Empirical aspects on defining product data for rapid productisation

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Purpose – Emerging customer needs are calling for companies to quickly create new solutions in business front-end e.g. in sales situation. However, bypassing predefined product development processes and thus product definition turns to be problematic and leads later problems in product management. The main objective is to study what kind of special issues is related on defining product data when rapidly productising products.
Design/methodology/approach – This is a qualitative case study including three descriptive company cases. The study is conducted to show special characteristics that occur when rapidly defining products and their product data.
Findings – The results indicate that the practices to carry out rapid productisation (RP) are very company specific. However, three common forms for RP can be recognised. It can be concluded

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that product data management needs in the productisation process are dependent on product structure and an original customer order point (COP) of the products. This study analyses the link between COP and the type of module added in rapid productisation and how it affects the product data handled.
Practical implications – By focusing the relevant product data companies can hasten rapid productisation and ensure sufficient product management during order-delivery process.
Originality; The concept of rapid productisation itself is quite novel although acute issue in practice. This research gives empirical insight about essential product data aspects when rapidly productising a new item.
Keywords – product data, product data management, product definition, productisation, rapid productisation, information systems, synergy, research
Paper type – Case study

1. Introduction

The increasingly competitive market environment today forces companies to continuously supply new products to serve the diverse needs of customer and market (Ulrich and Eppinger, 2008; Henard and Slymanski, 2001). To succeed on this environment companies are keenly searching ways to speed up product development and providing more variety when simultaneously reducing costs. High product variation, short delivery times and cost effectiveness are widely pursued by applying mass customisation, modularisation and product configurability in product development (Hvam et al., 2008; Saaksvuori and Immonen, 2008; Kratochvi´l and Carson, 2005; Pine, 1993). However, more and more customer needs may evolve and new options rise after products are launched. Especially in business to business environment companies face varying customer needs rising frequently in sales situation bringing rapid productisation as widely used industrial practice fast to answer these requests. The rapidly changing customer needs require a company flexibility and capability to react. Ability to react with an efficient information management enables rapid productisation and increasing the customer value of the products and services. This kind of new procedure should be sought to utilise knowledge assets ensuring efficiency (e.g. Moustaghfir, 2012).

These exceptional products may be critical to provide to succeed in competitive situations and ensure certain critical customer relationships (e.g. Forza and Salvador, 2008; Liu et al., 2006; Huang et al., 2004) though rapid productisation, however, potentially disturbing the flow of basic business processes. In these cases, the provided products may not always be technically complex. The actual differentiation from normal portfolio offering can be purely cosmetic or it can be just a re-defined product using product bundling strategy (Docters et al., 2006). However, even these small product changes have effects not only for product management issues but also the supply operations that product requires. Anderson et al. (2006) have stated that more often the customised products cannot handle via standardised processes and thus causing additional work in operative actions. The exceptional products may require unique manufacturing, delivery or maintenance solutions. Even though resolving customer specific product requirements is widely utilised practice, according to Bramham et al. (2005) research is lacking in discussion on managing variety at the business front-end. These exceptional products, which are not defined by full-scale product development and product definition processes, present a challenge for data management.

Today, when the business lies on information systems, it also highlights the importance to have basic product data correct and in the right place in order to enable effectively and timely operative actions (e.g. Kropsu-Vehkapera et al., 2009; Lee and Suh, 2009; Saaksvuori and Immonen, 2008). Product data has become a necessity for smooth business operations and effective sharing and utilization of product data is required to enable rapid product launches (e.g. Buffington, 2011; Ouertani et al., 2011; Terzi et al., 2010; Huang et al., 2004). Companies offering a wide variety of predefined and/or tailored product variants have high information-processing needs during their order delivery processes (Forza and Salvador, 2008). Thus, their information systems support to handle non-standard products outside of product portfolio is lacking leading to salespeople to rely their own personal knowledge of the company's capabilities (Trentin et al., 2012). Product managerial issues are requiring attention in order to handle and manage these products according to the good business manners.

The current studies are not discussing product data management challenges during rapid productisation and in handling the exceptional products. As a whole, current studies do not provide methods or examples on how product should be defined and what is relevant product data in rapid productisation process. Therefore, the purpose is to study through empirical cases how companies are defining and managing product data within rapidly productised products. In order to answer this target, following research questions are raised:

RQ1. What types of product changes are typical for rapid productisation?

RQ2. What kind of product data is critical when rapidly productising products?

This research is qualitative in nature and is organised in the following way. At first, we made a literature review about productisation and the key aspects of defining a product in the productisation process. Product data management literature is also reviewed for understanding its role when rapidly creating a product. The empirical study includes research design (interview set-up), data collection and case analysis phases. The data collection is made by interviewing industrial experts within three case companies to study their practises in rapid productisation, and especially find out product data related issues. After the data collection, each case was analysed to describe how they are making rapid productisation and to find out what is the critical product data in practice. Figure 1 illustrates the research process applied in this study.

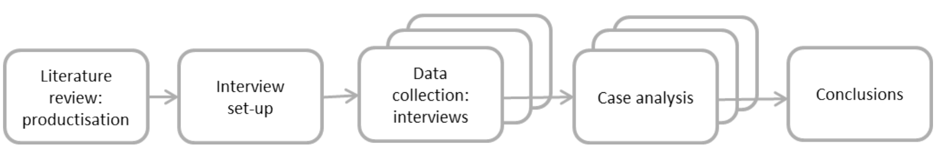

Figure 1: Research process.

It is widely known that companies meet these kinds of requirements to rapidly provide new products according to customer's perceives in business front-end. The focus of this study is limited on the cases where new offering to based on company's existing products and the product creation process is sales driven. These types of situations are very typical in the order negotiation phase in business-to-business industry. However, there rarely exist these studies where this phenomenon is described by product management and product data management viewpoint. Thus, the case study method is selected in order to tackle the challenge of fuzzy phenomenon as well as to offer more detailed view for rapidly productised products from product data management viewpoint (e.g. Yin, 2003).

Three companies were selected to show different types rapid productisation cases. The cases are analysed in order to find out the typical mode of rapid productisation in each company and what special product definition and product data management issues are related in these cases. After case specific analysis, the results are synthesised and special product data needs in the case of rapidly productised products are summarised and some guidelines for product data management in the case of rapid productisation are given.

2. Literature review

2.1 Defining productisation

Primarily, the concept of *productisation* refers to a product creation process (Suominen et al., 2009; Deuten and Rip, 2000). While that exact definition could also be used to refer to product development, it is usually applied to emphasising the process of making something unfinished to more a product-like object, which is tangible, standardised and easy to sell (Hietala et al., 2004). According to Suominen et al. (2009) productisation process utilises the information that basic research produce and creates an output that is an innovative product. In marketing literature productisation is meant to building more attractive offering (e.g. Simula et al., 2008).

In general, productisation is not widely utilised concept in the literature. Productisation as a concept is mainly used in the context of service development in order to emphasise the needs for clear product definition where productisation means that products, including services, should be standardised, defined, repeatable, configurable, automatised, priced and analytically developed (e.g. Saaksvuori and Immonen, 2008; Jaakkola, 2011). When the service is well defined and articulated, the object of exchange is easier to understand. In the case of services, to create service process description, aka a blueprint, is one way to standardise and define services and make them repeatable (e.g. Fließ and Kleinaltenkamp, 2004).

Condensing the previous views, productisation is understood following in this study: *Productisation is a process, which starts from an idea to fulfil a need or solve a problem of the customer, and ends with a defined, standardised and repeatable product and the product is easy to sell and buy.*

Furthermore, this study focuses on an activity that can be called rapid productisation (RP). RP is an alternative approach to be used in a situation when salesperson realises that the usual sales method is not suitable and a non-standard product is required. These potentially non-standard products may require a cooperative response from sales personnel and technical staff (Bramham et al., 2005). RP follows the productisation definition given but has some specific characteristics: 1) it starts from customer input, 2) it is a sales driven process, 3) it involves minimal use of engineering effort, 4) short-term planning is conducted, and 5) predictable delivery time can be given to the customer (Hänninen et al., 2013). Bramham et al. (2005) also states that fulfilling a non-standard request, necessitates for mechanisms to provide rapid effective quotations, and capabilities of identifying any constraints preventing a company to tender.

2.2 Productisation from order-delivery process point of view

Companies' current customer order penetration point (COP) and order delivery-process set the context for productisation (Hvam et al., 2008). COP divides the company's internal activities into two separate sections; actions performed before customer orders are received, and the ones performed after customer order has been received. Obviously, the variability of the product correlates directly with the COP, where early COP enables more variability and late COP reduces customer's choice. (Hilletofth, 2009; Hvam et al., 2008). This directly affects the completeness of a product specification and on which phase it is actually made. Having late COP (aka make-to-stock (MTS) products) product specification is done in conventional product development when early COP (aka engineering-to-order (ETO) cases) dictates that product is specified according to the customer involvement. Figure 2 represents the relation of COP and the specification level of the product (adapted from Hvam et al., 2008.)

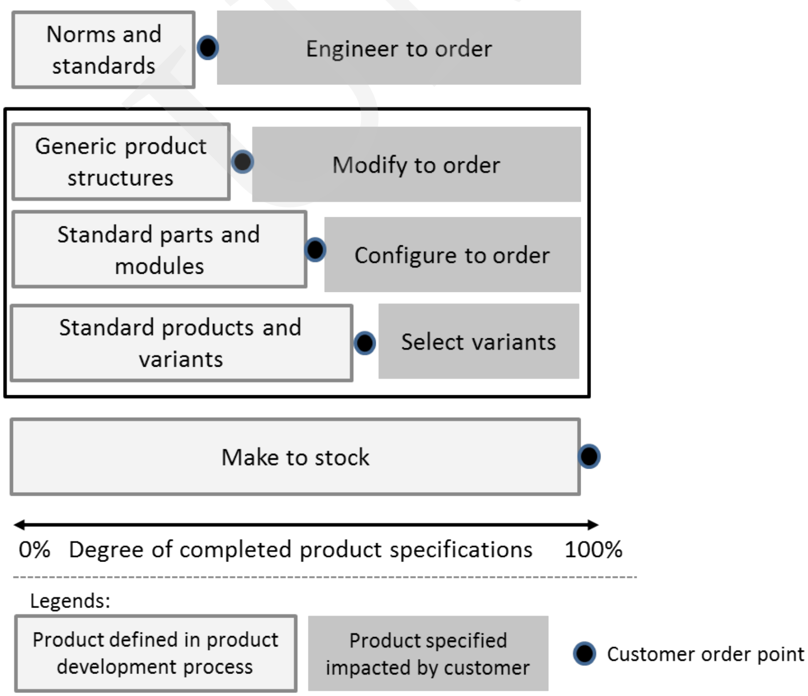

Figure 2: The connection of customer order point (COP) and completion of product specification.

Rapid productisation does not fit all kind of delivery modes. In case of ETO delivery mode, all delivered products are productised or tailored for customers by definition and rapid productisation is not a needed option. On the contrary, the MTS delivery mode focus on efficient operations with existing stock items excluding any new specifications for orders (Chung et al., 2007). Thus rapid productisation is not a meaningful option for companies having MTS delivery mode. Nevertheless, rapid productisation can be seen to fit for the companies that have adopted modular product structure and partially defined solutions. Typically modular product structure is associated with configure-to-order (CTO), assembly-to-order (ATO) and similar kind strategies that utilise modularity and partial product definition, where wide variety of different products is offered to the customer in relatively short delivery time (Hilletofth, 2009; Hvam et al., 2008; Olhager, 2003). To simplify, in these delivery modes products are built from standard parts and modules. In case of configurable products, possible variants are specified by a configurator according to predefined configuration rules (Hvam et al., 2011). If available configurations do not satisfy a customer, rapid productisation can be initiated to redesign or change existing modules to meet customer needs.

Product structure is one of the main factors affecting delivery and production lead times, and therefore affecting positioning of the customer order point. (Hilletofth, 2009; Hvam et al., 2008; Olhager, 2003). Product structure can be either modular or integral, but in the case where companies drive for high product variation and cost efficiency modular product structure is seen to be must. Typically modular product structure is associated with configuration-to-order, assembly-to-order and modify-to-order delivery strategies. (e.g. Hvam et al., 2008; Kratochvi´l and Carson, 2005; Pine, 1993). Thus it can be posed, that rapid productisation necessitates a modular product structure where productisation can take place by changing or redesigning single modules, not the whole product.

2.3 Product data and rapid productisation

Each order requiring rapid productisation increases product variety from the order-delivery viewpoint. Increased variety may be necessary to keep customers satisfied and to increase sales. However, it may disturb the order-delivery process and include hidden costs related to the processes. In addition, high product variety increases the amount of administrative work required to keep product related data up to date (Stark, 2005). Practitioners indicate the importance of product data to run the business and any flaws of business critical product data will have direct business impact (Kropsu-Vehkapera and Haapasalo, 2011).

Products' informational aspect is coming more critical when business processes rest on information systems. In order to represent product efficiently and formalised way, companies need to model their products uniformly. General product structure is perceived a way to model all company's products (e.g. Saaksvuori and Immonen 2008; Sudarsan et al., 2005; Svensson and Malmqvist, 2002; Andreasen et al., 1996) and it is utilised also when presenting products in information systems (Janardanan et al., 2008; Forza and Salvador, 2002b). General product structure is also kept a typical way to describe the configurable products and it is synthesising the various arrangements that product may have (Cheng and Wang, 2009; Newcomb et al., 1998).

Product structure can be defined *to represent the product, data linked to it, as well as the relationship between the components* (Saaksvuori and Immonen, 2008; Zhang et al., 2004; Svensson and Malmqvist, 2002). Typically, a product structure consists of diverse item types defined for different purposes (Jansen et al., 2005; Jung-Ug and Yeong-Dae 1996). Jansen et al. (2005) name the highest level item as the sales item that defines the product marketed to a customer. The following level is the deliverable item that describes the product to be delivered to a customer, including user manuals, end products, and accessories. The rest of the items are source items meaning sub-modules, source codes, and such.

Product data represents the product in applications (Liu et al., 2009). In the time of operational integration and co-operation also product data is currently understood to cover all product related information that is required to design, produce, sell, deliver, and maintain a product over its lifecycle (CIMdata, 2009; Saaksvuori and Immonen, 2008; Fensel et al., 2001; Liu and Xu, 2001). Therefore, it is obvious that product data is no more limited to product definition and technical data that serves only product development (e.g. Huang et al., 2004; Sulaiman, 2000).

In this sense, product data can be defined 1) to product master data that are utilised across business processes and operational and decision making systems (Dreibelbis et al., 2008; Loshin, 2009; Dayton, 2006) and 2) to other general product data that defines how the product is to be sold, produced, and maintained (Kropsu-Vehkapera and Haapasalo, 2011). This general product data can be more informal in nature and managed by each individual function (Lee et al., 2006). This data includes for example product specifications and other technical drawings, functional models, manufacturing bill-of-materials, user guides, work descriptions such as packing guidances and so on (e.g. Saaksvuori and Immonen 2008; Zhang et al., 2004; Crnkovic et al., 2003; Vroom, 1996).

Most of the product data is created during conventional product development process and extracted there to other operations (Saaksvuori and Immonen, 2008). Typically, the product data creation is an integrated part of product development work, which includes especially systematic creation of basic product master data, such as product description; product item code; product structure; basic specification such as weight, price or supplier information; configuration options and product classification in information systems (Kropsu-Vehkapera, 2012; Snow, 2008; Zhang et al., 2004; Nagi, 2001). Subsequently rapid productisation cases are not following these conventional steps there occur a risk for incomplete product data creation. Information system support for non-standard products may only be partial potentially leading to situation where some part of product data is generated manually (Trentin et al., 2012). Manually generated product data will have more errors due to various reasons, such as distraction, wrong calculations, misunderstanding instructions, and so on (Hvam et al., 2004; Forza and Salvador, 2002a; 2002b).

3. Results

The results are based on the data that was conducted with semi-structured interviews in three companies. The interviews were organised in order to allow the interviewees to explain and clarify the phenomena and topics as entities. Altogether, fourteen people were interviewed from three case companies. The interviewed people are representing the different organisational units to provide altered viewpoints for the rapid productisation cases in a company. Table 1 summarises the key characteristics of the studied companies. As an addition to interviews, publicly available information about case companies' products was also used as a data source.

	Company A	Company B	Company C
Company size	Medium	Large	Large
Number of sales items	around 1000	around 30 different devices, each have appr. 400 variants	tens of thousands
Type of product	Playground equipment and solutions	Consumer electronics and Services (not included in this study)	Telecommunication equipment with HW, SW, and services
Market	Acts over 50 countries	Acts over 150 countries	Acts over 100 countries
Production volume	Differs by product: from 1 to thousands	Typically millions; minimum tens of thousands/ hundreds of thousands per variant	High variety from 1/year to million / year
COP	Standard (MTS) and CTO	MTS/ATO	High volume product MTS(/ pack-to-order) Small volume product ATO(/ make-to-stock)

Table 1:
Case characteristics.

The next, each company's typical rapid productisation event is described from product data viewpoint. The cases are not representing the rapid productisation process in detail since in all the cases the process is following steps described by Hänninen et al. (2013). After each individual case, types of rapid productisation changes are summarised and their affects to product data management are discussed.

3.1 Case A

Case company A is a medium sized company providing playground equipment. According to the interviewees, they utilise rapid productisation quite commonly to find a solution for a customer's request. They have two different types of way to create a rapidly productised product. The most typical way to fulfil the customer need is *to bundle a third party item to an existing portfolio item*. This part of the product is handled as *an external entity and sourced by the third party vendor*. Another way to fulfil the customer needs is *to develop a new sectional module into some existing product*. Typically, these modules are developed in-house, but sometimes the module is outsourced. The major difference between these two types of RP cases is the level where the product change is focused on; product bundling occurs at product delivery item level when the integration of a new sectional module takes place on product's module or component level and thus requires handling the original product's design too (Figure 3).

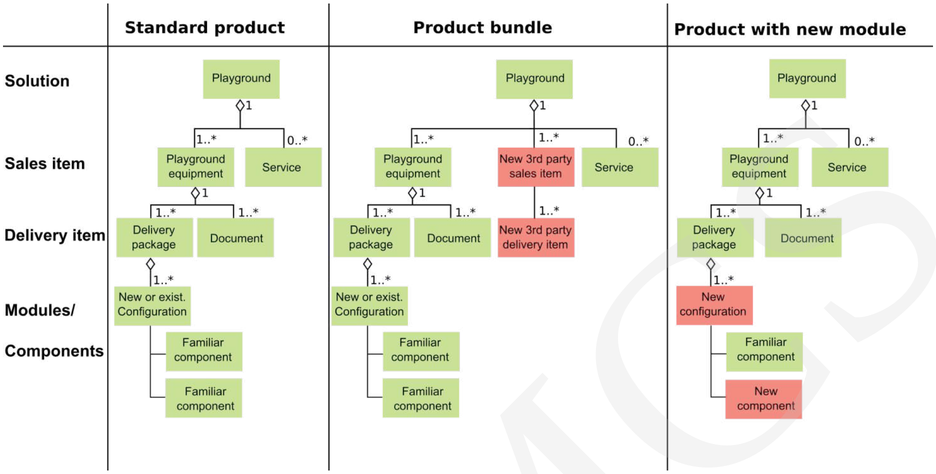

Figure 3: Product structures – case A.

3.1.1 Product bundling with third party item

An added entity from the third party vendor is typically something that has no direct interaction with the existing product. In the context of playground environment, these additions are typically specific type of trash cans or park benches.

Since the added module is not directly affecting other parts of the solution, the product data needs occurs in this type of RP case concern primarily the definition of the third party item and adding it as a delivery item to the current product structure. Since company A is responsible for all products they provide, they need to ensure the quality of the added item. This requirement emphasises the importance of vendor data of the item; what item needs to be delivered, which vendor can deliver the item, how quickly can they deliver it and with what cost? The most critical issues to solve in this type of RP case is to solve does the vendor can provide products with sufficient quality and require relevant agreements of the vendor.

3.1.2 New sectional module to the existing product

Company A's main products are typically realised as a combination of sectional modularity and cut-to fit modularity enabling endless amount of configuration options. Also, the configuration team is able to make cosmetic additions to the product as a standard product. When facing the situation where the available configuration options are not fulfilling the customer requirement, they design a new "LEGO-block" to be added into an existing portfolio product as their rapid productisation solution (see Figure 3: Product with new module).

When this type of new module needs to be developed, customer requirements are representing the initial product data needs. Whether the customer requirements are technical or functional, research & development organisation specifies the technical solution to meet the customer's requirements. It is also essential to evaluate the development and production costs of the configuration with a new component. According to the interviewees this kind of evaluation necessitates product data e.g. in the form of design requirements. Since the product is based on sectional modularity, in RP case only the new module and its integration to the existing product need to be specified.

3.1.3 Special characteristics of PDM in rapid productisation

Company A's standard products have endless amount of configuration options due to the high level of modularity. As an addition to pre-defined configurations aka standard products, they provide customer specific configuration by utilising sectional and cut-to-fit modularity. Since these new configurations might require new design drawings and other product-specific data like documentations, it can be difficult to state that product data needs drastically differ from their rapid productisation cases compared with their usual product definition and product data needs in the order-delivery phase. This might be the reason why interviewees did not consider product data definition in RP cases as a challenge or problem. However, based on their RP descriptions, we can conclude that they perceive the product data listed in Table 2 to be critical in order to ensure the profitability, quality and deliverability of a required rapidly productised item.

Product bundle	Product with new module
Definition of delivered item	Customer requirements
Product quality	Technical specification
– Quality Certifications	Design drawing
– Raw material certifications to fulfill required standards	Development cost
Vendor information	Development time
– Vendor agreements	Production cost
– Vendor quality standards	Production time
Delivery time	
Price	

Table 2: Product data needs in RP cases - case A.

3.2 Case B

Company B is a large-scale enterprise providing electronic devices for consumers. According to the interviewees, rapid productisation is considered as an activity, where new product variants were created for retailers and value-added resellers (VAR). Although they have enforced more rigid variant creation rules recently, company has the history of variety creation which can be identified as rapid productisation. The most typical rapid productisation case is *a new software application development* into the device. Other types of RP cases are *product bundles* creating by local sales organisations and *embedded physical modifications* to the product. These different types of RP cases and their influence on product structure levels are represented in Figure 4.

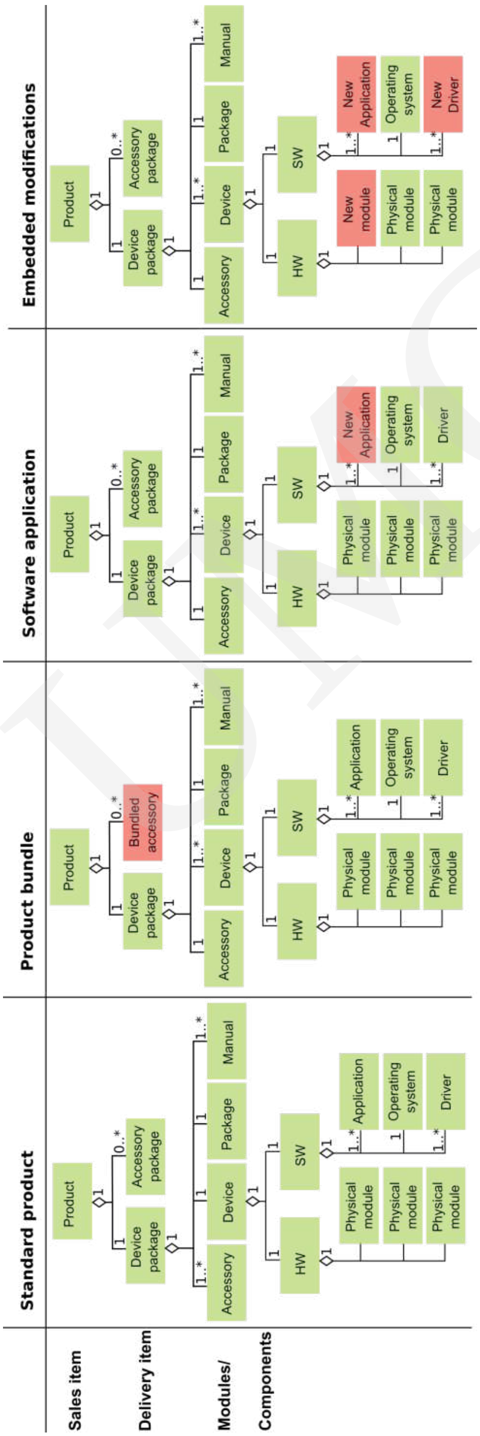

Figure 4: Product structures – case B.

3.2.1 New software application

The most typical variant creation for VAR includes software-related adjustments to the existing product. Usually this is as simple as configuring the device settings according to customer requirements. However, sometimes the VAR has more specific need meaning that new software needs to be developed. The development of software that are built in devices, utilises an application framework that defines specifications and boundaries for application development. The framework ensures that applications developed according to specifications should function without the need to test all other functionalities of the product. These software applications can be seen as integrated parts and can be treated as a single entity enabling rapid development and making the product data definition and its management easier.

When technical expert analyses that a customer need can be fulfilled with software application, product data requirements concern primarily the development of the application. In practice this means that customer requirements, technical specifications, development time and cost needs to be defined for the RP case. It was also stated, that delivery method for the software needs to be defined, since software can be pre-installed on the device or delivered utilising Internet technologies. From the product management viewpoint, the main product remains the same, since the physical device and some software elements like the operating system and drivers are unaffected.

3.2.2 Product bundling

In company B, local sales organisations have authority to create and logistics to provide certain sales area specific product bundles. This can be, as an example, a bundle that is a composition of the main device from the global portfolio and an additional, area specific accessories. The interviewees also stated that the package content can vary when creating a variant for value-added resellers.

Product data needs in this kind of situation concern primarily the definition of accessories included in a bundle. Typically these accessories are obtained from internal organisation that is responsible for accessories, but it was also stated that sometimes these accessories can be provided by third party vendors. When sourcing the accessories from third party vendors, the delivery time and cost of item are crucial product data in addition to product definition data.

3.2.3 Embedded physical modifications

The third type of RP example occasionally is realised with physical modifications in to the product. In these cases, new components are added to the existing product model. When implementing this type of change to the product that is a complex electronic device including both software and hardware, the technical impact of the customer requirement needs to be carefully analysed. Technical impact is the first issue to be defined for the RP case evaluation; what physical modules are affected (in product structure), what software applications and drivers needs to be developed, how much does the development cost and how much it takes time? Other crucial product data to be defined is what new components this change requires, and what kind of effect does the product change have in production. Vendor information, availability, delivery time and price of new components as well as testing equipment were identified as necessary information when rapidly productising an embedded physical module.

3.2.4 Special characteristics of case company B

The most imminent observation when analysing company B is to notice high product volumes. The company produces and delivers from tens of thousands to several million units per portfolio item. Even their rapidly productised products are ordered in large quantities and thus each rapid productisation case needs to be well reasoned. Nevertheless, rapid productisation cases are initiated from time-to-time and realised by three distinctive methods. Within these types of product change, the product data needs are somewhat diverging and are summarised in Table 3. It is also notable that their software application framework enables product customisation by new or modified applications without affecting other parts of the product structure. This is actually formalising rapid product variation in these cases.

Product bundle	Software application	Embedded modifications
Delivered item definition	Customer requirements	Customer requirements
Product quality	Technical specification	Technical impact
Vendor information	Development time	Development time
- Vendor agreements	Development cost	Components required
- Vendor quality standards	Delivery method	- Vendor information
Delivery time		- Delivery time
Price		- Cost
		Define the required testing equipment
		- Vendor data
		- Delivery time
		- Cost

Table 3: Product data needs in RP - case B.

3.3 Case C

Case company C is a global, large-scale enterprise offering telecommunication solutions. Even though they have a large product portfolio, they also provide often rapidly productised products for their customers. The typical RP case occurs when a customer requires some additional hardware or service outside their current product portfolio. These additions are always acquired by third party vendors. It can be stated that their rapid productisation products are always *a bundle where a third party item, either service or hardware, is connected to their existing product*. These different types of RP cases and their influence on product structure levels are represented in Figure 5.

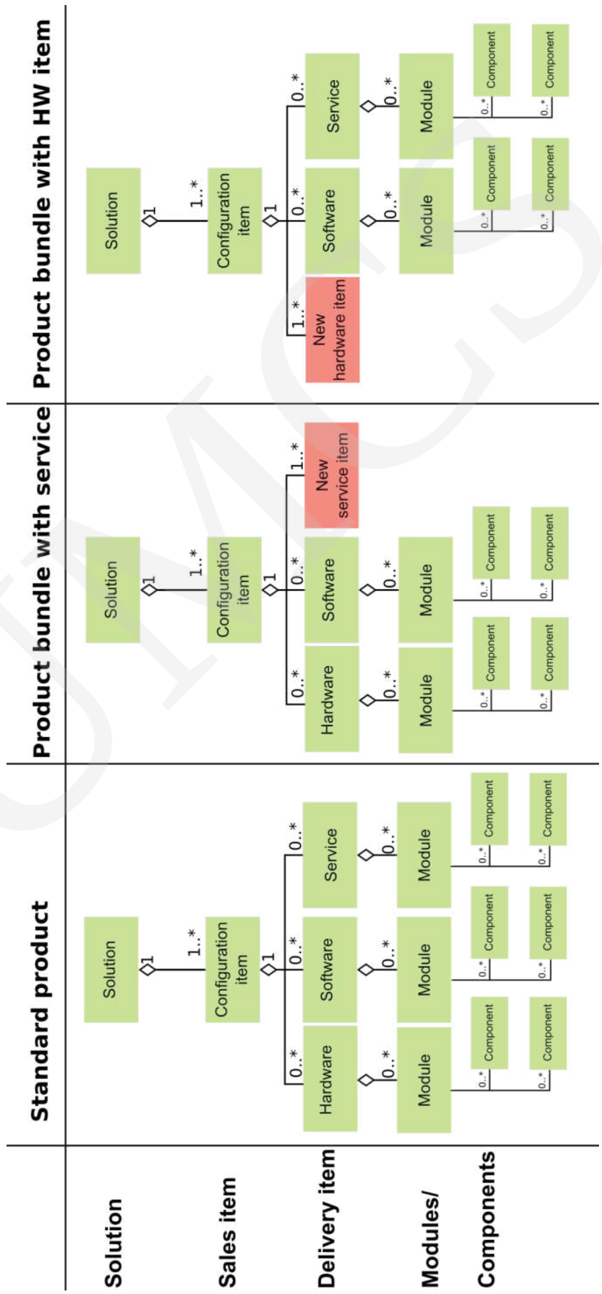

Figure 5:
Product structures - case C.

3.3.1 Product bundling with service item

Company C offers the so called solutions to the customer in local sales regions. Typically the offered solution contains some local services in addition to global portfolio items. Ideally all service items are specified beforehand, but sometimes local services offered in the solution are not defined.

The primary problem with service items offered locally is the lack of correct product data. Although these items might not require product structure or other definition data, the item must be correctly inserted into data systems in order to be able to invoice the service.

3.3.2 Product bundling with hardware item

The required addition can also be hardware, which is acquired from the original equipment manufacturer (OEM). The challenge with new OEM items is similar to service items; the items have to be available in product data management (PDM) systems before they can be ordered and invoiced and also maintained.

The most crucial information for the new item is the vendor data of the product. First of all, the supplier of the item needs to meet the quality standards specified the company C. Additionally it must be ensured if the new item is under the current agreement with the vendor.

Since company C has global supply chain and has tens of thousands different hardware, software and service items, the logistics related data of the items is necessary. Size, weight, lot size and other data related to logistics is necessary not only for transport equipment but also for tolls when transporting products across country boundaries are critical to ensure that the operations run smoothly.

3.3.3 Special characteristics of case company C

Product data management in rapid productisation is considered as a major challenge in company C. The rapidly productised product is not typically complex. Seemingly the primary reason for this is that the requirement of correct and adequately filled product data required by the information systems and formal processes of the company are too heavy and time consuming for rapid productisation. Since they have business reasons to offer RP products they also need some procedure to ensure that product data is in place when providing the products that are not developed according to the formal product development steps that fulfil the qualified product data. Table 4 summarises the identified product data that are required when rapidly productising bundles. In this case, the problem is not the complexity of the data needed but definitely the have a procedure that ensures that this product data will be collected during the differing productisation process.

Another explaining factor might be the vast portfolio and high delivery volumes of certain sales items. The rapidly productised products are typically delivered only one or few customers. However, the product data management systems and processes require a capability to handle products which are produced and delivered hundreds of thousands times per year, they might suit poorly in situations where single customer related product needs to be handled. Rapidly productised items are often answers to local conditions when typically the product portfolio is global. This again confuses the procedures and raises a question that should the rapidly productised products are managed as local or global products. Since the company has not defined this clearly, they face problems on their product data management and further in their delivery chain.

Table 4:
Product data needs – case C.

Product bundle with service	Product bundle with HW item
Delivered item definition	Delivered item definition
Price	Vendor information
Product data required by processes of the company	- Vendor quality standards
global invoice code	- Vendor agreements
	Logistics related data
	- Size
	- Weight
	- Lot size
	- Customs declarations
	Delivery time
	Price

4 Discussion

4.1 Findings of rapid productisation cases

Rapid productisation, as the analysed cases illustrates, is recognised practise in industry to quickly respond emerging customer needs. However, there are little research on rapid productisation and its true nature in companies earlier (e.g. Hänninen et al., 2013). The rapidly productised products are exceptional and presenting a challenge for data management since they are not defined by full-scale product development and product definition processes. This study shows that the rapid productisation cases are realised very company specific ways since the process is always in relation to the companies' conventional product development processes and product and delivery strategies. However, the studied cases express that regardless of the offsets similar characteristics can be found in rapidly productised products. The changes of rapidly productised products can be presenting three types:

Product bundle: product bundling means adding a third party item for an existing product portfolio item. The bundled module has no interacting interface for the existing product but it typically means to add some supplementary deliverable item for the offering. All case companies utilise product bundling for rapid product change.

Integrated module: the integrated module is interfaced with an existing product. The change typically takes place deeper in product structure compared to bundle aka module/component item level. In the case descriptions Case A sectional module and Case B software application are examples of this module integration.

Embedded module: the new module is embedded in the existing product. Within embedded modules, there are several interfaces between the existing product and a new, embedded module thus the impact of product change is wider. Case B embedded physical module is representing this type of product change.

Generally, the rapid productisation in all these case companies means implementing some kind of added module to the existing product. Interview material indicates, that the amount of product data required in rapid productisation process is dependent on the type of rapidly productised module interaction with the existing product. This is in line with the findings of Hvam et al. (2008). By identifying their types of rapid productisation companies can manage product definition and specification in rapid productisation in a proper way. This decreases fuzziness with the order-delivery process and product management after rapid productisation process.

4.2 Critical product data in rapid productisation

In the case of rapid productisation is emphasised the need to create just the very essential product data to answer for customer request of a new variant to secure that the company can manage rapidly productised items and to ensure that the data in information systems enables that the order can be placed, delivered and invoiced correctly. By focusing the relevant product data companies can hasten rapid productisation. To define all relevant product data is a similar necessity that it is also in predefined product development so that company can ensure sufficient product management during an order-delivery process e.g. ensure the traceability of products. The results highlight that the product data that is required for productisation decision (to productise the product or not) is critical in the rapid productisation. Table 5 summarise this critical product data.

Type of product change	Product data
Product bundle	Delivered item definition Vendor information and possible agreements Price for module Delivery time Product quality: required documents, standards etc. Logistics data: size, weight, lot size, customs declarations
Integrated module	Customer requirements Technical impact Development cost Development time Delivery method
Embedded module	Customer requirements Technical impact Development cost (including cost of production if produced itself) Development time (includes time for production) Define the required testing or production equipment

Table 5: Critical product data in rapid productisation.

Many companies are today forced resolving customer specific product requirements in business front-end. However, when the process support is not available the productisation decision may be made without relevant data. Thus the results of this research and defining the critical product data aspects help companies in making rapid productisation decisions and realising these products in practice.

Although our cases are representing medium and large size of companies, the results of this study may serve also small businesses where the rapid productisation is even more alive way of create new products. Formal product development processes, which are typically used in medium and large sized companies, include guidelines for product definition and product data creation. Rapid productisation is not following the formal processes but also in rapid productisation the required product data needs to be managed. Thus these results can be used in all types of rapid productisation cases to ensure that the critical product data will be defined. Companies can utilise these results as a first presumption that needs to implement on their rapid productisation process.

5. Conclusions

Rapid productisation is providing a quick way to answer customer request and to create a new product. It enables enormous time and cost savings compared conventional product development projects. However, when the rapid productisation process is led by sales instead of traditional product development the traditional roles and responsibilities hinder and for example product definition and data creation has been problematic.

This study takes product data perspective for rapid productisation. The results of this study indicate that *the changes that existing products face are typically bundling a third party item, adding an integrated module such as software, or developing a new/chancing embedded module into an existing portfolio product.* Modular product structure is seen to be necessary enabler for rapid productisation when the change is tried to focus on a single module that can be handled as independently as possible.

In order to make the decision to rapidly productise a product and later enabling the order, delivery, and invoicing of this product, *the very essential product data must be available*. The COP dictates when and in what extend product specification is done. In the case of rapidly productised products, the customised part is defined on the fly and it is not based on ready designed solutions as is the case with configurable products. *The cases indicate that the amount of product data required in a specific RP case was dependent on RP module interaction with the existing product. Furthermore, the source of new or changed module has also the significant impact of the type of product data required.* When RP is realised as bundling third party item, critical data is the data that describes the sourced item and in the other hand the quality documentation. When the RP is the type of the integrated or embedded module, the technical impact of the change and related development costs and time are critical data in order to give quick answer to the customer's request. The listed product data is not complex in nature. Nevertheless in the case of rapid productisation *the challenge is to rapidly provide this required data and thus it is important to clearly state and define what data is required*. Another challenge is defining the responsibilities to create, gather, and maintain product data when rapidly productising products.

As known, solving customer specific product requirements is widely utilised practice. However, the practical examples of product variety management at the business front-end are lacking. This study brings some practical examples to this discussion, especially from product data viewpoint. By better product data management in rapid productisation can be also help to tackle product variety in order to define and productise these special product cases according to company's product strategy. Also to get these special products following the same information model than company's typical products, all information systems can be utilised without any special needs.

Although the concept of rapid productisation itself is quite novel, the problem itself is topical and recognised. Global and increasingly competitive markets drive companies constantly to offer more variety while reducing costs. When the company decides to adapt to a new situation, several different business aspects needs to be considered. In this study, the problem is addressed from the product data management viewpoint. However, the limitations of the study include only analysing three companies. Although the number of cases is low, the heterogeneous type of studied companies indicates that the RP is acute in different types of companies and the solutions are created with the similar ways of adding/chancing modules. Also the empirical evidence of product data content is not listing all product data but focusing on the most critical one when rapidly productising a new item. The basic product master data is in any case needed leaving room for more detailed study. In the context of rapid productisation practitioners need more results that could support product data management responsibilities and roles setting in cases where product data is not created according to conventional product development.

The cases also show the role of product structure in rapid productisation. The results of this study propose that modular product structure and low interaction between changed components and the rest of the product facilitates rapid productisation. Future research could include more detailed studies on product structure to give guidelines for long-term product structure development. That would be beneficial for practitioners in order to develop their capabilities to react better to emerging and chancing customer requirements. In addition, future studies could extend understanding on the role of product data and information system in different contexts, e.g. in large enterprises with formal development processes and small and medium-sized enterprises with entrepreneurial development patterns.

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