

METRICS FOR THE PDM FUNCTIONALITY OF ERP SYSTEM

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1. Introduction

Although several authors of recent works ([Paul, et al. 1999], [Miller 1999] and [Ou-Yang, et al. 2003]) have discussed on incoming issue of Product Data Management (PDM) and Enterprise Resource Planning (ERP) systems integration, most of them considered PDM as stand-alone product that should share data with ERP system. Such a picture actually takes place, because the PDM solutions passed through significant process of development in past decade and had been very well adopted, mainly in companies that deal with lots of CAD work and engineering changes. Figure 1 shows a typical application scope of the PDM system. In left side is shown MRP system as it was predecessor of the ERP system. It is interesting, in a context of this paper, to accentuate such in-time parallel development of those two solutions.

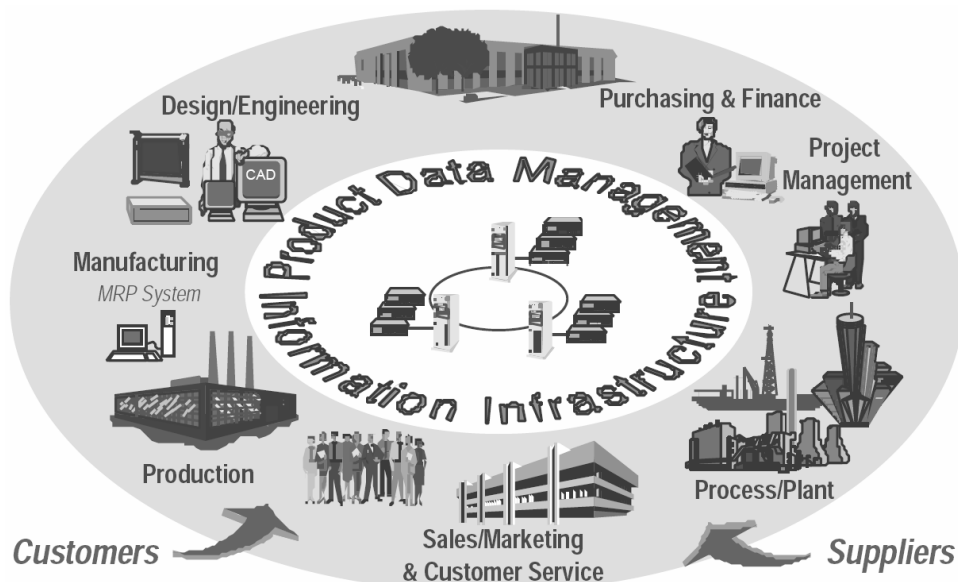


Figure 1. PDM scope [CIMdata 1997]

But on the other side Bourke in his article [Bourke 1997] tries to avoid observation of the PDM as just a one of the ERP modules, mainly provoked by the fact that most of the major and some of the midrange ERP vendors had implemented some of the PDM functionality by encompassing part masters, bills of materials, routings and engineering change. It should not be so unexpected, because

by following the fast growth of enabling Information Technology (IT), also in past decade, vendors of Enterprise Resource Planning (ERP) systems like SAP, Oracle-based solutions and PeopleSoft, has accomplished significant success in many production-oriented enterprises. Such especially financially successful stories have provided to vendors possibilities such as: to have influence in development of IT; to hire best IT experts and to integrate additional functionality based on cutting-edge IT achievements in their ERP systems. Therefore, extending possibilities of the ERP system by implementing additional functions like PDM is one of the logical steps for vendors to perform to be more competitive on the market, beside other factors significant for ERP success considered in recent papers [Hong, et al. 2002] and [Goodhuea, et al. 2000].

To estimate an implementation success of PDM functions, ERP developers but also potential and actual ERP users, need metrics i.e. guidelines to evaluate such a specific functionality. Therefore this paper is trying to discuss and propose appropriate evaluation guidelines for the PDM functionality of ERP systems.

2. PDM Functionality

Before proposition of evaluation guidelines, main PDM sets of functions are examined under this heading. Functions are examined according to several works [CIMdata 1997], [Peltonen 2000] and [Liu, et al. 2001]. Special consideration is given on integration possibility within ERP system, for each set. For later evaluation of implementation in the ERP system, sets of functions are classified in two levels: core and extended.

2.1 Core functions

2.1.1 Controlled secure storage and management of product data in a database

One of the primary PDM function. In ERP system it could be accomplished through common enterprise database, like Oracle in Oracle-based systems. With such implementation, access control is easily addressed through database management system on user level. Under management of design data are considered check-in and check-out functions for tracking design data changes.

2.1.2 Workflow and process management

Although almost every ERP system have modules for production workflow and production process management, in PDM systems such functions are dedicated to manage processes and workflows used to modify and control the product i.e. to manage Engineering Change Order (ECO) by tracking approvals and authorizations of changes to product data.

2.1.3 Product structure management

As one of the basic property of almost any product, a hierarchical product breakdown structure is considered. It describes how the product is divided into components, which are in turn divided into subcomponents, etc. The STEP standard further distinguishes between the Bills of Material (BOM) structure and the parts list structure of a product as enhanced BOMs, although such distinction is not used generally. But such an aspect is useful to compare this basic PDM function with those usually implemented in ERP systems. ERP systems usually support standard BOM that can be automatically extracted from PDM parts list structure.

2.1.4 Classification of parts

Set of functions that provides information on standard components and help in re-use of designs. Integrated in ERP system it can provide just-in-time relationship with suppliers of components based on product design demands. In other manner, integration in ERP system gives to design engineer quantity status of standard component considered to be part of product and possibility to alternate it based on that status.

2.1.5 Program management

Set of functions dedicated to provide work breakdown structures and allows coordination between processes, resource scheduling and project tracking. Although considered as PDM set of functions, it is actually base set in the most of the ERP systems. Therefore, evaluation of it is more about the ERP system than the PDM functionality.

2.2 Extended functions

For extended or utility functions that enhance the PDM system are considered: communication and notification; data transport; data translation; image services and system administration. Some of them, like communication and notification or system administration are common to many different information systems, only implementation may vary from system to system.

Communication functions, such as link to e-mail, provide for information transfer and event notification to on-line notify users about incoming events or activities.

Data transport functions are dedicated to track data locations and to move it from one location or application to another.

Data translation functions take care for file exchange in a proper format. Image services enable storing and accessing images like any other data, with implemented functions for image viewing.

System administration functions provide to the administrator of the PDM system: access and change permissions; authorizations; approval procedures; data back-up and security; data archive; system tailoring.

3. Evaluation guidelines

In an ideal situation ERP system would have the full PDM functionality. Such a situation can be evaluated with certain amount of points or percentage, e.g. 100 points or 100% of PDM functionality. In this paper full PDM functionality is marked with value of 100 points but word points is omitted for more convenient reading.

Metrics for the PDM functionality of ERP system can be divided in five evaluated levels: (1) level of the core functionality implementation, marked as L_{CF} ; (2) level of the extended functionality implementation, marked as L_{EF} ; (3) level of the integration of PDM functionality inside ERP system, marked as L_{II} ; (4) level of the accomplished product data integrity, marked as L_{PDI} and (5) level of the accomplished product data security, marked as L_{PDS} . Total sum of all evaluated levels should express accomplished PDM functionality, as it is written in equation 1.

$$L = \sum_{i=1}^5 L_i = L_{CF} + L_{EF} + L_{II} + L_{PDI} + L_{PDS} \quad (1)$$

In overall evaluation of PDM functionality, each level should not have same value, e.g. the level of core functionality implementation should contribute more in overall evaluation than the level of extended functionality implementation. Suggested point share of every particular level is given in Table 1.

Table 1. Point share by evaluation levels

<i>Level</i>	L_{CF}	L_{EF}	L_{II}	L_{PDI}	L_{PDS}	L
<i>Share</i>	50	20	10	10	10	100

For more accurate evaluation, contribution of the functions inside particular observed level should be analyzed more in detail. Therefore, such an analysis is performed in following subheadings.

Because user's needs and opinions are very important factors for success of ERP implementation, see [Goodhue, et al. 2000] and [Hong, et al. 2002], certain degrees of freedom are left to users in evaluation of each particular level. It means that if two users of the same ERP system are performing evaluation of PDM functionality, they can assign different value for same function in considered level.

Such freedom allows user to assign more value to PDM functions he needs more, and thus to fine tune evaluation for his purpose. Of course, potential weakness of such approach is that it could produce different evaluation of same ERP system. Therefore, degree of freedom must be well balanced, not to cause great deviations.

3.1 Level of the core functionality implementation, L_{CF}

Since there are five core functions with approximate equally importance for PDM functionality, total assigned value for that level could be proportionally divided for each function. So the maximum value that each of five functions could obtain is 10, so the level of the core functionality implementation can not be greater then 50, as determined in Table1. Point share in the level of the core functionality implementation is given in Table 2.

Table 2. Point share between core functions

<i>Function</i>	Product data storage and management	Workflow and process management	Product structure management	Classification of parts	Program management	L_{CF} (Σ)
<i>Share</i>	10	10	10	10	10	50

Although a few paragraphs above it was stated that certain degrees of freedom are left, in evaluation of the level of core PDM functionality implementation no such freedom is allowed and user must take off points strictly if insufficiency is noticed in certain functions. For example, if standard bill of material without hierarchical product breakdown structure is implemented in ERP system, then evaluation of product structure management in scope of PDM functionality can not pass over 0.

3.2 Level of the extended functionality implementation, L_{EF}

Point share in the level of the extended functionality implementation is given in Table 3.

Table 3. Point share between extended functions

<i>Function</i>	Communication and notification	Data transport	Data translation	Image services	System administration	L_{EF} (Σ)
<i>Share</i>	4	4	4	4	4	20

Implementation of communication and notification functions can be evaluated to maximum value of 4. If implementation does not enable on-line and automated notification of critical events then minimum of 2 points should be taken off. If implementation does not use standard protocols like electronic mail then maximum of 2 points should be taken off.

Data transport functions should be implemented in such a manner that data are stored and accessed under control of the ERP system, so an user does not need to know where on the network data are stored. The system should keep track of data locations and allow users to access it knowing only a data set's name. If so, implementation should be evaluated with maximum value of 4.

Data translation functions must provide as much translation is needed by users of system to obtain maximum value of 3. Additional 1 point can be added if translation is automatically triggered when needed.

Image services must enable raster, vector and video images viewing to be evaluated to maximum value of 2. Additional mark-up capabilities for commenting, reviewing and approving could bring additional 2 point.

System administration for evaluation with 2 point should enable basic administration functions mentioned in previous heading. If it enables additional functions for system adaptation in scope of user interface, system messages, integration of additional applications and new functionality, then 2 more points can be added.

3.3 Level of the integration of PDM functionality inside ERP system, L_{II}

If the most of the core and some of the extended PDM functions, like display of product structure, can be called as needed in other ERP modules without prior activating PDM module, then the level of the integration could be evaluated to the maximum value of 7. Words of limitations: "most and some", in previous sentence are putted before functions to instruct that for some functions there is no meaning to be called out of PDM module. Such functions are many of those from scope of ECO workflow and process management.

Rest of maximum 3 points could be assigned by considering three kinds of method for integration of PDM and MRP on database level, as revised by Ou-Yang [Ou-Yang, et al. 2002], and by adapting that methods. If all data are stored in common ERP database, assigned value is 3. If there are two databases, one for ERP and one for PDM data that shares data, assigned value is 2. Finally, if there are again two databases that only exchange data, assigned value is 1.

3.4 Level of the accomplished product data integrity, L_{PDI}

Crucial data needed for description and production of particular product must be available permanently through ERP system regardless of any maintenance processes. For example, failure of one database server should not disable access to product structure. Success of such implementation can be evaluated to maximum value of 10. Every noticed possible weakness point in data integrity should decrease that value.

3.5 Level of the accomplished product data security, L_{PDS}

Certain product data should be available only to certain users of ERP system, i.e. well protected from unauthorized access either from users on a different access level or from malicious attacks. In the evaluation of this level, well implemented authorization of access can gain maximum value of 5.

The remaining sum of 5 points is dedicated to evaluation of data back-up and archiving functions.

4. Evaluation example

As example for an evaluation, evaluated is PDM functionality of Oracle-based ERP system developed for production companies. Vendor of evaluated system is software company ININ which develops ERP systems in close cooperation with Department of the Organization and Information Technologies on Mechanical Engineering Faculty in Slavonski Brod, Croatia. Evaluation is performed through an interview with two separate teams: first compounded from two developers and second from three users. Before the interview, a detailed sheet for input of estimated values was prepared for both teams. Final results of evaluation by levels for both teams are given in Table 4.

Table 4. Results of evaluation

	L_{CF}	L_{EF}	L_{II}	L_{PDI}	L_{PDS}	L
Developers	27	15	8	6	10	66
Users	21	11	2	3	8	45

As can be seen from comparison of total sum L, a difference in the evaluation between groups is present. However, the difference is shown in expected direction: users were more unsparing despite in the evaluation while developers gave a slight softness in the evaluation of their own solution.

5. Conclusions

Authors are aware that proposed metrics for PDM functionality in ERP system can produce different results in the evaluation of same system. It depends on persons who perform evaluation but also on degrees of freedom left in point share. To assure the more accurate evaluation, it should be performed separately by developer or vendor, by users, but also by independent experts with a good background in both PDM and ERP systems.

Nevertheless, the primary aim of the proposed metrics was not to make a comparison chart between available commercial ERP systems (although it could be and will be used in that purpose). It is aimed more to help users and developers as a tool to evaluate observed system.

Also, it is not considered to be final version of metrics. It should be developed and changed based on suggestions and new directions in development of both PDM and ERP worlds.

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