Engineering IT Management on End-to-End PLM Structure in Automotive Sector

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Abstract. As of today, PLM infrastructure has key role on companies' processes with respect to their end-item quality whereas it also practically determines the company culture, validness of the data, complexity, singularity and most of all profitability. Moreover, in order to give birth to these integrated processes, systems of PLM are needed which are administrated by solution architects who are experts on both IT and engineering solutions. Occasionally, single tool is not capable of handling processes from beginning to end. For that reason, there occurs a demand in multiple softwares. These diverse programs have characteristic powerful aspects coming with their weaknesses as well and they determine companies' way of work. Nevertheless, they have tendency on creating complex flows on data and process. In order to avoid these interruptions and provide a single source of data, it is necessary to create end-to-end process on a single platform within the company. This is where the solution architects must lead this PLM journey for all departments according to their needs. Particularly in automotive sector, the journey starts with the requirements, which are then driven to functional and logical objects. The further phases are designing, manufacturing, planning and work instructions, which must be led by allocating the resources. It can be understood that all these functions require different expertise; however, traceability can only be handled on a linear flow so that the impact analysis and change management can work smoothly. In order to stand to those needs, solution architects should handle both IT and engineering requirements in order to create end-to-end process flow.

Keywords: end-to-end, plm, engineering it, cad, change

1 Introduction

This study presents a different perception on automotive sector in management of PLM and Engineering IT services. In order to define these concepts, the terminology behind PLM and Engineering IT should be understood preliminary.

Product lifecycle management (PLM) is a methodological approach for managing complex product information, engineering and manufacturing workflows, and orchestrating them with each other. Product data management (PDM) and product lifecycle management (PLM) systems provide support in companies by integrating and automating complex operational activities; mainly on design and change processes. Significantly, in a dynamic environment like automotive where time is of the essence, this approach is supported by engineering and business softwares which includes a PLM software as well. The construction and deployment of these programs require multidisciplinary and comprehensive approach where engineering and information systems (IT) start to merge.

PLM system tools are used for handling a variety of product definitions to manage workflow of development activities, and to measure relational properties such as cost and performance [1].

The most significant service to manage this orchestration is Engineering IT, which can be considered as a division including a group of solution architect professionals who can understand these requirements and provide solutions to all, including IT systems management, PLM and process designations. This topic will be covered in section 3 comprehensively.

Using all these approaches and techniques, the ultimate goal is to maintain a linear flow on processes in PLM starting from the first until the last. This concept can be called "end-to-end process management". Mainly in automotive sector, the most suitable way is to achieve this ultimate goal is by collaborating the main departments below:

- Program Management
- System and Configuration Management
- Process Planning
- Design and Engineering
- Production

In section 2, construction of this end-to-end collaboration will be explained in details. However, it should not be forgotten that even though these departments have different solutions to problems with different softwares, they can always be collaborated with the required database and process solutions. The single platform should always be the answer but when it is not possible to do that, methods have to be created for managing these bottlenecks between departments.

On a very high-level point of view, end-to-end PLM strategy in companies with related people and divisions will be an asset mainly on four points: [2]

- Cost reduction
- Quality improvement
- Time saving
- Traceability

Figure 1 shows a general perspective of PLM in automotive sector. In product life cycle process, it is necessary to supply different kinds of models with appropriate modules depending on departments. This the most challenging point in process deployment.

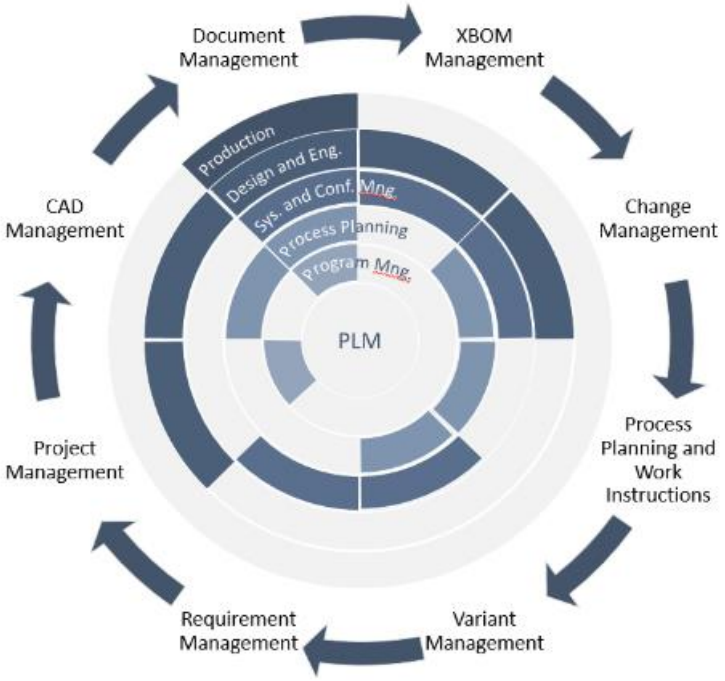

Fig. 1. PLM vision

2 End-to-End PLM Structure

In traditional management way of thinking, there are many ongoing methods to simplify and maintain workflows in a company to get suitable and desired outcomes and metrics. For instance, lean management can be adapted, which supports the continuous improvement in a company. Basic targets in a lean concept are used in order to eliminate the unnecessary time, excess effort and particularly excess money. This can only be done by analyzing a business process and revising it accordingly to make it suitable. Example of a lean model can be seen in Figure 2 [3].

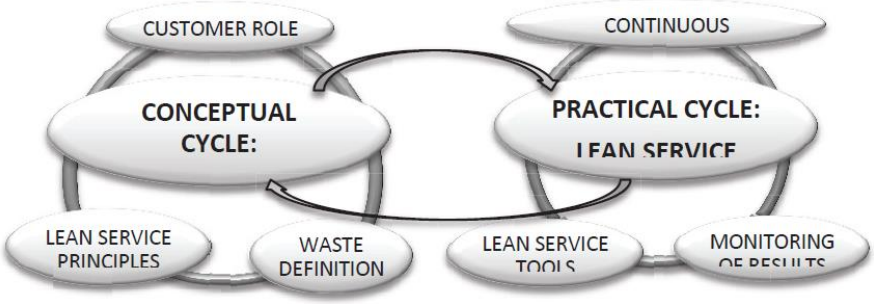

Fig. 2. Lean service conceptual model [3]

Furthermore, there are many agile methods for characterizing the companies' way of work for adapting business flows more accurately with less effort. All these different methods have to be used since companies' have many different divisions with many employees of expertise and they should be collaborated with respect to the business that they are involved in. Consequently, there is no doubt that when business models are being created, end-to-end business structure must be aimed.

Another model is seen in Figure 3 for estimating the time and costs of the end-to-end process to deliver a component printed through additive manufacturing [4].

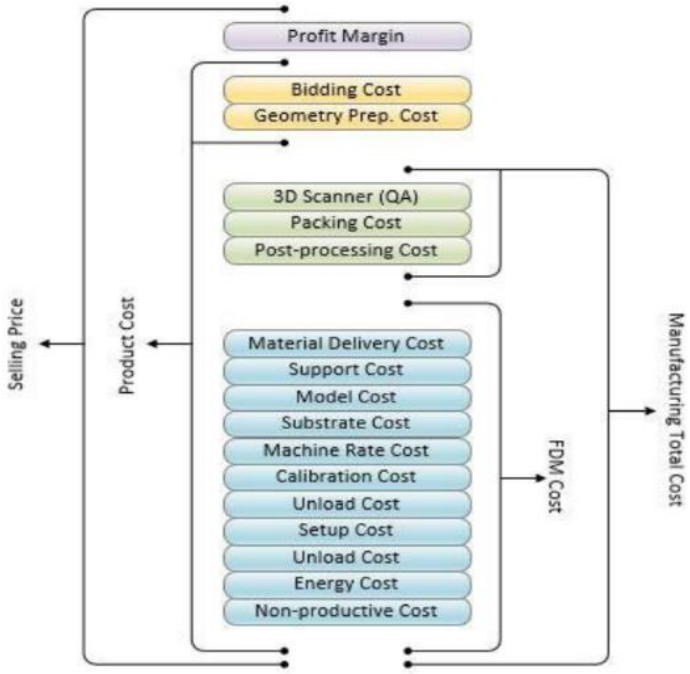

Fig. 3. Cost model to estimate the time and costs of the end-to-end process to deliver a component printed through additive manufacturing [4]

The big dilemma in adapting traditional ways for capturing end-to-end processes comes from its difficulty in deployment. Especially in automotive where dynamic changes are daily routine, most of the time it requires a very deep knowledge of impact analysis. In addition, some other factors for difficult deployment can be mentioned as below:

- Resistance to change
- Lack of agility in softwares
- Cultural change
- Fear of huge transformation and adaptation process
- Legacy data

For this reason, PLM can make a hugh difference in constructing an end-to-end process. In this section, a study will be taken to define end-to-end process of an automotive company including the bottlenecks of the data and workflow in a PLM platform. Table

1 defines the certain modules of a PLM software versus the departments in the company respectively;

Table 1. Modules of PLM and related departments

Modules vs. Departments	Program Management	Process Planning	System and Configuration Management	Design and Engineering	Production
Change Management		x	x	x	
CAD Management		x		x	
Document Management	x	x	x	x	x
Requirement Management			x		
XBOM Management			x	x	
Project Management	x			x	
Process Planning and Work Instructions		x			
Variant Management		x	x		

The need of the departments in a single PLM platform is constructed as a matrix in Table 1. This is the most important vision to see the exact requirements with respect to departments so that the required steps can be taken. An example CAD model of an end-item product (defense vehicle) in BMC is shown in Figure 4 where the study will be based on.

Fig. 4. Defense vehicle data model

Related departments in a company, PLM modules and external inputs are shown in Figure 5 in end-to-end structure. Significantly, in automotive industry, the life cycle of

a product launches with requirements and carries on with project management and designing stages. Starting with requirements, this cycle should be able to reach the production stage without any interruption (even by adding more data at each stage). Requirements are evaluated and turned into project tasks. In project stage, EBOM (Engineering Bill of Materials) is constructed as an output of the design stage and operation sheets and assembly instructions are prepared by process planning department. Moreover, EBOM evolves into MBOM (Manufacturing Bill of Materials) and the data smoothly flows into ERP system by integrations, which means that the product is ready for production. Document management has a role in being every stage in the process; however, change management and variant management have major effects on the process even though they are not mastered in every step.

In this process flow, traceability is essential because it allows changes to be propagated efficiently while implications can be detected easily based on relations between multiple artefacts [5].

Because of the insufficient abilities of the system and end users' traditional working methods, there might be external inputs coming from different sources on whole process. These external inputs are mostly requirements (eg. it may be necessary to use applications deemed appropriate by the national defense ministry in the defense industry.), outputs of project management tools and outputs of other design tools. To cope up with this complexity, use of engineering IT tools for computer-aided anything (CAx) is spreaded throughout the entire process [6].

Although the most accurate method to prevent bottlenecks and ensure traceability in the process is the management of the data in the single platform, in some cases, data flow and traceability can be ensured through the integrations between applications or customizations [7].

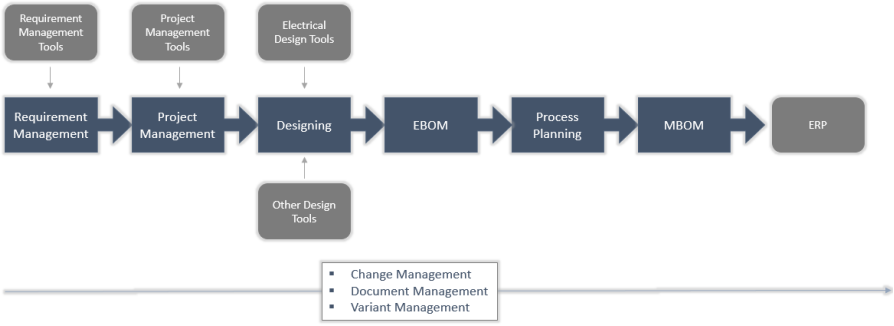

Fig. 5. End-to-End PLM process

End-to-end PLM process aims to provide traceability of the data and to create singularity of it. In order to make this manageable, various aspects of data management must be consistently implemented. The main issues of 'Single Source of Truth' are the relationships between data and dependencies and system conditions for workflows and interfaces [8].

It is proposed that increasing the role of information technologies in systems, traceability and sustainability will be supported, and in parallel, it will facilitate the cooperation of stakeholders in engineering and production processes [9].

3 Engineering IT Management on Business Process

This section aims to define how to best serve when building and deploying PLM and IT structures in a company to achieve end-to-end standards. The term "Engineering IT (Information Technologies)" can be considered as a service that is given to all engineering processes; particularly engineers on conceptual and theoretical phases as well as on technology and IT management aspect. This is not widespread in most of the companies however, in order to manage and understand processes and systems, IT and engineering point of view and expertise should not be taken apart from each other. Hence, solution architects that are responsible for Engineering IT department and concept should be willing to give solutions with both engineering and IT systems administrator approach. Success on processes' agility might only come with this understanding from internal or external customer. Moreover, this comprehensive insight of the requirement can be transformed and reflected into the system professionally.

A common known example of this kind of failure is examined in "Redafi Research and Development Africa Initiative" where Airbus A380 project was delayed for many years with a loss of billions of dollars due to:

- Configuration and change management insufficiency,
- Lack of collaborative environment [10]

Regarding this complex IT management systems, a defined vision of PLM in engineering networks is given in Figure 6 [11].

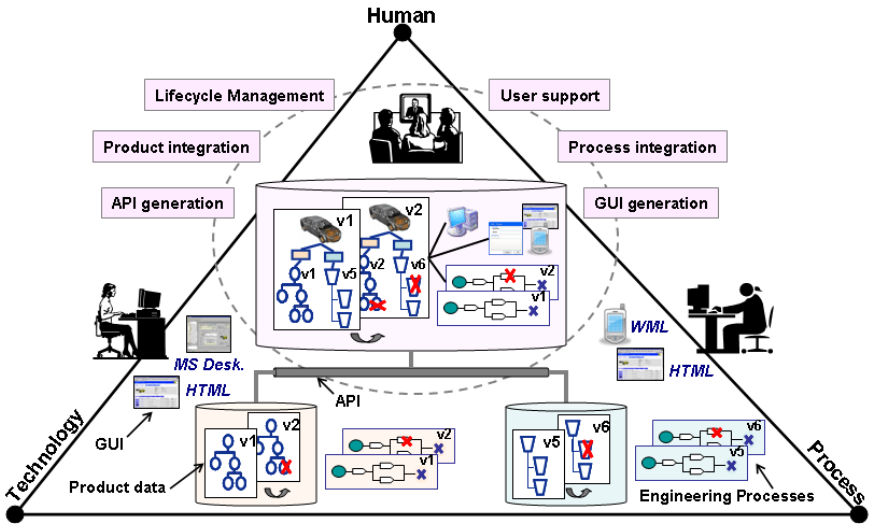

Fig. 6. Vision of PLM in engineering networks

Continuously, the major areas of Engineering IT and its methods that are applied by solution architects in automotive sector are listed in following sub-sections:

3.1 Solution Consultancy on Conceptual and Technical Phases of PLM and IT

The most important function of Engineering IT is the solution consultancy to different departments in a company. The requirements of departments might come with dependency to others and the system whereas sometimes they can be independent. In order to manage this; impact analysis should always be done and be prioritized accordingly. Most of the time; these requirements need collaborative management and the response times get extended because of the conflictions in between. This is why the solution architect has to have vast knowledge on business solutions so that he/she can lead the team to a common goal. During the conceptual idea growth phase, the technical feasibility must always be analyzed simultaneously by the solution architect. Otherwise, there emerges a risk on implementing the solution to PLM systems which then might lead to failure. This is the other major attribute of the solution architect that he/she must be fully capable of managing the services that he/she is responsible for.

A mapping of integrated multidisciplinary way is given in Figure 7 where the complexity between the departments and services can be seen [6].

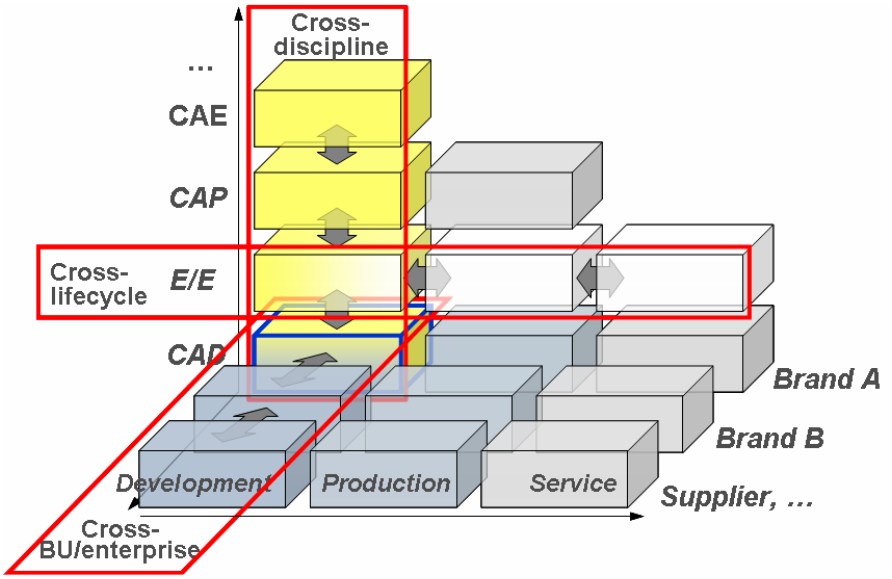

Fig. 7. Cross-x engineering in design dimensions [5]

3.2 Systems Architecture and Management

Another major responsibility of Engineering IT is to manage and administrate PLM and related IT systems and servers. The systems must always be up and they should be controlled and reported by SLAs (Service Level Agreement). On the other hand, based on customer requests and enhancements, daily and planned administrative activities should be done for improving systems' performance and agility. In addition, for maintaining an uninterrupted service to end users, high availability should always be taken into consideration supported by SPOFs (Single point of failure). Figure 8 shows the basic PLM system server architecture in BMC Automotive Company.

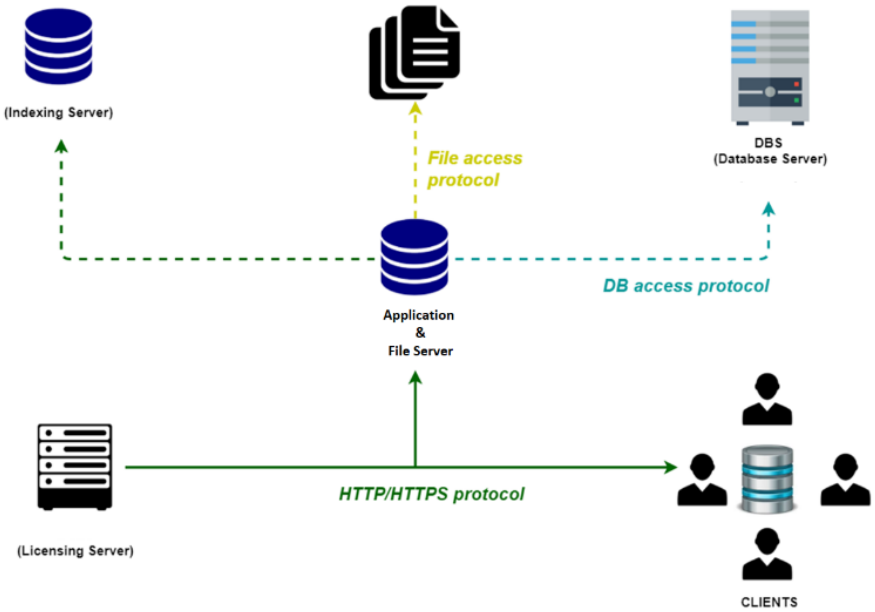

Fig. 8. PLM system server architecture

3.3 Business Solutions by Configuration and Code Deployment

As it can be interpreted from many cases, the platforms generally cannot satisfy the needs of the customer, therefore, many customizations on tool is done by solution architects. Some of them might be web-based adjustments whereas others might be done by scripts and batches. On a higher level, there are cases that require third part integrations with other business softwares and unique programs where code development and deployment stages become vital. Hence, Engineering IT is responsible for those processes as well.

3.4 Technical Support on IT Side (Helpdesk)

This section might be covered with a typical example of a change management process where configurative mistakes are mostly done by designers and product engineers. Some of these mistakes are caused by rule violations of PLM software's change management module and some are caused by hardware issues. These different feedbacks from end users can only be managed by helpdesk tools within the company. An example of this management can be seen in Figure 9.

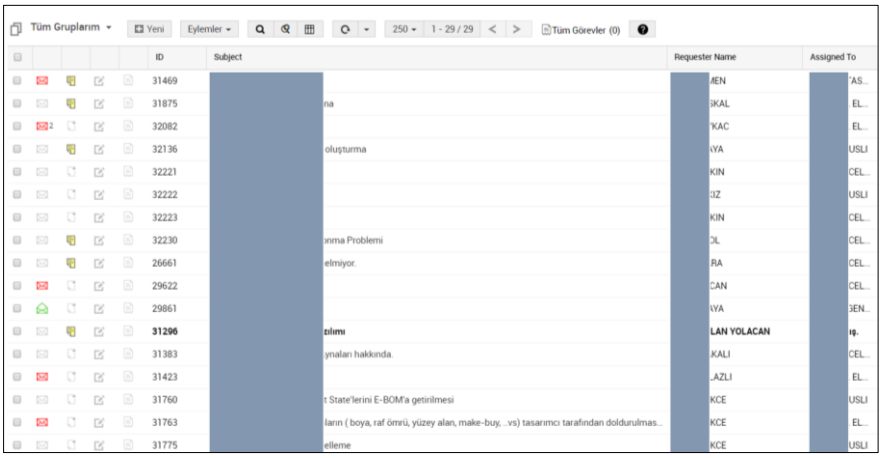

Fig. 9. Helpdesk management of Engineering IT

3.5 Knowledge Base, Lectures and Trainings

In order to provide a living mechanism of Engineering IT ideology, documents must always be created and revised accordingly for:

- Trainings
- Having a technical database (Knowledge base)
- Sustainability

3.6 Digital Mockup (DMU) Support on Vehicle Designing

Due to the fact that the Dynamic DMU runs along throughout the product lifecycle, it is linked to existing PDM / PLM structures [12]. At this point, it is very important that DMU support is provided by the engineering IT team due to having a comprehensive knowledge of the entire product design, privileges and ensuring cleanliness of data.

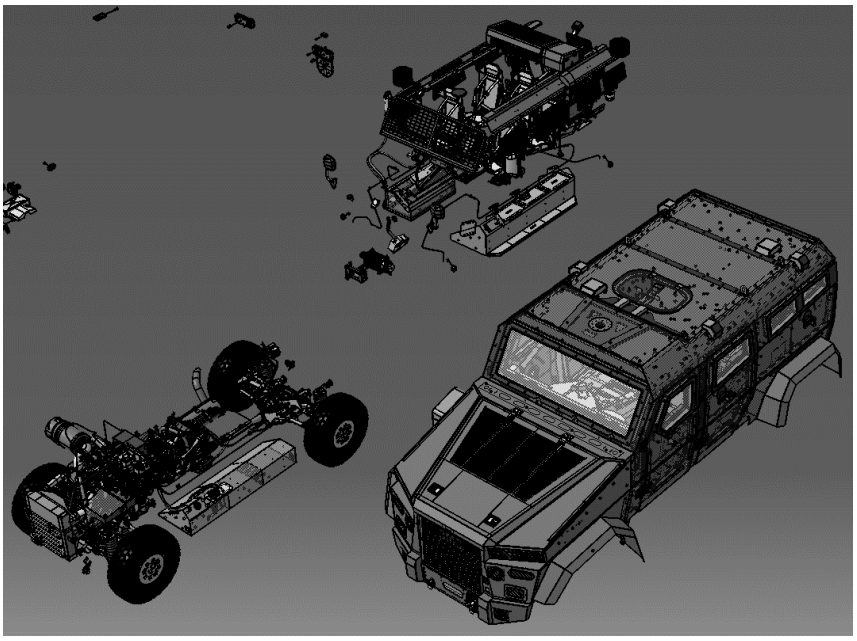

Fig. 10. Sub-components of a defense vehicle

3.7 Implementing New Softwares of Methods from Scratch to Be Used by Engineering Teams

One of the main responsibilities of solution architects is to implement new software for engineering teams. Demands and problems should be collected from the teams, benchmarking should be done, and the best practices should be presented by analyzing the requirement.

An attempt to introduce a new application stagnates because it's linked to changes in processes and working procedures. It calls for new skills and interfaces, and it has a tendency on changing old habits [13]. Therefore, being in touch with teams from start to finish will help in successful commissioning.

4 Conclusion

This study examines how engineering IT approach works on end-to-end PLM structure in a company. Furthermore, it is intended to be a guide for administrative structure that needs to be established for end-to-end collaborated processes, which has a key role on information technologies and product lifecycle management.

On the other hand, PLM applications in automotive industry have direct effect on whole process and products; therefore, it affects company profitability severely. End-to-end process can be considered as a key factor in successful PLM implementation where traceability is ensured by smooth functioning of change management and impact

analysis. Solution architects who are devoted to maintain sustainability of all these systems and provide continuous improvements are responsible for these systems. On engineering point of view, support is handled mainly in solution consultancy, digital mockup, implementation of new applications and trainings whereas on IT point of view, it is handled by system administration, software customization for business processes and helpdesk management.

As a conclusion, it is beneficial to take this study as a guide on reaching successful implementations on PLM and engineering applications.

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