, avoidingraw material shortages while saving money on readily available raw materials. In addition, it can account for delays and ensure orders are delivered on time without having to expend additional supplychain resources. Centralized data through PLM and ERP integration provides greatervisibility into operations while highlighting potential areas for cost reduction.

II. Methods And Results

The Product Lifecycle Management (PLM) or Product Data Management (PDM) systems - provide enterprise-wide collaboration for everyone involved in the product lifecycle - from engineering and supply chain to quality control and manufacturing. If everyone works from a central source, they can quickly bring better products to market.

Benefits of PDM[6]:

- Increase productivity
- Facilitate file searches.
- Minimizing rework.
- Connected teams
- Keeping everything in the same place and easier file sharing.
- Knowing who's working on what.
- Manage security
- Control who has access to view what files.
- Protecting intellectual property.

Because the Institute of Industrial Engineering and Management has an information system, IS CITO, in the next part, we will discuss the work with the information system, including the PDM module, and describe the work with the module in detail. It is a progressive information system designed to manage and control company processes. It considers the specific needs of small and medium-sized enterprises; therefore, it has a modular character containing basic functionalities (DMS system, CRM, etc.), to which it adds specialized modules

(project management, connection to 3D CAD systems, PDM, tool dispensing, etc.). All data is stored and backed up in an MS SQL database.

The IS consists of the following modules:

- *Customer communication*

The CRM module contains functionalities necessary for managing the data of business partners or employees of business partners. In addition to the basic functionality of the contact directory, it includes functionalities for managing the activities carried out towards the business partner.

- *Demand processing*

The Order module allows you to define the individual stages of business cases, such as demand, quotation, and order, including their documentation. All business cases are registered under a specific customer, thus providing a quick overview of the different stages in the business process. Interfacing with MS Outlook facilitates the sales department to import emails along with attachments. Workflow as a dedicated module is used to manage the lifecycle of an element (document, order, quote, query, etc.) in the CITO system. Thanks to this functionality, it is possible to familiarize company staff with a new record in the system and process individual activities' processing.

- *Construction*

The PDM agenda functionalities allow you to define structures (BOM, assembly, subassembly, part) of products. A standard part is the possibility to register documentation of individual products in documents directly in the product structure. The functionalities also allow the management of access rights to individually defined products or product documents. In the PDM agenda, there is the possibility of creating an approval process in the pre-production stages to ensure that the approved products and documents move into the production process. The PDM module can be interfaced with 3D CAD systems to ensure two-way communication and data transfer or to import data, e.g. from MS Excel.

- *Processing of production technology*

IS CITO defines technological procedures for products (assemblies, sub-assemblies, parts). Based on the design dimensions, the system calculates the material requirement for a given part, where it is also possible to enter the necessary allowances for material processing. Thanks to the technological procedures defined in this way, it is possible to correctly calculate the product's price, plan the production, and ultimately compare the plan with the actual reality of the production process. Each part of the PDM module can create a technological procedure. The system in this module allows the definition of cooperation and supports several alternatives (versions) of the technical process. Of course, there are sample operations and a preview of operations defined in the past.

- *Price offer*

In the quotation section, it is possible to calculate the prices of products depending on the number of pieces ordered (demanded) by the customer. Calculating and displaying planned margins, margins, versioning of offers, list of required materials, etc., is a standard part of this agenda. The calculator has the possibility of a % increase in production costs for individual items (material, labour, cooperation). The number of manufactured items is taken into account in the calculation. The price decreases for a higher number of pieces due to the budgeting of the lead time for several pieces. In this way, it is possible to quickly give the customer information on the number of pieces that will achieve the desired price.

- *Accepting an order, setting up a project*

Once the order is received, an order is created in the system, which downloads all the information from the CP. The agenda provides space for defining all essential dates of the order so that the order is entirely under control from a timing and financial point of view. If necessary, it is possible to start the approval process and thus forward the information about the order to the staff involved. To move to production, it is necessary to enter the required delivery date to the customer (essential information for production planning). Through the project management module, the CITO system allows you to plan orders in the form of a project. In this planning, project stages, tasks and milestones are defined. It assigns responsible personnel to the tasks, who are provided with a tool to write off the task status.

- *Production planning*

Production planning ensures efficient use of material resources, production capacities of the company and external cooperation about meeting the customer's deadline in the required quantity and quality. IS CITO plans within the limited capacities and, in planning, allocates the order according to the available capacities of machines, materials and cooperations. In this way, the system provides the planner with the expected completion date information.

- *Production and its optimization*

The functionality of the production module allows you to plan and record production. By using the functionality of this module, it is possible to know the expected completion date of production or before the actual receipt of the order to check whether we can meet the customer's required deadline on our machinery. We are in control of

cooperative operations. We know the actual cost status of each single order and the actual working time of production operators on individual orders or order items. Last but not least, we can quickly evaluate the efficiency of using the labour pool of workers. The terminal application records the work performed by production operators using barcodes of work order operations. It significantly contributes to increasing efficiency and reducing errors in data collection. Using the database of products that have passed through the production process, we can optimize production capacity by adjusting the technological process, material or cooperation.

For illustration, we will further discuss one module in particular, namely ***the processing of production technology***.
The basic functionality includes a previewofdrawings in DXF, DVG, PDF, 3D PDF (rotation options, dimensioning, selectionof individual parts in the product), etc... This preview is possible directly in the CITO system environment.The abbreviation PDM refers to a separate area – Product Data Management – the part of the product lifecycle management process responsible for managing and controlling the end product data. In the CITO information system, this part of the system is often referred to as PDM, also called Project Engineering.
To move the final product to the ERP module and manufacture, it is necessary to create elements of the Part orAssembly type in the Engineering Project sectionof CITO. On these elements, it is needed to define:
• material requirement (i.e. what the product will be manufactured from);
• technological process (how the product will be manufactured).

Product creation
Products in IS CITO are placed under the top Engineering Project, usuallycalled PDM or Products. A Product is the first level in the tree structure for subsequently creating assemblies parts and connecting purchased items from which they will then be related to realizations and sent to production.
To create a new product, right-click on the PDM and select the New command and the Under location. A newdialogue box will pop up in which we choose the Product type and confirm the selection by checking Create...
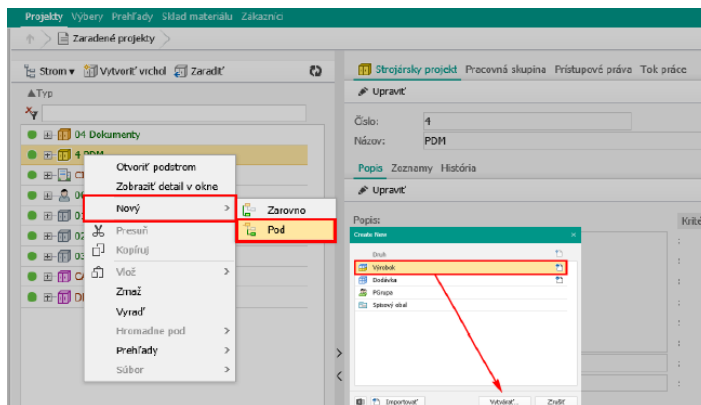
In the next dialog box, enter the Product Number and Product Name. The product number is unique, and the names can be repeated. Confirm the entered information by marking Create.
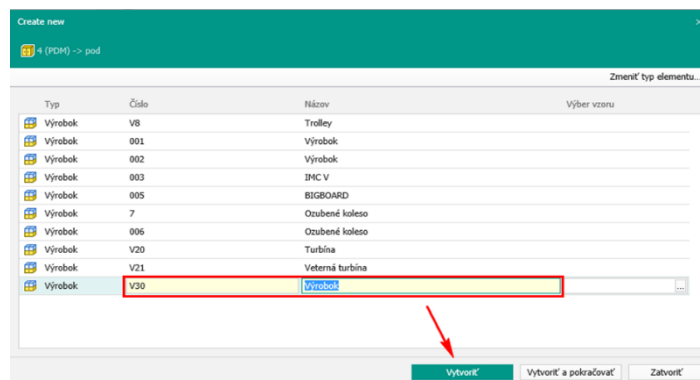
We can see the created element after expanding the PDM under which the product was made. In the next step, we create an assembly and part-type element.
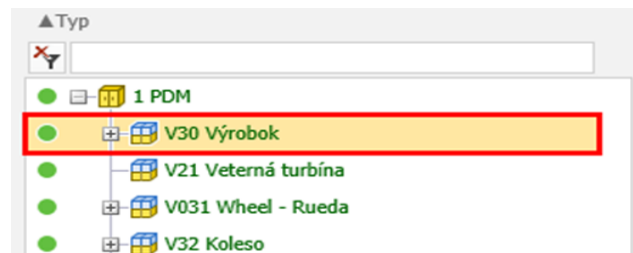
III. Discussion

In addition to the CITO information system mentioned above, several companies specialize in PLM systems. Among them are Siemens PLM Software Teamcenter, Dassault Systèmes ENOVIA, PTC, SAP, Oracle and many others.The main standard features of the PLM systems of these companies are: product management from initial design to production, product change management, product-based contract, inventory management, supplier management, technical documentation management, warranty management, support for product development, integration with external systems, and support for business processes.

Siemens PLM Software Teamcenter

Teamcenter is product information management software provided by Siemens. It is a highly integrated system that enables users to efficiently manage all aspects of product development, from design to final production. Siemens is a leading company in product lifecycle management (PLM). Teamcenter offers a portfolio of products and services that enable organizations to streamline product development, increase productivity and improve competitiveness. Siemens Teamcenter products include various software applications and services such as product development, product simulation, resource management, document management, quality management, schema management, etc. Siemens Teamcenter services include consulting, implementation and installation, support and management, training, and infrastructure management services. Siemens Teamcenter also provides a partner portal that contains product and service information and business opportunities for its partners. Siemens is also involved in research and development to offer cutting-edge products such as solutions for change management, cost management, supply management, product development management, production management, etc. [7]

PLM system from Dassault Systemes ENOVIA

ENOVIA is a cloud solution for product and data management. Dassault Systèmes' PLM system ENOVIA is a revolutionary tool that enables businesses to track and manage the entire product lifecycle. The system provides a comprehensive overview of all aspects of a product, from concept to customer support. ENOVIA is designed to provide enterprise information about the product and its lifecycle. It can be configured to fit the specific needs of an organization. It enables product development, design, manufacturing, distribution and customer support management automation. The ENOVIA system can integrate with other systems in the enterprise, such as ERP, CRM and CAD. This allows businesses to create a connected network of tools for product management. The ENOVIA system also provides data accessibilityacross the globe through cloud technologies. It allows customers and employees to access data from any location. The system also provides a range of security features to protect data. [8]

SAP PLM

It is a solution for product lifecycle management. It provides various features and tools to help organizations create, develop, maintain, and secure products in the best possible way. SAP PLM includes product design, configuration, product change management, product documentation management, product data ownership management, and more. It can also help organizations use their technology and resources better, helping them maximize revenue and profit. [9]

PLM system by PTC

It is a comprehensive solution for product lifecycle management (PLM). The PTC solution manages all elements of the product lifecycle, from design to production, accelerating product design, increasing quality and reducing production costs. The PTC PLM solution facilitates collaboration between development, manufacturing, sales, customer support and suppliers. The solution includes tools for product information management (PIM), component management, technical documentation, knowledge management and change

management. In addition, it also includes project management tools, database management, component and production management tools. PTC PLM is compatible with various other systems, including ERP, CAD, PDM and ERM. [10]

IV. Conclusion

Product Lifecycle Management has emerged after almosttwenty years of market and technological development. Since the mid-1980s and early 1990s, inconsistencies in the labellingof product-related information and particular engineering information have spurred interest in this relativelyunexplored area.

In the 1980s, American Motors Corporation (AMC) was a minor player in the automotive industry. The company needed to have the large budgets of the more prominent players in the market, which prevented it from competing effectively. AMC management developed the idea oftracking products from inception to end-of-life to improve processes and compete more effectively – the first iterationof product lifecycle management. They used the data they collected to informbetter decisions, from ideation to procurement to manufacturing. AMC increased its market share, and Chrysler later acquired the company, becoming the automotive industry'slowest-cost manufacturer by the mid-1990s.

It is time to focus on an area that has been a focus for businessesnow – planning and managing product-related processes. The ability to effectively manage the life cycle of products from initial conception through to scrapping and recycling represents the next level of business development, giving the prerequisite for success in the marketplace. It should be borne in mind that the current supplier must always do all of the above measures for success, from good ideas to effective use of information technology capabilities.

Acknowledgments:

References

[1]. Morháč, M., "What is PLM abbreviation", AT&P journal 6/2005, available at: https://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=0CAIQw7AJahcKEwjIneL34JD_AhUAAAAAHQAAAAAQBQ&url=https%3A%2F%2Fwww.atpjournal.sk%2Fbuxus%2Fdocs%2Fatp-2005-06-58.pdf&psig=AOvVaw0r6vgGCK68v0pkhvaE3MUi&ust=1685113789256581 **(2005)**

[2]. Morháč, M., "PLM solutions - a new strategy for business development", available at:https://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=0CAIQw7AJahcKEwjg5Leb7pD_AhUAAAAAHQAAAAAQAg&url=https%3A%2F%2Fwww.efocus.sk%2Fimages%2Farchiv%2Ffile_45_0.pdf&psig=AOvVaw3w0Qkvt1B4YzmnZGxBOVXg&ust=1685117192363205**(2006)**

[3]. Trebuňa, P., Kliment, M., Markovič, J., "PLM and its benefits and use in the management of complex business activities in the planning and optimization of production activities", In: Manažment podnikov, pp. 53-56. - ISSN 1338-4104 **(2013)**

[4]. https://www.sjf.stuba.sk/sk/ustavy/ustav-vyrobnych-systemov-environmentalnej-techniky-a-manazmentu-kvality/laboratoria/plm-laboratorium.html?page_id=5572

[5]. https://www.ipmsolutions.sk/home_old/informacie/novinky/integracia-plm-erp.html

[6]. https://www.inno-foodproducts-brainbox.com/2021/08/26/erp-and-plm-how-complete-integration-delivers-the-best-results/

[7]. https://www.plm.automation.siemens.com/global/en/

[8]. https://www.3ds.com/products/enovia/

[9]. https://www.sap.com/products/scm/product-compliance.html?url_id=text-glo-404-reclink

[10]. https://www.ptc.com/en/technologies/plm

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