

Product data management systems in support of product management

- A Qualitative Case Study of Elisa Oyj, Consumer Unit

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Bachelor's Thesis
Degree Programme in Information
Technology
2018



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| Degree program Tietojenkäsittelyn koulutusohjelma | |
| Thesis title Product data management systems in support of product management – A Qualitative Case Study of Elisa Oyj, Consumer Unit | Pages and appendices 53 + 7 |
| Thesis title in Finnish Tuotetiedon hallintajärjestelmät tuotehallinnan tukena – Laadullinen tapaustutkimus Elisa Oyj, Henkilöasiakasyksikkö | |
| <p>The subject of this study was product data management systems and the way they support the product management process. The aim of the study was to clarify the area of product data management systems because the field covers large amount of different types of data and processes, but the terminology used to describe different types of systems is vague. The first part of the study concentrated on the setting product management systems operate in. Concepts of product, product management and product data management were investigated quite thoroughly to understand how the product data management systems relate to these key concepts.</p> <p>After this study set out to produce a classification of the product data management systems to provide a better understanding of the different dimensions of these systems. This part of the research was conducted with method of content analysis by using different sources to collect information on product data management systems during September and October 2018. Classification identified the product management areas supported by the systems and provided a list of features attributed to the types of systems. The study employed the classification created in a case study in Elisa Oyj's consumer business unit In October and November 2018. Case study was conducted with a series of semi-structured interviews that were performed among the stakeholders of the consumer unit's product management process. Aim was to try out the classification and provide insights on the views of the stakeholders.</p> <p>Outputs of the study were the classification of the product data management systems and some recommendations for the future research and to the Elisa Oyj who is the beneficiary of the study. Classification created divided product data management systems to product configurators, product data management systems, product information management systems and product lifecycle management systems. From these classifications the product lifecycle management system merits further investigation specially to identify what form it will take as commercial product. As for recommendations for the case study organization first of the main findings in the interviews was that common terminology needs to be established in the discussions in the subject area. Second finding was that the stakeholders expressed need for better content management processes or a product information management system.</p> | |
| Keywords product, product management, product lifecycle management, product data management, product configuration, product information management | |

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List of Acronyms

CAD – computer aided design

PDM – product data management #

PC – product configuration

PIM – product information management

PLM – product lifecycle management

ISPMA - International Software Product Management Association

ERP - enterprise resource planning

PRM - product resource management

PCM - product content management

1 Introduction

The subject of this thesis is product data management systems and how these systems help to support product management. Subject seems quite straightforward but after more investigation it is apparent that the terminology used to describe different kinds of systems varies. When checking at something that is described as a product data management system one might expect to find certain set of features, but this is not so. Product data management (PDM) is a vast field and different terms are used interchangeably. Based on the terminology used it is hard to know the actual content specific system has to offer. Systems might also contain features attributed to one process and some to another. Systems rarely embody purely just one aspect of product data management. This vagueness causes a lot of confusion among stakeholders that are less familiar with the field. This makes scoping for possible improvements hard. Because of these reasons this study set out to clarify the terminology used when discussing product data management systems.

The recipient of this study is Elisa Oyj which is a domestic telecommunications, ICT and digital service company. The topic is relevant to the organization due to its continuous activity to improve master data and portfolio management processes. The case study part of this study will be conducted around Elisa's consumer business unit.

The goal of this study is to find or create a classification for different types of product management systems, to identify which parts of the product management process they support and to find out what the case study organization stakeholders think of these systems. The research questions of the study are:

1. What kind of features should different types of product data management systems contain?
2. Which parts of the product management function are they supporting?
3. How do case study organization stakeholders perceive these systems?

The classification created in this study will not provide a comprehensive list of all product data management systems on the market or describe their technical functionalities. The aim is to describe features that a type of system might contain and to create a clarifying typology for the recipient of the study. The case study part will consist of interviews conducted among the stakeholders and will hopefully shed more light on how they perceive the systems and what kind of thoughts this classification raises in them. Because the

study is a bachelor's thesis its scope is quite limited. The study will be explorative and will produce a classification that can be used to clarify future discussion on the subject area and to help stakeholders understand the possibilities different systems have to offer. This study should also provide suggestions on what kinds of issues raised in the interviews might require investigation or actions in the case study organization.

The structure of the study will reflect the exploratory approach of the study. The first part of the study sets out to clarify the setting where data management systems are operated by digging into the key concepts of a product, product management and product data management. The second chapter will clarify the research strategy of the study. After this there are two chapters that present the findings of the empirical study. The first part will present the system types and common features identified. The second will present the summary of the case study interviews which were conducted utilizing typology created in the first part of the study. Finally, conclusions will raise the main points of the study and provides recommendations for future research.

2 Background

The purpose of this chapter is to provide clarifications for the most relevant underlying concepts of this study, namely the product, product management and product data management. Each one sounds clear enough but as with most concepts when one starts digging in to them it gets more complicated. Clarification is needed because the concept of the product will help us understand the scope and dimensions of product management. Defining product management and product data management is in turn needed to understand how the selected systems impact product management and help with the identification of the process participants and stakeholder groups.

2.1 Product

When discussing the concept of the product the first item that should be clarified is the relationship between a product and a service. One way to see the difference between these two concepts is the tangibility or intangibility of an item. In this case the service would be intangible and the product something tangible like a physical good (Spacey 2016, National Archives). However, one offering can contain both tangible and intangible parts like a physical device and a warranty as a service for the device. There are also different levels of tangibility. For example, a consultation service is almost wholly intangible excluding possible documentation, but a software service does require hardware somewhere to function.

To avoid discussion on these distinctions that are not relevant to the study a broad definition of a product that encompasses intangible and tangible parts will be adopted. A product is “any want-satisfying attribute consumer receives in exchange” (Chunawalla 2009, 1) or more plainly put anything that is sold by an organization to its customers (Gartner). In this definition intangibility and tangibility is described with a concept of goods and services which can both be included in the definition of the product. (Avlonitis & Papastathopoulou 2006, 12). To continue the earlier example a product is anything sold to or exchanged with a customer, like a phone. A phone as a product consists of goods and services. Goods like a physical device consist of its parts like a battery and additions like a charger or a hands-free. Services for the device product could be for example software or a warranty. This definition is illustrated in figure 1.

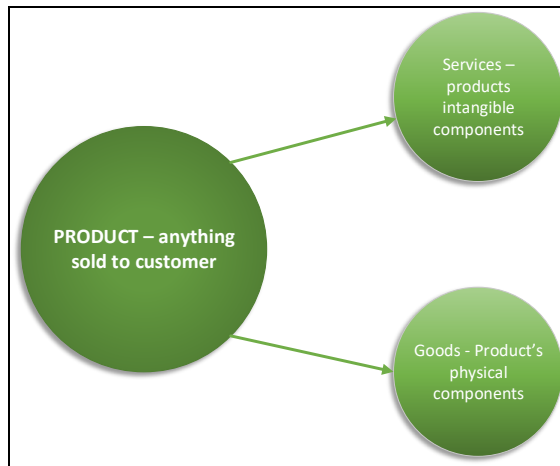


Figure 1. The product, services and goods

2.1.1 Product levels through customer value

The content of a product can also be analyzed through the value it creates to a customer. For this purpose, Theodore Levitt (1980) has proposed a version of 5-level model. Each level adds more customer value and taken together they form a customer value hierarchy (Levitt 1980, Avlonitis & Papastathopoulou 2006, 3). This customer value model helps to broaden the definition of the product and to understand scope of the product management activities and stakeholder groups.

Levels of the model are as follows.

1. The first level in the model is the core benefit which refers to the main benefit or a core functionality a customer is getting from a product.
2. The basic product describes the basic characteristics of a product without which a product would not exist.
3. The expected product embodies the characteristics that are the minimum purchase conditions for a customer.
4. The augmented product refers to the characteristics that surpass customers' expectations.
5. The potential product refers to those characteristics that could be added to the product in the future for customer delight.

(Avlonitis & Papastathopoulou 2006, 4, Levitt, 1980.)

If we take a mobile voice subscription as an example the core benefit customer is looking for is communication. In this example the basic product would consist of network and signaling capabilities that make messaging via voice, text messages or data possible. The

expected product could be good voice quality and network coverage. The augmented product could be free of charge VOIP calls. The potential product in our example could be 5G capability or an integrated wakeup call service that recites poetry.

Lawley and Schure (2017, 11) employ similar levels but use only three levels with slightly different definitions: the core, the actual product and the augmented product. The product core in this model is the same than in the Levitt's model. The actual product is the product design with all aspects of it like features, brand and packaging. In this model the augmented product does not mean the things that surpass customer experience. It means all the additional parts of the overall solution that support the customer experience (Lawley & Schure 2017, 10) like support for purchase process, customer service quality, maintenance processes or technical support. This approach suits the purpose of this study better because it gives more tangible definition for what is part of product and what is not.

The way customer experience is related to the product is the product promise. "Product promise is an implied guarantee of what kind of experience you're offering to customers" (Lawley & Schure 2017, 10). What customers are expecting to get is the minimum the augmented product needs to deliver. In this way the augmented product makes all product related customer experiences part of the definition of the product. The product levels are depicted in figure 2.

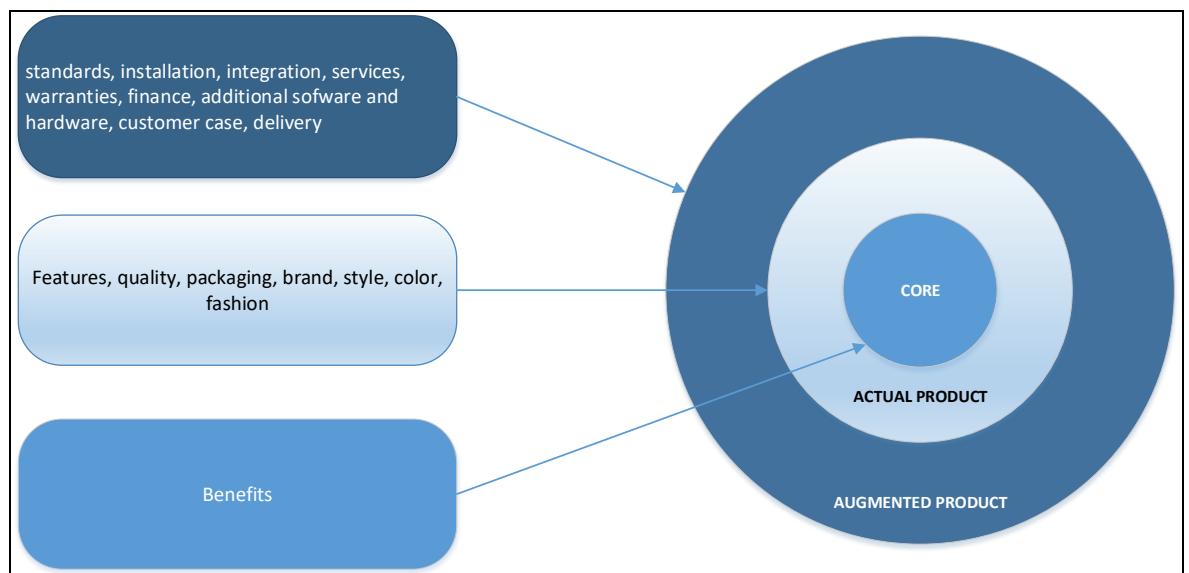


Figure 2. The whole product offer (modified from Lawley & Schure 2017, 11)

2.1.2 Product hierarchy levels

A product can also be classified based on its relationship with other product objects. This sheds further light on the different levels product data should be managed at. This also sheds light on different kinds of classifications and hierarchies needed to understand the objects in uniform ways. Either a phone or Samsung Galaxy S7 could be referred as a product in a discussion, but from the data structure point of view these are totally different levels of things. For this purpose, Avlonitis & Papastathopoulou (2006, 4) present Kotler's seven product hierarchy levels.

- Need family
- Product family
- Product class/category
- Product line
- Product type
- Brand
- Item/stock-keeping unit/product variant.

The levels and their definitions are described in table1.

The need family is like the core of the product in the earlier definition of the product value. It describes the need that is being satisfied with the product. This is high level and encompasses several different product families. This level of definition is useful from a marketing or a product strategy point of view but does not have much bearing in this study. The Product family is all the classes that satisfy the need in the definition of the need family. If the need family would be communication all devices for electronic information exchange would be the product family. The product class or the category is something more tangible like a phone. It is a group of products inside the product family that have certain functional coherence. (Avlonitis & Papastathopoulou 2006, 4.)

The product line is a group of products within the product class that are closely related because they perform similar functions. For example, the product class could be phones. Inside that product class there are product lines like fixed line phones, radio phones and GSM devices. The product types are different forms of the product class like a smart phone. The brand is a product name in the product line that is used to identify the source or character of the items. An example of this would be Samsung or Samsung Galaxy. Finally, the product variant is a distinct unit within the brand or the product line distinguishable by size, price, appearance or some other attributes such as Samsung Galaxy S7. (Av-

lonitis & Papastathopoulou 2006, 4.) Different product hierarchy levels are illustrated in the table 1.

Table 1. Kotler's product hierarchy levels (Avlonitis & Papastathopoulou 2006, 4)

| Hierarchy | Definition | Example |
|---|---|---|
| Need family | Basic need underlying the existence of product family. | Information exchange. Communications |
| Product family | All the product classes that satisfy the basic need effectively | Devices for electronic information exchange. Wireless information devices e.g. tablets, pagers, phones. |
| Product class or category | A group of products within the product family recognized as having certain functional coherence. | Phone |
| Product line | A group of products within a product class that are closely related because they perform a similar function, are sold to the same customer groups, are marketed through the same channels or fall within given price range. | GSM device, mobile phone |
| Product type | A group of items within a product line that share one of several possible forms of the product | smart phone |
| Brand | The name associated with one or more items in the product line that is used to identify the source or character of the items. Name of the product. | Samsung or Samsung Galaxy |
| Item/stock-keeping unit/product variant | A distinct unit within a brand or product line distinguishable by size, price, appearance or some other attributes. | Samsung Galaxy S7 |

2.1.3 Product definition

In summary of the above chapters the product definition used in this study is “anything sold by the organization to its customers”. A product can have different levels of tangibility but usually consists of both goods and services. A product is also defined through the value it provides to a customer which means that whole of the product experience is seen as part of the product. This widens the product management's scope and amount stakeholder groups related to the process. A product can also be defined in hierarchical levels which impact the scope of management decisions.

2.2 Product management

To understand how product data management can support product management the function needs to be explained in more detail. This chapter will explore how product management and the product management process can be defined. After this the product management related functions will be defined.

Product management as a concept has been around since late 19th century and has gone through several different phases starting from the owners being responsible for day-to-day guidance of their product. The most prominent phase started in the 1930s when Procter and Gamble formalized the product management structure. In this model product managers were general managers of their product. They coordinated all activities with respect to pricing, packaging, product attributes, promotion and distribution. (Katsanis & Pitta 1995, 54-56)

The classic model was wholly dominant for some decades, but 1980s recession brought changes and caused for some organizations to shift the product management function from individual to number of subordinate, specialized functions within the organization (Roach 2011, 696; Katsanis & Pitta 1995, 57). This time the focus was on the team approach with objectives to enhance channel relationships, increase external environment focus, increasing entrepreneurship and profit-line accountability. (Katsanis & Pitta 1995, 57; Roach 2011, 696.)

Whether the responsibility of the product is on the individual or multifunctional teams' companies must still have a system to coordinate the product related activities (Roach 2011, 698). Organizations themselves might have varying understandings on the product management definition depending on the company specific context but in general the product management function has specific tasks that should be performed regardless of which part of the organization is performing them. In this study product management is assumed to be the complete management of the product (Billgren & Bjernulf 2018, 2) that has a general definition and a goal of ensuring product success.

Product management is also interdependent and boundary spanning (Katsanis & Pitta 1995, 53) This means that product management has many dependencies and feedback loops between different functions. Integral part of product management is also processing information from outside and inside in order to disseminate it to relevant parties in the organization. (Roach 2011, 697.) For this reason, much of the product management litera-

ture is concentrating on the role of the product manager who has traditionally coordinated this information processing. A product manager has a crucial role in many organizations, but role of the manager should be distinguished from the function which involves several individuals and groups. Simply put product management is a function in the company that is ultimately responsible for the success or the product in the company. This organizational level approach differs from the agency level approach concentrating on the product manager.

2.2.1 Product management process

Definition of the process is “*A series of actions or steps taken in order to achieve a particular end*” (Oxford Dictionaries). Goal of this chapter is to define these steps in the product management process.

Traditionally, managers break down their business systems in production terms. "Step one: plan the product. Step two: make the product. Step three: sell the product" (Golub et al. 2000) but the product management process can also be viewed through the value it is creating via a business system. A business system is a group of activities that are carried out to produce the wanted output. In this case a product that will be sold. In the value delivery sequence value is first identified, then provided and lastly communicated. (Chunawalla 2009, 12-13; Golub et al. 2000.)

A business system is seen as a value delivery system, which is geared toward advancing the value proposition at each stage of production and distribution. Step one: choose value. Step two: provide value. Step three: communicate value. This way product management can make sure that the value proposition of the product pervades every layer of the organization. (Golub et al. 2000; Chunawalla 2009, 13.) Viewpoint of the traditional model and the value delivery system is different and very important when considering the mindset of product management. However, neither of the models depict the continuous nature of product management and don't seem to have any steps after the product is sold.

Product lifecycle is one of the most important product related concepts often used as bases for describing the product management process and strategies. Product management can also be seen through the product lifecycle. Product lifecycle management (PLM) is integrated management of a product through the product lifecycle. The PLM approach supports product management as a boundary spanning activity by understanding the product lifecycle as a chain of interrelated activities representing the product chain. The

approach also implies involvement of many stakeholders internal and external to the organization (Hadaya & Marchildon 2012, 561).

The product lifecycle can be divided to three phases.

1. Beginning on life when a product is conceptualized and created.
2. Middle of life when the product is used, serviced, maintained, developed further and sold.
3. End of life when decisions of what should be salvaged and when the product should be disposed are made.

PLM approach necessitates the exchange of information to support the product chain spanning over the three phases of a product's lifecycle. (Hadaya & Marchildon 2012, 561-562.)

Lawley and Schure (2017, 42) also use the product lifecycle to describe the product management process which they call the optimal product process. This process has seven lifecycle stages that are uniform to all products.

- Conceive
- Plan
- Develop
- Qualify
- Launch
- Maximize
- Retire

This model reflects the actual product management practice better because all stages of this model from conceive to maximize repeat during the product lifecycle until the product is retired.

During the conceive phase a company or a team is generating new ideas. This may be done formally or accidentally through observing customers and identifying their latent needs. It may also be done by executives, engineers, product managers, salespeople or others coming up with potential products and new features. At this stage all generated ideas are evaluated and prioritized to determine whether they are worth time and resources. (Lawley & Schure 2017, 36.)

During the plan phase after having come up with a prioritized list of opportunities additional time and effort can then be spent doing some true planning like business case and product requirements. After the planning phase is done development priorities are agreed on and the product is moved to development. As the end of the development nears, the team determines if the product is ready to move into the final qualification phase. In the qualify phase beta or pilot programs are run to determine if the product is fully ready for production. After qualifying the product to ensure that it meets appropriate standards and will be accepted by customers and the market, a company then officially launches the new product (or an updated version for existing products) into the marketplace. (Lawley & Schure 2017, 47-50.)

After the initial launch, the product requires ongoing marketing and other activities to ensure that it continues to be as successful as possible. This includes demand generation, competitive responses, public relations, ensuring customer feedback is included in the next revision of the product, and supporting the sales force and channels. (Lawley & Schure 2017, 50.) The cycles from conceive to maximize run repeatedly as long as the product is profitable or needs to be maintained for some other reason. Retirement is the only lifecycle stage that should be repeated only once. Retirement might mean new version as a replacement of the product. The product might also be intentionally discontinued or sold on an ongoing basis without much effort being put into it (Lawley & Schure 2017, 51). However, this stage also requires a plan, so that the organization has control over its product variety. The product processes are illustrated in figure 3.

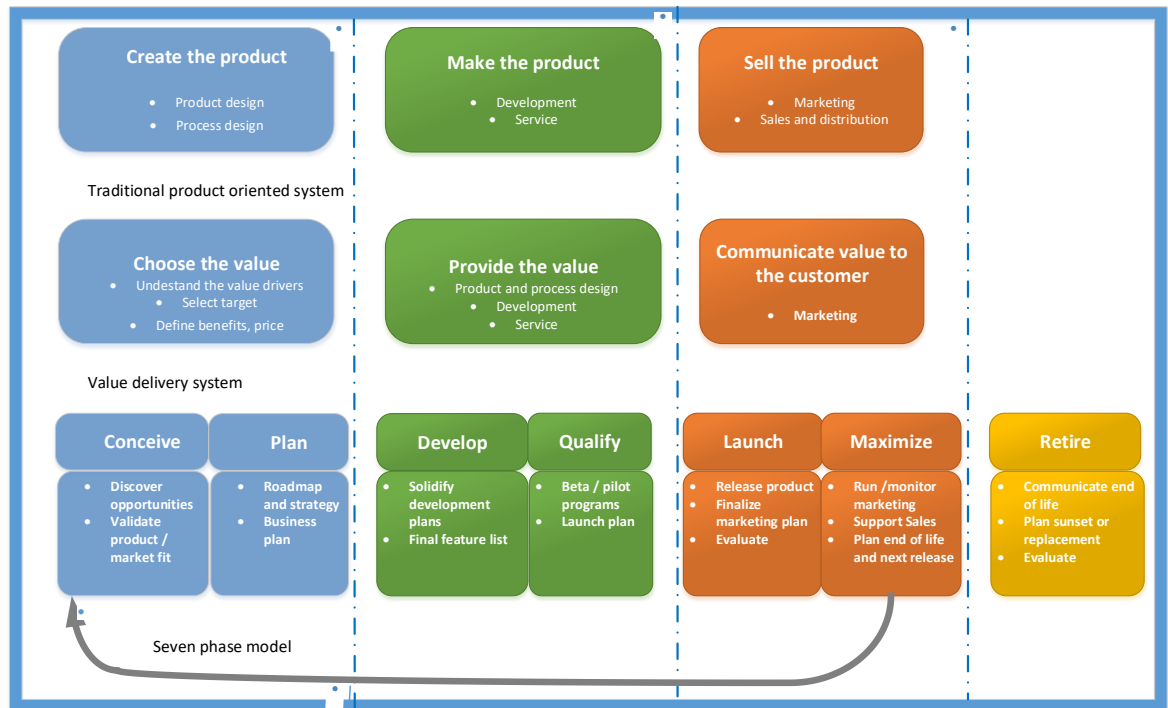


Figure 3. Product processes (modified from Lawley & Shure 2017, 53; Golub et al. 2000; Chunawalla 2009, 13)

2.2.2 Product management functions

The purpose of this chapter is not to give a detailed list of all product management related activities or tasks of the product manager. The idea is to try to outline high level and generic product management areas and functions. Identifying the different functions that play part in the product management process gives more concrete view on different interfaces and stakeholders from whom product data needs to flow in product management.

According to Billgren and Bjernulf (2018) product management has a core area that can be divided to four key areas.

- Insights
- Product strategy
- Product planning
- Product marketing

Each of these key areas has high-level objectives that constitute the core practice of product management.

The insights are about understanding legacy, markets and the driving forces. The insights are based on knowledge, analysis and data collected. These are used as an input for all the levels starting from strategy ending up to product delivery. (Billgren & Bjernulf 2018, 3, 5, 7, 14.) The insights can be obtained through observation, research, reporting or analysis. Roach (2011, 698-704) has reviewed the earlier product management literature to identify the key product management capabilities that impact organization's performance. Several aspects of the insights can be found from that list. List includes processes such as internal and external monitoring of the environment, business case assessments, profitability analysis, customer research and forecasting of volume and revenue.

The product strategy gets its input from the insights and forms the core of product management (Roach 2011, 699; Billgren & Bjernulf 2018, 3, 5; Chunawalla 2009, 4). It is guide to product value delivery over the product lifecycle (Chunawalla 2009, 4; Billgren & Bjernulf 2018, 3) and provides inputs to product planning and marketing. Usually the product strategy encompasses things like choosing what products to develop or retire, responding to changing requirements, allocating budget and resources and balancing investment and focus between innovation and customer-requested enhancements from an offering perspective (Berkowitz 2014).

Product planning and product marketing in turn are getting their inputs from the strategy. The high-level objective of the product planning is to ensure that the correct product, that is aligned with company's and product's strategy, is being developed and offered. (Chunawalla 2009, 4; Billgren & Bjernulf 2018, 3). Product planning collects requests, proposals and ideas to be refined and prioritized for processing (Chunawalla 2009, 4; Billgren & Bjernulf 2018, 5; Roach 2011, 702). Product marketing is about the product being able to reach its potential (Billgren & Bjernulf 2018, 3). Here product management defines and communicates the value to product marketing. In other words, explains which valuable market problem is being solved with the product. (Lawley & Schure 2017, 17; Billgren & Bjernulf 2018, 6.)

By looking at the product management core areas it is easy to understand the central role correct information plays in product management. The product management core revolves around correct information because such things as decisions, innovations, requirements, marketing, understanding of the strategy all rely on the correct data and mutual understanding on how that data should be interpreted. The product management core is illustrated on figure 4.

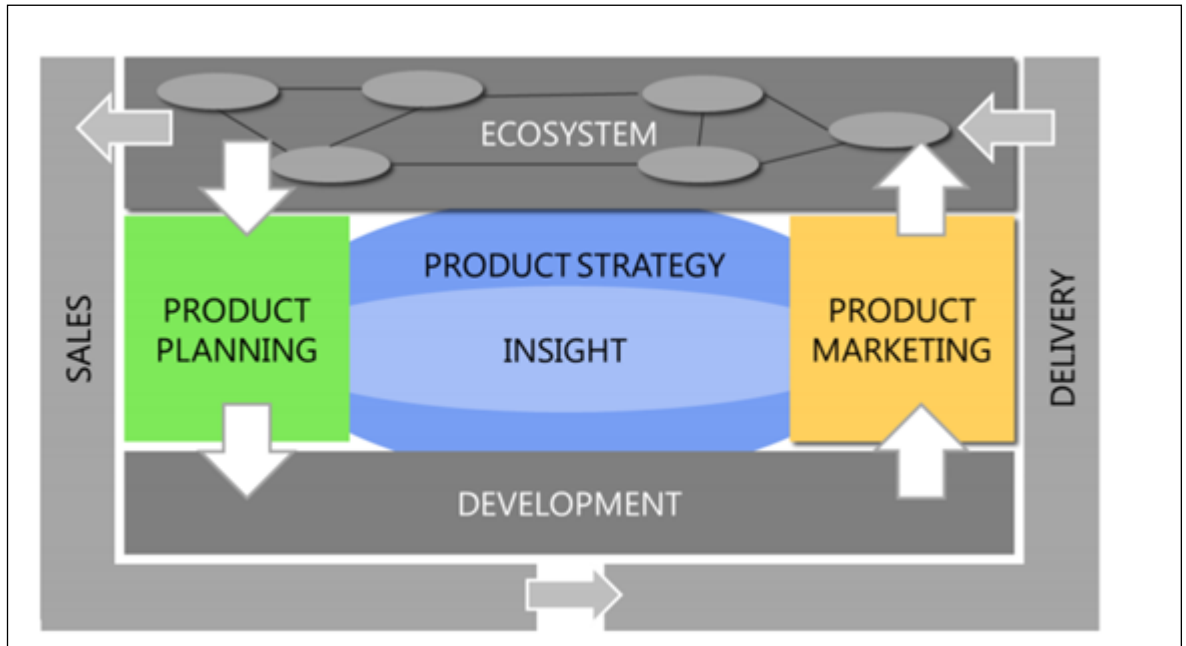


Figure 4. Product Area (Billgren & Bjernulf 2018, 3)

Because product management is a boundary spanning function there is no single instance that executes all the activities from strategy to sales. Thus, the product management process participants come from several different functions on the organization that executes the product management tasks.

A good view of the related functions can be found from the International Software Product Management Association (ISPMA) product management framework that Billgren & Bjernulf (2018, 13-19) have modified to cover more than software products. It presents the product management core area as well as other areas in which product management either participates or is a guiding and influencing force. The framework is illustrated in figure 5.

| Strategic Management | Product Strategy | Product Planning | Development | Marketing | Sales and Distribution | Service and Support |
|-----------------------|---------------------------------|----------------------------------|----------------------------------|----------------------------|----------------------------|----------------------------------|
| Corporate Strategy | Positioning and definition | Product Life Cycle Management | Engineering Management | Marketing Planning | Sales Planning | Service Planning and Preparation |
| Portfolio Management | Delivery model Service Strategy | Roadmapping | Project Management | Customer Analysis | Channel Preparation | Service Provisioning |
| Innovation Management | Sourcing | Release planning | Project Requirements Engineering | Opportunity Management | CRM | Technical Support |
| Resource Management | Business Case and Costing | Product Requirements Engineering | User Experience Design | Marketing Mix Optimization | Operational Sales | Marketing Support |
| Market Analysis | Pricing | Product Architecture ** | Quality Management | Product Launches | Operational Distribution | Sales Support |
| Product Analysis | Ecosystem Management | | | Operational Marketing | Supply Chain Management ** | |
| Insights ** | Legal and IPR Management | | | Value analysis ** | | |
| | Performance and Risk Management | | | | | |
| Participation | Core | | Orchestration | | | |

Figure 5. Product management Framework (Billgren & Bjernulf 2018, 13)

There are seven main areas in the framework.

- Strategic management
- Product planning
- Development
- Marketing
- Sales and distribution
- Service and support

Along these functional areas the organization specific internal stakeholders for the product management process should be identifiable.

Strategic management is the activity in which organization's strategy is implemented and evaluated. The most important interface in this activity is the management. Product management participates in this by producing market and product data and by aligning the product strategy to the corporate strategy. The product strategy, market analysis, product analysis and the insights are the core functions with objectives to ensure the profitability of the product and to initiate the product lifecycle related changes. (Billgren & Bjernulf 2018, 8-14.)

Product planning is another core function. It defines the product offering over time. Development contains all technical aspects of the product meaning this is the area of product creation. The key interfaces in this area are development teams and project managers. The marketing area contains all the functions that are related to marketing and deployment of the products. Product management defines the value for marketing to communicate. Sales and distribution contain supply chain and sales and distribution to the customers. The key interfaces here are delivery and sales functions. The service and support area consist of the product related services and consulting provided to the customers. (Billgren & Bjernulf 2018, 8-14.)

2.2.3 Product management definition

The ultimate objective of the product management is to ensure the success of the product or the product line. Product management as function is cross functional and boundary spanning, meaning it is executed throughout different functions. Product management has a core. The core contains the functions solely concentrating on the product. In the other product management related functions product management either participates or supports other functions in the organization. When considering the boundary spanning nature of product management it is easy to see why product data management plays a key role in the success of the product management process.

Product management process can be seen through product lifecycle that has seven stages. The first stages of the lifecycle are conceive and plan in which value that will be provided to the customer is chosen. These stages are where the product management core areas of product strategy and product planning are executed. The most important interfaces for these stages are management, reporting, research and development. Management provides the resources and guidance of corporate strategy to the conceive and plan phases. Reporting and research provide insights for idea generation and development receives the output from the plan phase.

After the plan phase comes the development and qualify phases where the value is provided. Product management influences and supports the development phase. The key interfaces at this stage are development teams, project managers and other solution area experts that are needed for the technical definitions, product creation and testing.

The launch and maximize phases of the lifecycle are where value is communicated to the customer. In this phase the core area of the product marketing will communicate that value for marketing and sales. The key interfaces are the marketing and sales organizations.

At this stage product management also support sales and distribution and service and support area by providing the subject area knowledge and making sure that all processes are in place. The key interfaces are the delivery, sales and support organizations.

The Product retirement stage does not get much notice in the literature researched for this study and does not provide customer value. This is however a part of product management core in the strategy where the product's viability is estimated, and replacement planned when time is right. The key interfaces at this point are support organizations and possibly sales or development depending on the strategy taken for ramping down the product.

2.3 Product data management

Product data management is essential in any modern company. As already pointed out product management is a boundary spanning process. This means that product data is required by both internal and external functions in different phases of the product lifecycle. However, in the modern complex environments product data exists in various forms and systems. It is also often in conflicting formats due to lack of standardization (Kropsu-Vehkaperä & Haapasalo 2011, 61). Lack of agreed standards also leads to differing terminology which makes it hard to match or find data from different silos it is residing in. However, offering large variety of products at competitive prices with fast time to market requires a firm grasp on product information (Forza 2008, 817.) and that is why functional product data management is a must for any organization planning to succeed in the market.

Product data management is a general term that encompasses all processes of creation, enrichment, sharing, storing and modifying and classification of product data. Product data management can be defined as “the process of capturing and managing the electronic information related to a product so it can be reused in business processes such as design, production, distribution and marketing. It usually involves the use of a dedicated software application and centralized database” (Rouse b.).

At this point is important to make the distinctions between the PDM process and the PDM system defined in this study. The product data management process is something that encompasses all of product data. In this study the systems designed to support the product data management process have different dimensions and what is labeled as the PDM system here supports only some parts of product data management. The PDM system classification will be described later in more detail.

Product data can be divided into product master data and other general data. “Master data is the core data that is essential to operations in a specific business or business unit. The kinds of information treated as master data varies from one industry to another and even from one company to another within the same industry” (Rouse a.). Product master data could be such things as product descriptions, item codes, service provisioning information, prices and supplier information, but general standardized definition for product master data does not exist (Kropsu-Vehkaperä & Haapasalo 2011, 62).

Other general data is more relevant for single function purposes and often informal in nature. Examples would be product specifications, technical drawings or functional models. Some studies expand the concept to include data like user guides, engineering change information (Kropsu-Vehkaperä & Haapasalo 2011, 62) and marketing material.

3 Research strategy

This study is a qualitative study that takes an exploratory approach to phenomenon that is being studied. The qualitative research can be distinguished from the quantitative research for example with distinction of numeric and non-numeric data (Saunders 2016,163). A qualitative research utilizes qualitative data like interviews, documents and observation. These are used to understand the phenomenon that is being studied as opposed to a quantitative study which uses measurable data to understand the subject.

An exploratory approach is taken when researcher wishes to clarify his understanding of an issue, a problem or a phenomenon (Saunders 2016,175). In this case the aim of this study was to clarify what types of systems are available for product data management. How these systems relate to product management and how are they seen by the stakeholders in case study organization. Because the whole setting of the study is trying to clarify the understanding of something that is not clear quantitative data or measurable questions aren't available. Therefore, qualitative and exploratory approach is chosen for this study. There are several ways to conduct exploratory research. These include a search of the literature; interviewing experts in the subject; conducting in-depth individual interviews or conducting focus group interviews (Saunders 2016, 175).

The research strategy chosen was twofold. The first research questions are not specific for the case study organization and require content analysis from secondary sources. A content analysis is a detailed and systematic examination of the contents of a particular material for identifying patterns or themes (Thinagaran 2014, 112). For the purpose of understanding common classification and features of different types of systems sources used were books, academic articles, blogs, commercial and research materials from consultant companies and system providers.

The last research question was explored in a form of a case study. A case study is an in-depth inquiry into a topic of phenomenon within its setting (Saunders 2016, 184). This case study was targeted to product management process of organizations consumer unit's subscription products. The case study was conducted as series of semi-structured interviews for the stakeholders of this process.

Interviews can be classified as standardized or non-standardized interviews. Structured interviews have specific sets of questions all interviewees answer. Semi-structured and in-depth (unstructured) interviews are 'non-standardized'. In semi-structured interviews the

researcher has a list of themes and possibly some key questions to be covered, although their use may vary from interview to interview. (Saunders 2016, 391.) For the case study semi-structured interviews were selected as a method. In this case some material generated from the first part of the study was presented to the interviewees. Conversation was opened by explaining the background of the study and asking a very generic question on their views of the systems and the features presented on the material. The presentation used in the interviews can be found in attachment 1.

4 Product data management systems

Before reviewing the product data management classifications generated in this study there are couple issues that need clarification. First, terms used to describe the different types of product data management systems are used very interchangeably in lot of public internet sources like industry expert blogs, academic literature and commercial system descriptions. Product data management, product information management and product lifecycle management are also often used as synonyms. This classification is based on the material used for this study and its aim is to describe the different aspects of the product data management. So, reader needs to be aware that this is only one interpretation of the field and not a single source of truth.

In below sections we are referring to the term product several times. Definition for the product in this study was anything that is sold to the customer. This might create some confusion because sometimes what is sold to customer is a solution or a bundle which consists of components that can be sold as standalone products. Product is always the entity sold to the customer and in the cases when product comprises of multiple “products” term component could be used to describe the product that is part of larger product definition. This is also part of the complexity of the product data management systems for organizations that provide products with varying structures. They need to be able to define what are the levels of the product hierarchy defined for the data management systems and how they should be handled. This part of the study will not go in those details but tries to describe the different aspects of the product data management systems on a general level.

4.1 Product configuration systems

Product configuration (PC) systems are not usually listed as product data management tools. In most cases they are seen as providing the functionality for selection and delivery of the product and as source for product data that a product data system would use. However, the product configurator can also be an application or a module in a product data management system. The product configurator was chosen as part of this study because the case study organization currently uses a configurator that also retains some functionalities of the other product data management systems. Another reason for adding the product configurator to the list is that it needs to either use or provide the product structures and the models of the product data management systems for the process to be effective.

Product configuration is a process that refines the product requirements to a specification necessary to produce a product variant as an output for next part of the process. Product related configuration can be divided to sub-processes of sales configuration, technical configuration (Forza 2008, 819-820; Martio 2015, 13, 25), document configuration and process configuration (Martio 2015, 25). The product configuration process output is the product variant the customer is buying with all the properties chosen by the customer.

The sales configuration process includes all the activities carried out to identify the complete and congruent commercial description of the product that best fits the customer. Customer is mostly interested in product properties like functionalities, models, colors, additional components, installation etc. Sales configuration takes care of defining a sellable product that contains variety of these properties, mandatory parameters values needed from customer and eligibility rules. The sales configuration model is a formal representation of the product space and of the procedures according to which a sales configuration can be defined within such space. (Martio 2015 25-27; Forza 2008, 819-820.)

The technical configuration model, also called the product model, is a formal representation of the links between the commercial characteristics of a product and the documents that describe each product variant. The technical configuration process includes all the activities that generate the documentation of the product variant, based on the sales description of this variant. The technical configuration process takes the sales configuration chosen by the client as an input and identifies the product components corresponding to that input. The product model, therefore, is a logical structure that formally ties together which of the product characteristics are offered to how products are made. (Forza 2008, 819-821.)

In a simple case this could be a delivery of e-book for a consumer customer. This product has similar delivery process regardless of the item bought. For the manufacturing organizations or solution sales product configurator has the same function of producing the information needed for the delivery but process is much more complex. In this case configuration should contain the needed product structures, solution delivery parameters / manufacturing parameters, generate documentation related to production of the structure, generate information needed for post sales like information on spare parts, contain user and installation guides and maintenance instructions (Martio 2015, 35).

Documents and files configuration at its simplest is using parameters to define which documents are relevant for a specific product configuration. Process configuration in this context means that the order and delivery processes might depend on the properties chosen

during the sales configuration. (Martio 2015, 37-38.) This means that different process options need to be definable in the product configuration. Good example would be the delivery options chosen for consumer devices where customer can choose to pick up the device, have it delivered home, or have it delivered to the post office. Different delivery processes follow the customer's decision.

Products can be classified based on their modifiability to four types of products: fixed products, configurable products, modifiable products and project products. (Martio 2015, 13.) A Product can be fixed which means that all versions are identical and made in large patches. Example of this would be 2x4 pine plank which is always the same material and size. Configurable products are products that can have different variants and can be configured using a configurator. Example would be a mobile voice subscription product that can have lots of variation. For example, it could contain 300 minutes or 5000 minutes of free of charge calls or its function could be limited to domestic use or enable roaming.

Modifiable products are partially configurable but also required customer specific planning for delivery. Example of this could be private branch exchange (PBX) solution for a customer. In this case compatibilities with the existing solution needs to be considered in selection of hardware and/or software. Other considerations could be the training requirements and the timing of the delivery, but components available for the configuration would still be preselected. Project products are made-to-order which means they are almost always build and developed from the scratch for a specific customer use. Point of this classification of the different types of products is that extent of the sales configuration needed depends on the product type.

The systems performing the configuration are referred as configurators and are rules-based or knowledge-based tools that generate 1) a list of components or assemblies, 2) a product structure, and 3) associated documentation (NPD Solutions). The product configurators enable organizations to define relations between different configurable parts of the product and to create new sellable product variants using pre-developed components quickly and accurately (Rautakoura 2018, NPD Solutions).

To offer configurable products a company should comply with two requirements. The first requirement is a precise definition of what the company is potentially ready to offer and what not. Otherwise all the products would need to be handled as individual projects. The second requirement demands the necessity to establish a link between the commercial and the technical characteristics of the product. This means that the configurator needs

predefined components that can provide a selected function or a process automatically. (Forza 2008, 820).

In synthesis, the product configurator guides the sales process in several ways. The product configurator:

- Helps user in creating new product configurations in the sales process.
- Supplies information in real time about the feasibility of the configuration.
- Displays prices, properties and characteristics of the product.
- Generates the sales offers.
- Takes care of the fulfillment of the order.

In addition, modelers can build sales configuration models and, therefore, define the structure of the questions, constraints, phrases, images and films explicitly used during the sale. They can also build or modify the product model, defining the product characteristics, the constraints that specify the relationship between the characteristics and the values that these characteristics can assume. (Forza 2008, 821-822.) The product configurator features are collected in table 2.

Table 2. The product configurator features

| Process | Features |
|---|--|
| Sales process | Guides end user (sales, customer) in generating or searching for complete and valid product configurations |
| | Validate chosen components. |
| | Show technical characteristics of components and products |
| | Show prices |
| | Supply information in real time on the feasibility of a product configuration, on the prices, or on the technical characteristics of components and products |
| | Generate sales offers |
| | Generate the data sequences (configuration) that are necessary for delivering the goods and services |
| Sales configuration | Define the structure of the order |
| | Define constraints |
| | Define images |
| | Produce documentation |
| Technical configuration - product model | Define the product characteristics |
| | Define constraints that specify the relationship between the characteristics and the |
| | Define values that characteristics can assume |
| | Produce documentation |

Because the product configuration activity relies on predefined components and does not require development, product configurator activity concentrates on the value communication of the product management process where the product sales activities are executed. Location illustrated in figure 6.

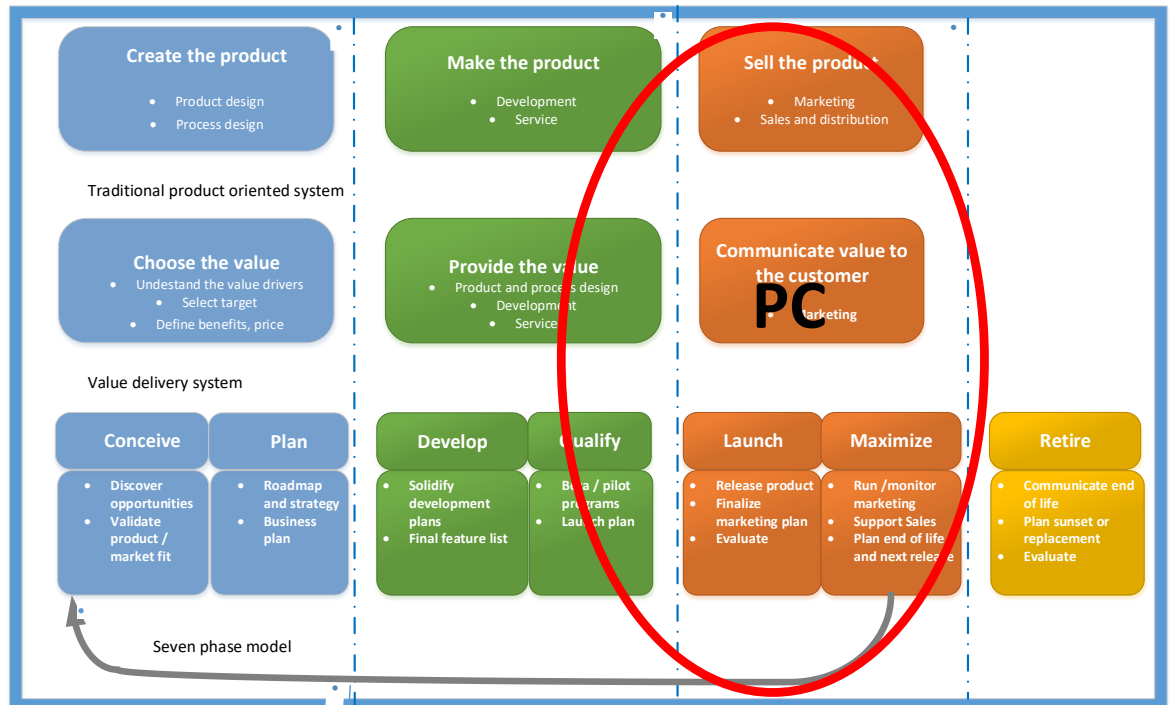


Figure 6. The product configurator in the product management process (modified from Lawley & Shure 2017, 53; Golub et al. 2000; Chunawalla 2009, 13)

This also means that the functions that receive the product configuration output are sales, sales support, fulfillment processes and technical support. Obviously, the product management core is also interested in the configurator because of its capability to produce variations that satisfy the business needs, but assumption is that those needs also arise from the customer demand that gets its voice via sales and other customer interfaces. The related functions illustrated in figure 7.

| Strategic Management | Product Strategy | Product Planning | Development | Marketing | Sales and Distribution | Service and Support |
|-----------------------|---------------------------------|----------------------------------|----------------------------------|----------------------------|----------------------------|----------------------------------|
| Corporate Strategy | Positioning and definition | Product Life Cycle Management | Engineering Management | Marketing Planning | Sales Planning | Service Planning and Preparation |
| Portfolio Management | Delivery model Service Strategy | Roadmapping | Project Management | Customer Analysis | Channel Preparation | Service Provisioning |
| Innovation Management | Sourcing | Release planning | Project Requirements Engineering | Opportunity Management | CRM | Technical Support |
| Resource Management | Business Case and Costing | Product Requirements Engineering | User Experience Design | Marketing Mix Optimization | Operational Sales | Marketing Support |
| Market Analysis | Pricing | Product Architecture ** | Quality Management | Product Launches | Operational Distribution | Sales Support |
| Product Analysis | Ecosystem Management | | | Operational Marketing | Supply Chain Management ** | |
| Insights ** | Legal and IPR Management | | | Value analysis ** | | |
| | Performance and Risk Management | | | | | |
| Participation | Core | | Orchestration | | | |

Figure 7. Main users of the configurator (modified from Billgren & Bjernulf 2018, 13)

4.2 Product data management systems

Gartner glossary defines product data management as follows:” PDM technologies and products have historically been positioned as the primary application backbone for managing and controlling the flow of design intent across the three major design stages: concept design, detail design and production. But in practice, PDM has served as a complementary application tower to computer-aided design (CAD) and enterprise resource planning (ERP) systems by providing the main repository for production-approved engineering data (i.e., vaulting) and managing the changes to production – approved data (e.g. engineering change orders and configuration management).”

Even if definition is from manufacturing industry it brings out the point that the PDM systems have evolved mainly to aid technical aspects of the product development and production. This can be seen in a way they support versioning, approval and quality processes (Martio 2015, 10). Location of the PDM systems on the product management process is illustrated in figure 8.

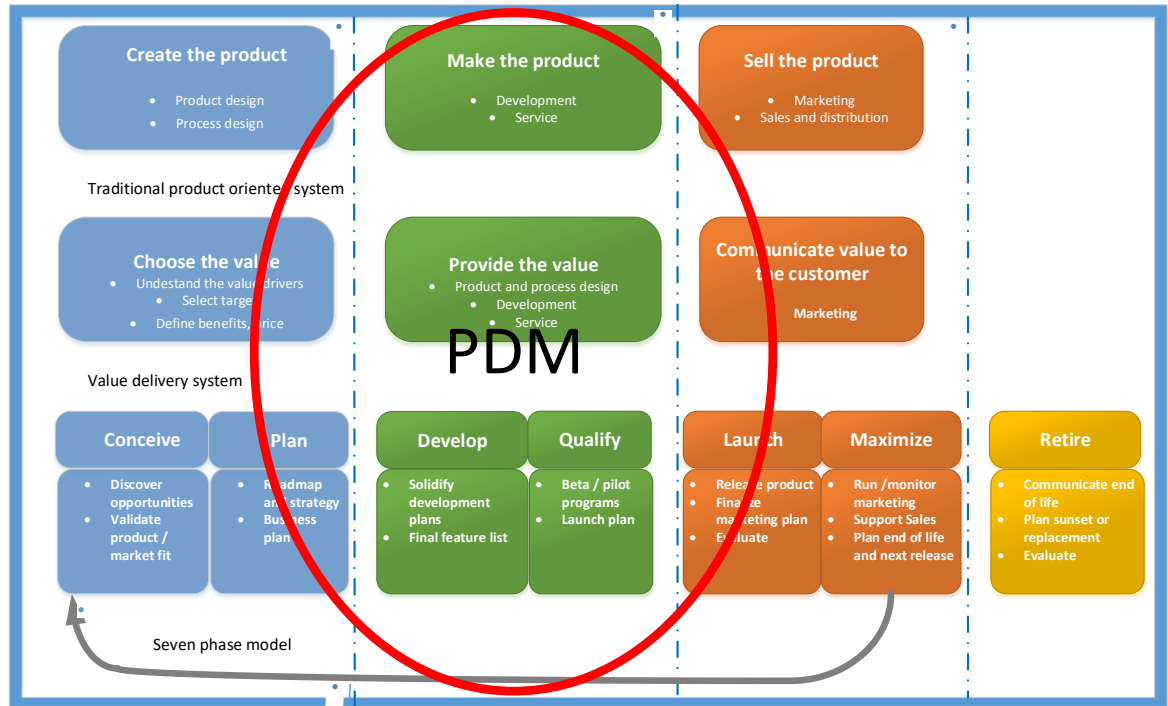


Figure 8. PDM system in product management process (modified from Lawley & Shure 2017, 53; Golub et al. 2000; Chunawalla 2009, 13)

Martio (2015, 48) divides product data management to seven main areas.

- Item management
- Document management
- Product structure management
- Configuration knowledge management
- Change management
- Access management
- Integrations to other systems creating product data

Item management encompasses any item like a component or a document which must be classified and should be under version control (Martio 2015, 49). Any business-related element can be defined as an item, but managing the items requires effort so new items should be considered carefully. Often these elements are products, product management, materials, documents, resources and activities. Item management should support item lifecycles, classifications, attributes, searches, metadata, language versions of data, status and hierarchy of structure. (Martio 2015, 51-54.)

Document management is one of the features organizations are usually looking for in a PDM system. PDM systems provide organized and classified storage and distribution of

the product documents for easy retrieval during the product lifecycle. The management of document status (draft, approved, phased out, etc.) as part of change management is also an important feature. (Forza 2008, 823; Martio 2015, 99-100, 172.) Document is an item and all features of the item management apply to it. However, in addition to the item attributes document has a unique dimension of the document content. The PDM system should provide ways to view the documents without the specialized tools used for creating the content and versioning for the content modification. Some PDM systems also support integrations to the data creation tools. These are implemented to make modifying the documents easier for the user. (Martio 2015, 99-100.)

Product structure management means management of the product hierarchies and the product models. Martio (2015, 111) defines a product model as definition of the product following a predefined structure created for a specific use. The same product usually has several different definitions depending from which angle structure is viewed from. For example, the mobile voice product from our earlier examples looks very different if one is looking at the sales description or the technical description of the service. The Product models and the product structures might have differed levels like product line or product variant, but the models and the structures help in understanding the interdependencies between the products or the product components. If for example IT is planning to ramp down a specific service, the product model definition shows how many products or product components are using the service. The idea is to identify dependencies between the components faster in the change situations to enable fast time to market and to avoid quality issues. This also requires some level of configuration knowledge management from the PDM system.

Change management support is one of the most important functions of the PDM systems. This is achieved by coordinating and registering all the changes impacting the products. Part of the change management function is also to implement an organization specific change management processes to the workflow. Definition entails defining different types of changes to a product document or an item. Depending on the type of the change the item will follow a specific revisioning and workflow process before change to the document and sometimes to actual the product is approved. (Martio 2015 170-172, 179) Workflow management is usually part of the PDM system and enable organizations to define repetitive workflows into the PDM systems (Martio 2015, 179; Forza 2008, 823). An example would be how standard change requests are handled and were tasks relating to them are assigned to.

The authorization process makes sure that data is available to all the correct parties and no one else. It also defines which users are authorized to modify, view and delete the data. (Martio 2015, 274.) Integrations to the systems generating the product data is also important part of the PDM system. Usually systems like ERPs and CADs (Martio 2015, 49) and product configurators are integrated to the PDM systems. A Product configurator can also be part of the PDM system to simplify the system architecture (Martio 2015, 267), but the PDM systems for the most part do not provide adequate support for the sales product configuration. (Forza 2008, 826.)

Product lifecycle management is part of the product data management system, but concentrates on development, versions and technical specifications does not support sales or marketing. (Silvennoinen 2016.) For after sales technical support and error handling the PDM system documents would also be essential. The Features of PDM system can be seen in table 3.

Table 3. The PDM system features

| Process | Feature |
|------------------------------|---|
| Item management | lifecycle management |
| | classifications |
| | attributes |
| | Title searches |
| | metadata |
| | language versions |
| | Title status |
| | structure hierarchies |
| Document management | Same features than for title management |
| | View document (e.g. CAD file) |
| | Versioning and workflow for content changes |
| | Tool integrations e.g. CAD |
| Product structure management | Product models |
| | Product hierarchies |
| | Interdependencies |
| Change management | understand dependencies |
| | coordinate and register changes |
| Define workflows | Assign |
| | Approve |
| | Notify |
| Authorization | access |
| | view |
| | modify |
| Integrations | ERP |
| | CAD |
| | product configurations |

Due to the PDM system concentrating to the technical aspects of the product, functions receiving the output and using PDM system are product planning, product development and maintenance, fulfillment, incident management processes and technical support. The related functions presented in figure 9.

| Strategic Management | Product Strategy | Product Planning | Development | Marketing | Sales and Distribution | Service and Support |
|-----------------------|---------------------------------|----------------------------------|----------------------------------|----------------------------|----------------------------|----------------------------------|
| Corporate Strategy | Positioning and definition | Product Life Cycle Management | Engineering Management | Marketing Planning | Sales Planning | Service Planning and Preparation |
| Portfolio Management | Delivery model Service Strategy | Roadmapping | Project Management | Customer Analysis | Channel Preparation | Service Provisioning |
| Innovation Management | Sourcing | Release planning | Project Requirements Engineering | Opportunity Management | CRM | Technical Support |
| Resource Management | Business Case and Costing | Product Requirements Engineering | User Experience Design | Marketing Mix Optimization | Operational Sales | Marketing Support |
| Market Analysis | Pricing | Product Architecture ** | Quality Management | Product Launches | Operational Distribution | Sales Support |
| Product Analysis | Ecosystem Management | | | Operational Marketing | Supply Chain Management ** | |
| Insights ** | Legal and IPR Management | | | Value analysis ** | | |
| | Performance and Risk Management | | | | | |
| Participation | Core | | Orchestration | | | |

Figure 9. Main users of PDM systems (modified from Billgren & Bjernulf 2018, 13)

4.3 Product information management systems

Rise of e-commerce and online stores has made product information management (PIM) popular after the turn of the century. (Abraham 2014, 1; Vijverberg 2017.) Number of products sold in online stores has made selection available hundreds or thousands of times larger than it used to be. Managing this number of products in online stores requires different caliber of organization and tools than it used to. The customers of the stores also require more detailed information of the products they are viewing. Another reason for the growing need of information management is that products themselves are increasingly becoming information. Examples of this kind of products are e-tickets, online training courses or online games. For a customer to buy this kind of a product much information is needed in form of photos, demos, videos and specifications. In many instances companies are also obliged to store more information of their products than before. Information that needs to be kept can be for example about materials used for production, information about storing and security, information about way the product is being sold and where products are being sold to. Finally, distribution and selling of products is becoming more

complex due to more finetuned customer segmentation and internationalization. (Abraham 2014, 1-2.)

“Product information management (PIM) refers to processes and technologies focused on centrally managing information about product, with focus on the data required to market and sell the product through one or more distribution channels.” Central concept is that product information is entered and stored once, and the PIM systems is single source of truth from where information is distributed to other systems without being manually handled. (Abraham 2014, 3.) To understand how the PIM system is positioned in the product management process it is important to understand, that the PIM system is especially responsible for product information needed by marketing and sales. The goal is to make buying and selling easier by offering enriched product information to different channels. (Silvennoinen 2016, Rautakoura 2018.) Also, to clarify the terminology used product resource management (PRM) and product content management (PCM) are sometimes used as alternative terms for PIM (Abraham 2014, 11).

The core processes of PIM are collecting, consolidating, enriching and distributing the data to the omnichannel environment. One of the primary tasks of the PIM system is collecting the product related data from across the organization and beyond. The product related information is usually stored in multiple sources and in multiple formats. The PIM system maps the imported data to the specific product attributes and if necessary transforms the data to correct standard set. (Abraham 2014, 4, Vijverberg. 2017.) For example, the phone device price and payment options could be stored in one system, purchase price and identifiers in different system, size, weight, technical specifications, delivery times and colors could be available in third. If the device is purchased from United States size could be in inches instead of centimeters. All this data needs to be collected, ordered and converted so it can be used in an online store in Finland.

Idea of the PIM system is to be the single source of truth for each product. Because of this exactly same product should exist only once in the PIM system. The PIM systems should have a selection of tools to clean, merge and consolidate the product information. The data quality capabilities vary from analyzing and reporting the data quality, to applying business rules and facilitating processes to improve data quality. (Abraham 2014, 4-5; Vijverberg. 2017.) In the previous example this might mean that the same phone model is in the system twice because if it is bought from two different suppliers or is available in two different colors. In this case only one phone device product with information of both suppliers or color variations should exist.

The sources of the product data usually contain only basic data of the product. One of the key functions of the PIM system is to enrich that product data. In the simple form this means adding descriptive content like sales pitches, descriptions, videos or pictures. For media assets converting files to correct formats and sizes plus adding the relevant metadata is also a PIM functionality. The PIM systems also enables creation of categorizations and classifications of the product and adding of attributes to the product. This can be used to guide different online channels on rules of selling and buying the product. In practice this means being able to show similar products, up-sell, cross-sell, offer additional related products, communicate mandatory products, create bundles and more. (Abraham 2014, 5; Vijverberg. 2017.) Quality controls are part of the enrichment process. The PIM system can contain validations for the data fields, for example mandatory information or prevention of inserting wrong type of data. PIM workflow processes also allow for validation process before publication. Logging and authorization are part of PIM data enrichment. (Abraham 2014, 6.) PIM systems' generic features are listed in table 4.

Table 4. The PIM system features

| Process | Features |
|---------------------------------------|--|
| Data collection | automated data collection from surrounding systems |
| Data consolidation and quality | Data modification to correct format |
| | Data validation and consolidation e.g. identifying double records |
| Enrichment of data | Localization for different sales locations |
| | Adding content: descriptions, media files, technical documents |
| | Automated media file collection, modification and metadata |
| | Product classification and hierarchies |
| | Sales rules: up-sell, cross-sell, bundling, product variants, channels |
| | Data validation: mandatory fields, data format |
| | Process for workflow - assigning the work, validation |
| Access rights | |
| Product data distribution | Automated or manual |
| | Different format |
| | Easily add new products and specials like bundled offers online |

As for exporting data the PIM system does not serve as publication channel, but it can export data to other systems by request or regularly in different formats (Abraham 2014, 6). The PIM system is solely concentrated on collecting and distributing the data. The sources for data collection might include enterprise resources planning systems (ERP), warehouse systems, cash registries, procurement systems, product supplier systems,

data suppliers, translation agencies and other content providers. Data can also be feed-back from the marketplace like customer reviews or feedback. The number of channels using PIM systems as a source of data is growing all the time. These channels can for example consist of different digital customer channels, digital internal channels, digital third-party channels, data warehouse and printing houses. (Abraham 2014, 9-10.) Possible data sources and export channels are illustrated in figure 10.

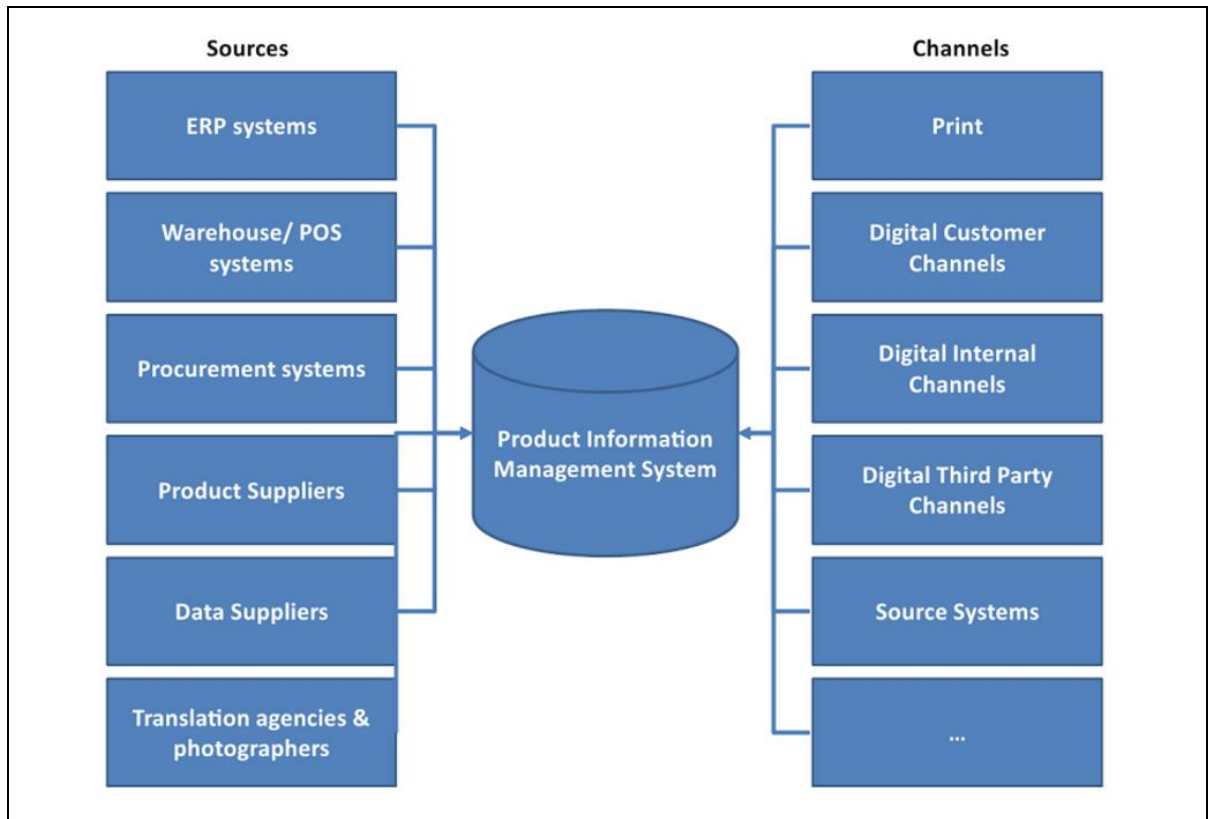


Figure 10. Data sources and export channels (Abraham 2014, 8)

The PIM system positioning in the product management process is clear. It is heavily focused on the value communication to the stakeholders and the customers. It is getting it's input from other parts of the process but it's main function is to make selling and buying easier. It touches value creation by being part of product process design, user experience design, piloting and it could also participate to choosing the value by providing inputs for further developments. The positioning in the product management process is illustrated in figure 11.

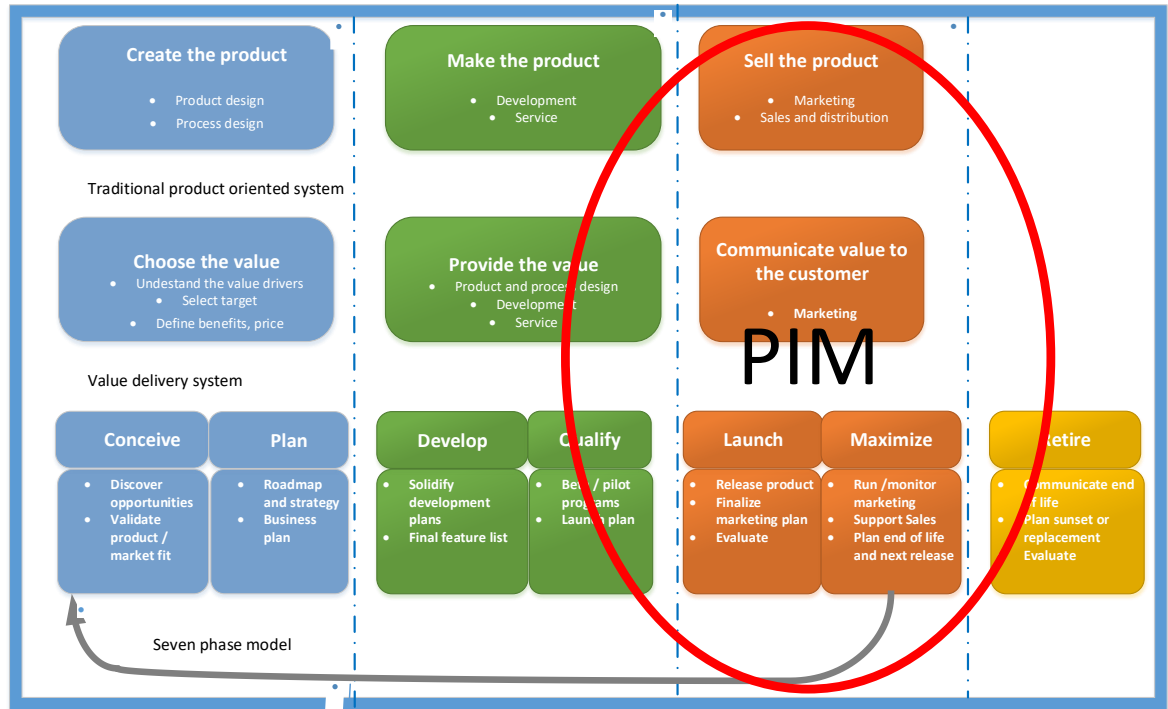


Figure 11. The PIM system in the product management process (modified from Lawley & Shure 2017, 53; Golub et al. 2000; Chunawalla 2009, 13)

Following this positioning most impacted functions and stakeholders should be found in the marketing, sales and distribution areas. The marketing stakeholders are the instances in the company who are responsible for product marketing and take care of the offering as well as the marketing customer path. In other words, they decide what is being offered, how is it being presented and to whom. This is where the designing of the user experience comes in as well because PIM can handle up-selling, cross-selling, bundling and is responsible for the uniform customer experience.

Sales and distribution is about presenting the products in the correct channels with the correct information. The supply chain management stakeholders are suppliers, procurement, logistics, delivery and warehousing management. The stakeholders in the sales area are the people responsible for digital channel development, the sales managers and the sales people.

Because selling and buying and owning the product always requires marketing, the marketing and sales support functions are included in the PIM system users. This includes customer services and company's internal support for sales. Technical support and provisioning were excluded from related functions because the PIM system descriptions don't include more detailed technical specifications of the product structure or technical functionalities as part of the product data imported to the system. However, technical support

could be interested in sales specifications of different types of devices. This means users of the data could be from other areas than identified as main users in this study. The most impacted functions are highlighted in figure 12.

| Strategic Management | Product Strategy | Product Planning | Development | Marketing | Sales and Distribution | Service and Support |
|-----------------------|---------------------------------|----------------------------------|----------------------------------|----------------------------|----------------------------|----------------------------------|
| Corporate Strategy | Positioning and definition | Product Life Cycle Management | Engineering Management | Marketing Planning | Sales Planning | Service Planning and Preparation |
| Portfolio Management | Delivery model Service Strategy | Roadmapping | Project Management | Customer Analysis | Channel Preparation | Service Provisioning |
| Innovation Management | Sourcing | Release planning | Project Requirements Engineering | Opportunity Management | CRM | Technical Support |
| Resource Management | Business Case and Costing | Product Requirements Engineering | User Experience Design | Marketing Mix Optimization | Operational Sales | Marketing Support |
| Market Analysis | Pricing | Product Architecture ** | Quality Management | Product Launches | Operational Distribution | Sales Support |
| Product Analysis | Ecosystem Management | | | Operational Marketing | Supply Chain Management ** | |
| Insights ** | Legal and IPR Management | | | Value analysis ** | | |
| | Performance and Risk Management | | | | | |

Figure 12. Main users for the PIM system (modified from Billgren & Bjernulf 2018, 13)

4.4 Product lifecycle management systems

The product lifecycle management (PLM) process was shortly reviewed in earlier chapter where it was presented as product management business process. Product lifecycle management was defined as integrated management of the product through the whole product lifecycle. This means that this process follows the product from its birth to its retirement. Then how does a PLM system then support this effort?

A PLM system as a concept seems very underdefined because product lifecycle management as a process encompasses all of product management from the idea of product to its death. The definitions of the system functions seem to vary from pure product related data management and sharing to product simulations and reporting. PLM systems seem also to be in midst of changes as the first versions were only extensions of CAD and PDM systems, but the evolving systems are reaching for more holistic view of the product lifecycle.

It is important to understand that product lifecycle management is not only a system but a process like the PDM and PIM systems. The confusion on the PLM system processes and features is caused by current PLM systems covering different parts of the PLM process.

For this study the idea is to find the all the system processes and features that address the PLM process.

PLM can be defined as a strategic business approach that applies consistent set of business solutions in support of the collaborative creation, management, dissemination, and use of product definition information across the extended enterprise. The supported processes span from product concept to end of life, integrating people, processes, business systems, and information. (CIMdata, Ming 2005, 313.) According to Brown (a.) product lifecycle management is a software-enabled strategy to improve processes of conceptualizing, designing, developing and managing the products to drive higher levels of product profitability.

Need for a PLM system has its origins in a situation where different specialized IT - systems like CAD, PDM or ERP systems are utilized during the product lifecycle. Despite the fact that these systems are efficient in their purpose they might cause bottlenecks elsewhere in the dataflow. Product lifecycle management has emerged to address this lack of collaborative capabilities throughout the product lifecycle. Its main objective is to support and coordinate all the separate product related activities taking place in different parts of the organization. (Vargas-Orellana 2013, 5-6; Ming 2005, 314.)

In general, the PLM system should provide mechanisms for company for implementing the PLM process by integrating the functions, processes and systems and providing means for managing the product data through its lifecycle. (Vargas-Orellana 2013. 1.) The PLM system should support the capability of collaborative creation, management, dissemination, and use of product assets (including data, information, and knowledge) in a virtual enterprise integrating people, processes and technology (Ming 2005, 312).

PLM system can be divided into five core elements against which different features are identified.

- Product data management is a key foundation technology for engineering data management and control.
- Collaborative product design facilitates the sharing of designs across an extended value chain.
- Direct materials sourcing/supply chain management
- Requirement management captures product requirements.

- Product portfolio management to enhance monitoring and assessing risk across multiple development projects.

(Stackpole 2009, Techtarget.)

Product data management has been discussed in earlier chapter describing the data management system. PDM however serves as the backbone for most PLM systems and provides three important capabilities, helping companies control product data; allowing easy, selective access to information; and providing a mechanism to share that data with employees outside of engineering or R&D. (Brown a. & b.) PDM provides a way to import and create warehouse for all information that affects the product (Rouse a.) making sure that all information is in the right place at the right time with the quality that has been defined by the organization and reviewed by and accessible to the correct people (Symetri).

Lately systems have started to provide functions further up and down the product lifecycle process, providing support for the "front end" of innovation all the way to service and support. The incorporation of a richer view of the product, evolving from the traditional roots of focusing primarily on the technical product information to include the commercial data like the marketing data. (Brown a.)

Collaborative product design is represented by the tools the PLM system provides to manage complex product development and engineering programs. Other product data management systems are integrated to this in order to make all relevant product data available in integrated visual way to all participants inside and outside of organization. In addition to the data sharing and creation capabilities the modern PLM technology provides socially oriented collaborative techniques for product development teams like messaging platforms or note-taking capabilities (Brown a. Product lifecycle stages).

Supply chain management brings visibility of integrated material sourcing information to development processes. This can help to reduce time to market and enhance cost effectiveness of the development projects. Direct materials sourcing might include capabilities like: bid event creation, notification to suppliers, control processes for event management, inclusion of part and reference information, a supplier web portal for receiving bid requests and submitting bid proposals, automatic tracking and communication, detailed cost breakdowns and bid analysis. (Geometric Solutions, Siemens.)

The product-related information ranges from marketing requirements, product specifications, product structures and test instructions, to the maintained configuration data from

the field. The PLM solution links information from many different authoring tools and other systems to the evolving product configuration. (CIM data, Brown a.) Requirements management brings product requirements from different instances to the PLM system enabling product development validation, traceability and version control. Validation means that the right product is being built and the requirements have been understood. Traceability means that development can get back to requirement to check does the product match the requirements. Version control means ability for track requirement changes. (Razor-leaf.)

Product portfolio management in the PLM system enables organizations to define and optimize portfolios by helping companies to make critical tradeoff decisions related to product investments (Brown a.) with help of lifecycle intelligence data analysis and collection. These tools enable the user to leverage data for better decision making and process optimization. By collecting all the relevant data in one place and providing tools for its assessment and analysis, the PLM platform makes it easy to identify patterns and create projections. (CIMdata.)

In addition to the listed core elements the PLM solution helps to define, execute, measure and manage the key product related processes like change management, risk management, project information management and quality management (Hadaya & Marchildon 2012, 561). More evolved PLM systems have encompassed more processes, including important functions like product cost management and product compliance and sustainability. (Brown a.)

All and all the PLM system tries to cover everything product related from processes and functions to product configuration. For example, system providers list core components, they are offering in following ways:

- Product Data Management
- BOM & Configuration Management
- Project & Program Management
- Change Management
- Supplier Management
- Requirement management
- Process Management
- Business Intelligence
- Design Automation and tools

- System Integration & Migration
- Compliance management
- Product cost management
- Product configuration

(vdR Group, Razorleaf.) The PLM system features are demonstrated in table 5.

Table 5. The PIM system features

| Process | Feature |
|--|--|
| Product data management | PIM (integration or PLM application) |
| | PDM (integration or PLM application) |
| | Configurator (integration or PLM application) |
| Collaborative product design | Tools for sharing data inside and outside of organization |
| | Socially oriented collaborative techniques |
| Direct materials sourcing | visibility to material sourcing information |
| | Supplier portals |
| | Bid automation |
| Requirement management | Link requirements to product from different instances |
| | Requirement traceability |
| | Final validation against requirement |
| | Version control on requirement updates and changes |
| Portfolio management | lifecycle intelligence data collection |
| | lifecycle intelligence data analysis |
| | identify patterns create projections |
| Process management - define, execute, measure and manage | define - change management, risk management, project information management, quality management |
| | execute -change management, risk management, project information management, quality management |
| | measure - change management, risk management, project information management, quality management |
| | manage - change management, risk management, project information management, quality management, cost management |

Because the PLM system definition is still finding it's form, it is impossible to say with certainty where it would be placed in the product management process or framework. PLM as a process is all that is the product, so one must assume that it should impact all functions and stages. However, when looking at other types of systems and their placing in the product management process it is quite evident that the product process core functions are quite neglected. The systems support development, sales or marketing but aren't real-

ly planned for the product management process owners like product managers. The PLM system tries to fill that gap by providing tools for the strategy, process planning and decision-making. Another justification for an existence of this type of a system is it providing all-encompassing view on the product in the name of information sharing and collaboration to bridge the data silos most organizations have.

4.5 Summary

This study divides the product data management systems to four types: product configurators, product data management systems, product information management systems and product lifecycle management systems. The product configurator is most basic of the lot and needs to provide most functionality because it is tied to selling and delivering the products. The Product configurator relies on predefined components that can be used for sales and technical configurations and in final sales process. The product configurator is source of product data but also needs to implement the product models decided in the product data management process.

The product data management system is a storage of technical product data that contains the data management practices and workflows to guide the product related development and management processes. The product data management system either uses configurator data or has product configurator integrated. The predominant features of the PDM system are product document management mainly to aid development and production and change management in order to identify dependencies and version control of the documents.

The product information management system collects and stores content data from other systems and shares it to all the channels that need to consume that data. The main functions of the PIM system are to collect, consolidate, structure and enrich the data. The main benefit in the PIM system is uniform customer experience that one source and process of publishing can provide.

The product lifecycle management system as a concept is quite unclear. Product lifecycle as a process encompasses all that is the product. In a way, this is also the contribution the PLM system is trying to make by incorporating data from the PC, PDM, PIM and other systems in one place to support all-encompassing development and management endeavors as well as providing the business and the other interested stakeholders 360° - view on the product.

5 Stakeholder perspectives

The case study was conducted in Elisa Oyj's consumer unit's product department. Interviewees were concentrated in subscription and device areas of the consumer business. The material of the study consists of six interviews conducted between 31st of October and 7th of November 2018. The participants of the interviews were selected from different business units and departments with the criterion that they participate in product management process for the consumer products and would represent as many different functions as possible. This ensured that different perspectives of the same process would be represented in the study. Roles chosen for the interviews were:

- Business manager (Consumer unit)
- Business product owner for product development (Consumer unit)
- Group manager for Online development (Consumer unit)
- Development manager in billing and products department (Company IT)
- Solution area architect in customers and online department (Company IT)
- Channel developer for online transactions (Consumer unit)

The business manager role in this case covers responsibility of a certain product line from birth to grave from the strategy to following up on the sales support. The business product owner in this unit is responsible for the business requirements of several product areas and for prioritizing and coordinating the developments with the development teams. The group manager for online development represented sales point of view because big part of the this is working with Elisa's online store and the other purchasing and marketing channels. The development manager interviewed is responsible for technical and sales configuration a specific stack of consumer products. The solution area architect provided overall view on the status of the systems and development functions point of view on the system classification. The channel developer's responsibility is to ensure fluency of customer interactions in online channels. To encompass all the product management related functions was not possible when considering the scope of this study, but interviewees all had long careers in Elisa Oyj and experience in different types roles in the consumer unit.

The study was conducted in series of semi-structured in-dept interviews where the interviewees were presented with the background of the study and descriptions of the key concepts of the product and the product management. After that each type of product data management system was presented with list generic of features. The interviews were more of free-flowing discussions on whatever interviewees thought of the topics presented. It needs to be noted that views expressed in the interviews are based on the inter-

viewees personal experiences and the goal of this study was not to verify the claims of case study organizations having a specific process or system in place. The aim was to find out what the stakeholders expressed when they were presented the material generated in the first part of the study.

5.1 Views on product configurator

In general, the configurator didn't generate that much discussion from the point of view of new capabilities that would be needed by the organization based on the classification presented. Case study organization employs a configurator that is developed in house and is deeply embedded in the CRM organization is using. The capabilities that have been developed over several years are versatile and configurator is partially performing roles attributed to the PIM and PLM systems like adding content to the online channels, restricting the visibility in the sales channels, adding product to the specific channels, adding the product lifecycle status and more.

On the other hand, there isn't unified documentation about the configurator functionalities or user guides on how configuration should be performed. Interviewees also criticized bad usability and lack of validations for correct values in relation to technical and sales configuration. These two-combined means that user of the configurator must really know what they are doing in order to avoid mistakes. However, lack of documentation of the system isn't a product data management system issue and based on the interviews it seems that mostly the stakeholders interviewed thought that the current configurator is performing the basic tasks of technical and sales configuration adequately. The problems perceived were related to varying product structures and content are in the scope of other systems of this study and are handled there. Summary of the issues in presented in table 6.

Table 6. Case study – The PDM system summary

| System | Process | System value | System challenges |
|----------------------------|---|--------------|---|
| Configurator in use | <ul style="list-style-type: none"> Technical and sales configuration performed sometimes by the business sometime subject matter experts or developers | | <ul style="list-style-type: none"> Validation building |

5.2 Views on PDM system

None of the interviewees identified that there would be a PDM system in use for this organizational unit. There are processes in place for documentation, but they vary between the development and operational teams. The common consensus seemed to be that different tools like Jira, confluence and SharePoint perform roles in product data management, but there isn't a place for formal link between all these documents and the product or the product component.

The change management procedures for the development in the organization are formal and unified but means of improving identification of dependencies for the change management were valuable. Logging and versioning the changes and modifications was also identified as something that should be improved. The change management process has a record of the larger changes and assessments related to them, but smaller changes like small configuration changes e.g. removing campaign from sales channel, changing the price of a product or changing a device revenue codes should also have a record related to them. The product configurator in use has logging for some changes and reason for the change can be linked to product configurator but there is no formal process for this.

Another use for the PDM systems in this context was creating formal product models that would be then implemented in the configurator. If these models would be visible and structure would be adhered this would help reporting automation which was also identified as one of the current product data challenges. New product structures often require changes in the reporting and in the worst-case scenario it takes a while notice that changes are needed. In the case of formalized structures new modes would always be a result of some deliberation and the old models reused as often as possible which would benefit development and reporting both. On the other hand, the product structures were also seen as a possible challenge for the PDM system. The system would need to be able to support several differing product models as well as different kinds of product hierarchies.

In general views on the usefulness of separate PDM system were divided. Others saw it could bring value to the organization, but others thought system classification reflects too heavily product model of manufacturing industry and PDM is best handled as a process without use of separate system to collect the information from different instances. Summary of the findings is presented in table 7.

Table 7. Case study – The PDM system summary

| System | Process | System value | System challenges |
|----------------------|---|---|--|
| No PDM system | <ul style="list-style-type: none"> Product related documentation processes vary from team to team Product technical data and change history fragmented to different tools | <ul style="list-style-type: none"> Dependencies management on product level Versioning, change history Control over product models | <ul style="list-style-type: none"> Not optimal for the Telco, ICT industry Can systems really accommodate all needed product structures? |

5.3 Views on PIM system

The PIM system and process generated most lively discussion in the interviews. It seems that the stakeholders had been lately combating issues related to content management. Reason for this is that the product information in the case study organization is quite fragmented. The content is stored in different places and can be read from several places for one product. The storages of content also vary from one product structure to another. Some parts might be in the configurator and others might be downloaded from an external system. The information exists and is available if one knows where to look but trying to figure out where a specific text or image is coming might be a challenging task for an outsider. Knowing all the places where a specific product is represented in online environment is very challenging. A simple example of a situation where this information would be needed could be a product name change.

Another point raised by several of the interviewees was the structure of the product content which is not formalized. It is hard to do comparisons or simply present the information when content is unstructured or differs from product model to another. If the size of the memory for a device is stored in a free text field, it is hard to list all devices based on this definition if a customer shopping in an online store would require it.

Due to above mentioned reasons the interviewees expressed interest in the PIM system. There were several different features that were seen as valuable. First, one single source of product data for online channels and other channels using product data like personalized marketing tools would reduce need of integrations and logic in the downstream systems. Formal structures for the content and handling for those would also simplify the work related to future products or could mean that no development for the online channels would be required at all.

The stakeholders were also hoping for better support for external data sources. It is useless to produce the content if it already exists and can be reused. Also, better control over the content published e.g. descriptions following uniform tone of voice might be achieved with a right tool. Finally, if there would be only one place to edit and publish product content even if it is fetched from other sources to PIM. For example, in earlier name change example all publishable product descriptions, banners and text should be found from the PIM system. Summary on the PIM system views on is presented on the table 8.

Table 8. Case study – The PIM system summary

| System | Process | System value | System challenges |
|----------------------|---|--|--|
| No PIM system | <ul style="list-style-type: none"> Content information fragmented to different tools Different sources depending on the product structure | <ul style="list-style-type: none"> only one instance for online and other channels to fetch product content Formal structures for the content Better support for external data sources One place to edit and publish workflows for content creation | <ul style="list-style-type: none"> No issues raised in the interviews |

5.4 Views on PLM system

There is no PLM system in use in the case study organization. Discussion of the PLM system concentrated mainly on the product lifecycle in general and the portfolio management perspective of the system. The organization has had a product lifecycle and portfolio management process for many years already but tools for it are mainly manual and main participants creating the data are the business managers. The interviewee comments on the product lifecycle management were that the organization is very efficient on the go-to-market process but specially end of life could get more attention. Systematic follow up and procedures to determine product lifecycle stage of the product are also not consistent in all different units.

Views on the PLM system were also divided. Some thought that this area is better left as process. There have been some tryouts for portfolio management tools, but none tried were applicable for all product areas because of the differing structures and processes. The expectation is that a possible PLM system would face the same issue. Evaluating the features was also seen as somewhat challenging because the definition was so unformed.

The PLM system definition would need to reach a better state of maturity before it can be evaluated in this general level study aimed at.

On the other hand, some saw that if a PLM system could provide 360° -view on the product via reports and business intelligence this would be exactly what business needs to make informed decisions related to the product lifecycle. This feature would also extremely helpful for other processes to understand what kind of tradeoffs are profitable and where should the improvement efforts be concentrated when looking at the product level. For example, customer interactions are often working towards reducing unnecessary customer contacts but in some cases, it might be more profitable to accept these contacts. For example, in a case where change creating the contacts is bringing sizeable cost reductions for the product maintenance. Naturally there are other considerations like customer experience but bringing product specific metrics in one view would not only benefit portfolio management but the other stakeholders as well.

Table 9. Case study – The PLM system summary

| System | Process | System value | System challenges |
|----------------------|--|--|--|
| No PLM system | <ul style="list-style-type: none"> PLM and portfolio management process | <ul style="list-style-type: none"> 360° -view for business and other stakeholders | <ul style="list-style-type: none"> System definition not very mature Doubt on whether PLM product lifecycle and portfolio can accommodate several different product structures |

5.5 Overview

Based on these interviews there isn't much to be said about the configurator. The current system has its issues and they were raised in the interviews. However, looking against the classification created in the first part of the study there isn't any comparisons to be made. Either classification created isn't deep enough or the current system is performing its configuration tasks adequately. PDM was useful by some of the interviewees, but discussion on the need for centralized technical documentation was limited. Could be that current ways of storing the documentation are adequate or the benefits of unified product structures were not visible to the interview participants. Procedures and extent of documentation could be enhanced but system does not generate the documentation. It only stores it and maybe guides on the processes. From the all interviews performed PIM system seemed to be most interesting and closest to the daily work for majority. Centralized product information management was seen to produce most benefit for the organization in the

current situation. The PLM system was most undefined of all and it reflected on the discussions. Most interesting features of the PLM system were based on underlying reporting capabilities which are not created by the PLM system itself but data collection and reports from other system.

All together general doubt on any system to be able to support these product management processes was created by complex and varying product structures used in the industry. Viable option for systems would be to define the related processes better. It is also worth pointing out that many of the interviewees also emphasized that in the case study organization the operating environment is fragmented, and many different tools and systems perform product data management roles. However, many agreed that before these information silos could start to be integrated common language and agreed upon data structures would be required.

6 Conclusions

After concluding the study, it must be said that it does not contribute much to wider discussion on product data management. The academic achievements of the study in that sense are quite limited. The study produced a typology of the types of systems supporting product data management to help understand the field and its dimensions. Based on the study some merit could be found by researching the product lifecycle management systems. The concept and process definitions exist but how a system could support those seems to be still evolving phenomenon.

When estimating the outcome of the study in general level there was no hypothesis to verify. The aim was to explore and clarify existing phenomenon. The expected output was to provide clarification of the concepts and the classification to be used as tools to help further discussions on the subject. The other part of the study aimed at testing that model and providing some insights to the stakeholder views on the subject. The classification seemed to perform its purpose and was understandable to the interviewees. Before any recommendations are presented it needs to be pointed that these are very tentative due to number of interviews conducted. Some more Investigation would be necessary to state these outcomes with more conviction.

Recommendations based on those interviews would be for the case study organization or of Elisa Oyj to define and deploy a common terminology to be used when discussing product data. Practical examples are also something that would clarify the implications to stakeholders not so deeply entrenched in theory. If such terminology is in place in some part of the organization more effort in disseminating the information and reminding people when opening the discussions on the subject area might be in place. The other issue raised from the case study is a need for more controlled product content management. Whether a process or system it seems obvious that the interviewed stakeholders felt the need for improvements in this area.

The study does not claim that any system whatever the acronym used for it would provide value to the case study organization unless the underlying processes of product data management are in place. A good example would be the PLM 360° -view which does not provide any value unless there are valid reports and measures that can be presented in the view. One of the key findings of the study was also that system was not a magic word for all the stakeholder. In many cases the usefulness of the process was agreed upon but need for a single system performing the data sharing and storage functions was not deemed necessary.

It must be said that the process and output of the study reflect very strongly the explorative approach of the study. Because the researcher didn't have clear conception of the field at the beginning of the study quite a lot of the time used for the study was spent in investigating the background. This might still be reflected on the structure of the paper where quite a large part is dedicated the product, product management and product data management. As the study has progressed aim has been to remove irrelevant information, but emphasis of the study might still be a little unbalanced.

Also, in hindsight study would have formed more coherent whole if it would have only concentrated on the system classification. More research should have been concentrated on commercial materials of system providers and interview portion of the study should have been expert interviews to develop the typology further or get legitimacy for it. Regardless of all these concerns related to structure it must be said that more personal goal of gaining more understanding on the field of product management was fully reached in this study.

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Appendices

Appendix 1. Interview presentation



How do product data management systems support product management?

Interview
Kaisa Juvonen

Background

- I've participated in some discussions regarding product data management and systems used for them and noticed that usually stakeholders have a very different conceptions on what is being discussed and how issue is related to product management
- I decided to dig in to the subject to clarify it for myself
- I also wanted to see what kind of general level classifications of systems there exists for product data management

2

elisa

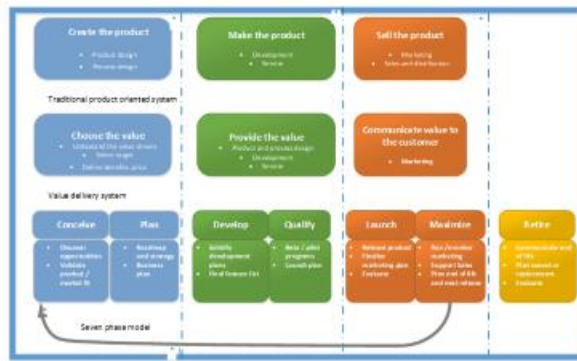
Product

- Anything sold to customer
- Can contain goods and services
- Augmented product – customer experience as part of the product

3

elisa

Product management – everything for birth to grave



Product processes (modified from Lawley & Shure 2017, 53; Golub et al. 2000; Chunawalla 2009, 13)



4

| Strategic Management | Product Strategy | Product Planning | Development | Marketing | Sales and Distribution | Service and Support |
|-----------------------|---------------------------------|----------------------------------|----------------------------------|----------------------------|----------------------------|----------------------------------|
| Corporate Strategy | Positioning and definition | Product Life Cycle Management | Engineering Management | Marketing Planning | Sales Planning | Service Planning and Preparation |
| Portfolio Management | Delivery model Service Strategy | Roadmapping | Project Management | Customer Analysis | Channel Preparation | Service Provisioning |
| Innovation Management | Scouting | Release planning | Product Requirements Engineering | Opportunity Management | CRM | Technical Support |
| Resource Management | Business Case and Costing | Product Requirements Engineering | User Experience Design | Marketing Mix Optimisation | Operational Sales | Marketing Support |
| Market Analysis | Pricing | Product Architecture ** | Quality Management | Product Launches | Operational Distribution | Sales Support |
| Product Analysis | Ecosystem Management | | | Operational Marketing | Supply Chain Management ** | |
| Insights ** | Legal and IPR Management | | | Value analysis ** | | |
| | Performance and Risk Management | | | | | |
| Participation | Core | | | | Orchestration | |

Product management Framework (Bilgiren & Björnulf 2018, 13)



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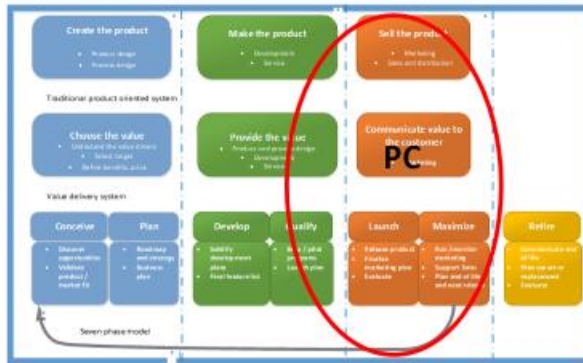
Product configurator

- Product configuration is a process that refines product requirements to specification necessary to produce product variant as an output for next part of the process")
- Technical and Sales configuration from predefined components
- Final configuration is the what is selected for specific customer
- Configurator is the tool used for configuration

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Which part of product management process?



Product processes (modified from Lawley & Shure 2017, 53; Golub et al. 2000; Chunawalla 2009, 13)



End users?

| Strategic Management | Product Strategy | Product Planning | Development | Marketing | Sales and Distribution | Service and Support |
|-----------------------|---------------------------------|----------------------------------|---------------------------------|----------------------------|----------------------------|----------------------------------|
| Corporate Strategy | Positioning and definition | Market Life Cycle Management | Engineering Management | Marketing Planning | Target Planning | Service Planning and Preparation |
| Portfolio Management | Delivery model Service Strategy | Roadmapping | Project Management | Customer Analysis | Channel Preparation | Service Provisioning |
| Innovation Management | Sourcing | Release planning | Project Engineering Engineering | Opportunity Management | CRM | Technical Support |
| Resource Management | Business Case and Costing | Product Requirements Engineering | User Experience Design | Marketing Mix Optimization | Operational Sales | Marketing Support |
| Market Analysis | Pricing | Product Architecture ** | Quality Management | Product Launches | Operational Distribution | Sales Support |
| Product Analytics | Ecosystem Management | | | Operational Marketing | Supply Chain Management ** | |
| Insights ** | Legal and IP Management | | | Value analysis ** | | |
| | Performance and Risk Management | | | | | |
| Participation | | Core | | Orchestration | | |

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Features

| Process | Features |
|---|--|
| Sales process | Guides end user (sales, customer) in generating or searching for complete and valid product configurations |
| | Validate chosen components |
| | Show technical characteristics of components and products |
| | Show prices |
| Sales configuration | Supply information in real time on the feasibility of a product configuration, on the prices, or on the technical characteristics of components and products |
| | Generate sales offers |
| | Generate the data sequences (configuration) that are necessary for delivering the goods and services |
| | Define the structure of the order |
| Technical configuration - product model | Define constraints |
| | Define images and other content |
| | Produce documentation |
| | Define the product characteristics |
| | Define constraints that specify the relationship between the characteristics and the |
| | Define values that characteristics can assume |
| | Produce documentation |
| | |

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Features

| Process | Feature |
|------------------------------|---|
| Item management | life cycle management |
| | classifications |
| | attributes |
| | Title searches |
| | metadata |
| | language versions |
| | Title status |
| | structure hierarchies |
| Document management | Same features than for title management |
| | View document (e.g. CAD file) |
| | Versioning and workflow for content changes |
| | Tool integrations e.g. CAD |
| Product structure management | Product models |
| | Product hierarchies |
| Change management | Interdependencies |
| | understand dependencies |
| | coordinate and register changes |
| Define workflows | Assign |
| | Approve |
| | Notify |
| Authorization | access |
| | view |
| Integrations | modify |
| | ERP |
| | CAD |
| | product configurations |

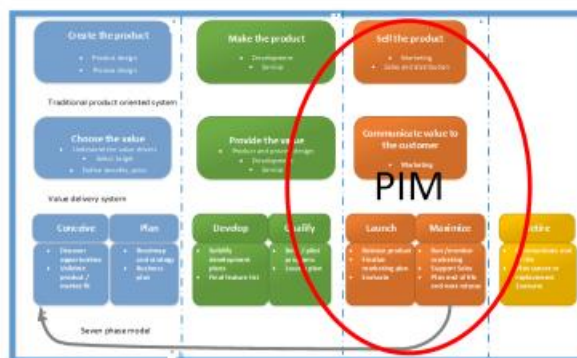
Product information management (PIM)

- Product information management (PIM) refers to processes and technologies focused on centrally managing information about product, with focus on the data required to market and sell the product through one or more distribution channels

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Which part of product management process?



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Product processes (modified from Lawley & Shure 2017, 53; Golub et al. 2000; Chunawalla 2009, 13)

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End users?



Product management Framework (Bilgiren & Bjørnulf 2018, 13)

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Features

| Process | Features |
|--------------------------------|--|
| Data collection | Automated data collection from surrounding systems Data import/exports capabilities |
| Data consolidation and quality | Data validation and consolidation e.g. identifying double records Localization for different sales locations Adding content descriptions, media files, technical documents Automated media file collection, modification and metadata Product classification and hierarchies Sales rules for sales process optimization, product variants, bundles Data validation mandatory fields, data format |
| Enrichment of data | Process for enrichment: assigning keywords, categories Access rights Automated enrichment Different format |
| Product data distribution | Easy, intuitive products and special like needed offers online |

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Product life cycle management(PLM)

- PLM as a strategic business approach that applies a consistent set of business solutions in support of the collaborative creation, management, dissemination, and use of product definition information across the extended enterprise, and spanning from product concept to end of life-integrating people, processes, business systems, and information.
- PLM system should provide mechanisms for company for implementing PLM process by integrating the functions, processes and systems and providing means for managing the product data through its life cycle.

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Features

| Process | Feature |
|--|--|
| | Link information across systems |
| | Real-time information flow |
| Product data management | Configure digital or PLM applications |
| | Integrate product development and production |
| Collaborative product design | Cloud-enabled collaboration techniques |
| | Enable collaboration across organizations |
| Direct materials sourcing | Supplier risks |
| | Self-organizing |
| | Integrate with the production of finished pieces |
| | Configure and manage |
| Requirement management | Manage requirements and change orders |
| | End-to-end lifecycle data capture |
| | Integrate with design processes |
| Portfolio management | Low-risk portfolio check-in practice |
| | Manage the product lifecycle from development to production |
| | Management, quality management |
| | enable change management, risk management, project portfolio management, quality management |
| | Integrate with design processes for change and production |
| | Management, quality management |
| | Manage change management, risk management, project portfolio management, quality management, risk management |
| Process management - define, execute, measure and manage | Management, quality management, risk management |

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