What Do We Know about Software Product Management? – A Systematic Mapping Study

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Abstract—Software product management (SPM) offers tools and practices for achieving business goals of a company as well as for increasing the predictability and profitability of software product development. Despite the importance of this topic, the studies of SPM have this far been fragmented. The goal of the present study is to summarize the existing knowledge in software product management and identify the areas which need further research. The paper reports the conduct and the results of a systematic mapping study which identified 25 studies on SPM. Still, most of the papers had only hypotheses and theories that were not empirically confirmed or the confirmation was based on a small set of cases. The existing knowledge of software product management consists of small and unconnected pieces. In addition to this, our specific interest, software product management in the cloud environment has not been studied at all. However, since both researchers and practitioners find research in SPM important, this area needs more research in the future.

Keywords: systematic literature review; systematic mapping study; software product management; cloud environment; services

I. INTRODUCTION

Software product management (SPM) is “the discipline and business process governing a product from its inception to the market or customer delivery and service in order to generate the largest possible value to a business” [1]. This definition includes all essential activities related to software products. The success of a product depends on all the activities from strategy and marketing to product launch and customer support as well as on the development activities. An empirical investigation of the projects in the industry suggested that focus on software product management allows the company to reduce cycle time in the business unit by 36% compared to the initial estimation [2]. SPM also has a positive impact on delays and quality which, according to the same study, can be improved by 80% with product management practices [2]. Other benefits of SPM include increasing the profitability and predictability of software product lifecycle in accordance with business goals of a company [3]. And finally, software product management plays a critical role in managing and achieving business goals by providing practices for the winning strategy in the market [4].

The principles of how software products are introduced and delivered are changing rapidly. For example, today many companies are moving their business to the cloud environment which means a change from selling products to providing services. Services can be seen as higher level products comprised of the software product and its service delivering the product as a service to the user [5]. The intersection of software product management and cloud environment is an important area for every company that provides or uses services, because software product management attempts to give an answer to the question of how to improve the product success rate in terms of predictability, quality and efficiency [2].

We started the research with an idea to summarize the existing information about SPM in the cloud but it soon became evident that even traditional SPM studies are fragmented. Thus the purpose of our study was refined to analyze systematically the existing literature on SPM to establish a solid basis for future research.

The rest of the paper is organized as follows. Section II provides a description of the research process. In Section III we justify the selection of databases and search queries. In Section IV we describe the pilot search and its results and the actual search. Then, in Section V, we show the results of our literature analysis. In Section VI we discuss the implications and limitations of the study. Section VII concludes the paper.

II. RESEARCH PROCESS

The conducted systematic literature review followed the formal process described by Kitchenham and Charters [6]. In particular, this review can be classified as a systematic mapping study (or scoping study) that is “designed to provide a wide overview of a research area, to establish if research evidence exists on a topic and provide an indication of the quantity of the evidence” [6]. We chose the mapping study because the goal was to explore the existing studies in software product management. The results of the mapping study will help us to identify research areas within this topic where primary studies are required.

In the beginning we defined three research questions as follows:

1. What research questions in software product management are being addressed?
2. What original research exists in the intersection of software product management and cloud (service) environment?
3. What areas in software product management require more research?

We started our research with developing a protocol including all steps, research questions, inclusion and exclusion criteria, and analyses procedures. This enabled us to conduct a pilot search for tailoring the search terms. In general, the process progressed along the following steps:

1) Protocol preparation which included defining
   a) the process
   b) the research questions
   c) the inclusion and exclusion criteria
   d) the analysis procedures
2) Conduct of a pilot study
   a) defining search queries
   b) choosing the digital libraries and other sources of materials
   c) searching
   d) reviewing the results
   e) summarizing and analyzing the results
   f) refining the queries for the actual search
3) Conduct of the actual search
   a) selection of databases and search queries based on the pilot study results
   b) searches
   c) removal of duplicates
   d) application of inclusion and exclusion criteria
   e) classification of excluded articles
   f) summary and analysis of the results
4) Data extraction
   a) review of the articles
   b) gathering information from the articles
   c) classification of the articles
   d) identification of primary studies
5) Analysis of the results
6) Development of conclusions
7) Reporting

The described process is based on the review process described in the guidelines for performing systematic literature reviews [6], but some steps such as quality assessment and data synthesis were excluded because of their unsuitability for the mapping study.

Classification of included and excluded articles is a challenging task for every mapping study [7]. To ensure consistency in this task we used an approach described by Budgen et al [7], but we reviewed the papers twice. The first round focused only on the titles, abstracts, and keywords of the papers to identify the fundamental topics of each study, the units of analysis [8]. The articles where units of analysis were not related to SPM were excluded from the next round. In the second round, we read the full text of the remaining papers and extracted additional information such as research questions, research approaches, and number of participants. We also checked that the units of analysis were identified correctly and refined them as appropriate.

III. SELECTION OF DATABASES AND SEARCH QUERIES

The results of a literature study are heavily influenced by the databases and the keywords used in the searches. To get an idea of the available articles, we did a quick search on Google Scholar with default options using “software product management” as the keywords and got about 1,940,000 hits including articles, patents, citations, etc. However, putting quotes around the keywords decreases the number of hits to 474 indicating that “software product management” as a single concept has raised considerably less interest than software, product, and management as distinct keywords.

Since the present study focused on software product management, we further explored the literature base by narrowing the searches to articles having this phrase in the title, and got down to 62 articles. This appeared like a reasonable basis for a literature review, so we moved on to continue our study in scientific databases since Google Scholar searches across many resources including “articles, theses, books, abstracts and court opinions, from academic publishers, professional societies, online repositories, universities, and other web sites” [9].

The actual literature searches were conducted in two phases: pilot search and actual search. The purpose of the pilot search is to identify appropriate sources of information (conferences, databases, journals) and refine the search queries. We started the searches with looking at conferences on the main topics of interest – software product management, cloud, and service computing – which resulted in four conferences:


We studied the prior reports on systematic literature reviews [7],[10],[11] in our field and learned that they had found the IEEE, ACM and ScienceDirect databases as the most useful ones. Thus we decided to include these databases in our searches, too, but added two new ones, ABI and Ebsco. Thus the initial list of the digital libraries was as follows:

1) IEEE Xplore (http://ieeexplore.ieee.org/Xplore/dynhome.jsp)
2) ACM DL (http://portal.acm.org/dl.cfm)
3) Science Direct (http://www.sciencedirect.com)
4) ABI/Inform (http://proquest.umi.com)
5) Ebsco (http://search.ebscohost.com).
The keywords are used to find the most relevant papers in the databases. Since we had two topics of interest, we also used two kinds of keywords – the first one focused on the main topic of the study, “software product management”, and the second one explored the cloud computing area. Cloud computing has been defined to cover three service models [12]: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). In our search we used only the term SaaS because PaaS is a special part of software (middleware) and IaaS is only a method of providing infrastructure. In both cases software is only a part of solution, and therefore we excluded these terms from the search queries. The second keywords were further combined with product management related keywords since especially the cloud word is in no way constrained only to the software engineering context. In the end we used the following keywords in the searches:

- "software product management"
- SPM AND (cloud OR SaaS)
- "product management" AND (cloud OR SaaS)

In the pilot search we did not put any further limits on the publication year etc. because we wanted to get as many results as possible before refining the queries and removing irrelevant queries. During this stage we included all papers about software product management or management problems in the cloud and papers that describe management issues and/or differences between products and services. Three kinds of papers were excluded from the study at this point of time: first, papers about technical issues of moving to the cloud such as virtualization, development and architectural issues, and other problems. Second, business articles that had too general business point of view. And finally, papers not related to the studied topic or only available in the form of abstracts or presentations.

IV. SEARCH RESULTS

This section summarizes the results gathered during the pilot and actual searches.

A. Pilot Search

The results of the search are presented in Table I. The numbers in the table show the total number articles and the number of included articles according to criteria described above. As can be seen from Table I, the term “SPM” did not produce any relevant results so we excluded it from the search. We do not report the ACM papers because these papers were found in the other databases. The search in the ABI/Inform digital database produced a result where most of the articles were already found from the other databases and some other articles were published in journals like Business Wire that had too much business emphasis from this study point of view. Thus ABI/Inform database was excluded from the actual search and, instead, Springer digital library was added there (http://www.springerlink.com/home/main.mp).

During the conference paper review (Table II) the following observations were made:

- Many articles used different terms for the same concepts. Thus, in addition to the "cloud" and "SaaS" terms, the term "service" was added to the list of search terms. At the same time the term “service” is widely used in any field, therefore we searched this term together with additional context words only in titles.
- There was no need to search in the conference proceedings separately because the conferences were included in the IEEE Xplore digital database and were found during the search in the database.

During the pilot search we did not remove duplicates so the results include some articles several times.

B. Actual Search

The actual search was done in four digital databases (IEEE Xplore, Springer, EbSCO, and Science Direct) with the following queries:

- "software product management"
- "product management" AND ("cloud" OR "SaaS" OR "services")

Searches were conducted on May 3rd, 2011. During the actual search the queries were searched in document titles and abstracts. In our case full-text search gave irrelevant results because product management, cloud, and SaaS are general enough terms to be found in most software engineering articles. The results of the actual search are shown in Table III. As a result of the actual search we found 52 articles and after removing duplicates we had 41 unique papers.

The final decision about including a paper in the review was done based on the study of the title, abstract, keywords, and availability. We identified six categories for excluding the articles from the final review (Table IV). “Support materials” mean that keywords were found in the title pages, workshop introductions, and posters. “Not relevant articles” refer to articles from other research areas such as mathematics, stochastic processes, and medicine. At the end of this step we got 25 articles that were related to the software product management issues.

### Table I. The number of found and included papers based on the pilot search in digital libraries

<table>
<thead>
<tr>
<th>Search terms</th>
<th>IEEEXplore</th>
<th>ACM</th>
<th>ABI</th>
<th>Science Direct</th>
<th>EbSCO</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>“software product management”</td>
<td>39/32</td>
<td>21/12</td>
<td>49/12</td>
<td>6/5</td>
<td>10/2</td>
<td>125/63</td>
</tr>
<tr>
<td>SPM cloud</td>
<td>0/0</td>
<td>0/0</td>
<td>12/0</td>
<td>7/0</td>
<td>2/0</td>
<td>21/0</td>
</tr>
<tr>
<td>SPM SaaS</td>
<td>0/0</td>
<td>0/0</td>
<td>8/0</td>
<td>0/0</td>
<td>0/0</td>
<td>0/0</td>
</tr>
<tr>
<td>“product management” and cloud</td>
<td>0/0</td>
<td>2/0</td>
<td>50/6</td>
<td>0/0</td>
<td>0/0</td>
<td>52/6</td>
</tr>
<tr>
<td>“product management” and SaaS</td>
<td>2/0</td>
<td>1/1</td>
<td>22/0</td>
<td>0/0</td>
<td>12/4</td>
<td>37/5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>41/32</strong></td>
<td><strong>24/13</strong></td>
<td><strong>142/18</strong></td>
<td><strong>13/5</strong></td>
<td><strong>24/6</strong></td>
<td><strong>235/74</strong></td>
</tr>
</tbody>
</table>
TABLE II. RESULTS OF PILOT SEARCH IN THE CONFERENCES

<table>
<thead>
<tr>
<th>Conference</th>
<th>Total</th>
<th>Included</th>
<th>Excluded</th>
</tr>
</thead>
<tbody>
<tr>
<td>IWSPPM'2006</td>
<td>9</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>IWSPPM'2008</td>
<td>7</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>IWSPPM'2009</td>
<td>8</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>SOCCER'2006</td>
<td>8</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>SOCCER'2008</td>
<td>8</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>World Congress on Services 2008</td>
<td>137</td>
<td>10</td>
<td>127</td>
</tr>
<tr>
<td>World Congress on Services 2009</td>
<td>120</td>
<td>3</td>
<td>117</td>
</tr>
<tr>
<td>World Congress on Services 2010</td>
<td>117</td>
<td>5</td>
<td>112</td>
</tr>
<tr>
<td>CLOUD'2009</td>
<td>33</td>
<td>7</td>
<td>26</td>
</tr>
<tr>
<td>CLOUD'2010</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>450</strong></td>
<td><strong>51</strong></td>
<td><strong>399</strong></td>
</tr>
</tbody>
</table>

TABLE III. RESULTS OF THE ACTUAL SEARCH

<table>
<thead>
<tr>
<th>Search Term</th>
<th>IEEEExplore</th>
<th>Ebsco</th>
<th>ScienceDirect</th>
<th>Springer</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>“software product management”</td>
<td>28</td>
<td>9</td>
<td>7</td>
<td>0</td>
<td>44</td>
</tr>
<tr>
<td>“product management” and cloud</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>“product management” and SaaS</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>“product management” and services</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>29</strong></td>
<td><strong>12</strong></td>
<td><strong>8</strong></td>
<td><strong>3</strong></td>
<td><strong>52</strong></td>
</tr>
</tbody>
</table>

TABLE IV. ARTICLES EXCLUDED FROM THE FINAL REVIEW

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>General issues of cloud computing</td>
<td>2</td>
</tr>
<tr>
<td>Support materials</td>
<td>3</td>
</tr>
<tr>
<td>Architecture and development issues in the cloud</td>
<td>4</td>
</tr>
<tr>
<td>Not relevant articles</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>16</strong></td>
</tr>
</tbody>
</table>

V. DATA EXTRACTION

A. Summary of Included Articles

Each of the included articles was reviewed for studying the context of the article, research questions, and empirical confirmation of the results. Table V summarizes the information about included articles. Only 4 of 25 articles were published in journals and other articles were conference papers. In addition, only 6 of 25 articles had clearly presented research questions that could be reliably extracted from the paper, for example, as a list. The empirical approaches in the papers consisted mostly of case studies in small companies or studies where only one project was studied for theory creation. Many of the studies were made in companies providing telecom services, which left other industry fields less studied. We extracted the main keywords from the articles and classified papers by authors and units of analysis. Clustering by authors showed that there are three clusters which include at least 3 articles: Brinkkemper (7 articles, [3],[13],[16],[19],[30],[31],[36]), van de Weerd (5 articles, [3],[13],[19],[36],[37]), and Kilpi (3 articles, [21]-[23]). Van de Weerd and Brinkkemper have 4 articles written together so these two clusters are overlapping. The Kilpi articles were written in 1997-1998 indicating that the point of view to software product management is not very recent, but it still provides insights into the evolution of SPM.

<table>
<thead>
<tr>
<th>Units of analysis</th>
<th>Research questions</th>
<th>Research approach</th>
<th>Type, Year, Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>company context, key success factors</td>
<td>&quot;What are the most important situational factors influencing the selection of the method fragments for software product management processes? “</td>
<td>case study, one company with many projects</td>
<td>conf, 2006, [13]</td>
</tr>
<tr>
<td>company context, key success factors</td>
<td>&quot;What skills do client organizations seek in their employees regarding the utilization of IT? “ &quot;What skills do IT software and service providers seek in their employees regarding their IT service offerings? “</td>
<td>survey, 104 responses</td>
<td>journal, 2008, [14]</td>
</tr>
<tr>
<td>Topic</td>
<td>Question</td>
<td>Methodology</td>
<td>Source</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>project management, agile project management practices, software</td>
<td>&quot;Are there any differences in desired skills between client organizations and IT providers?&quot;</td>
<td>case study in the medium-sized Norwegian software company</td>
<td>journal</td>
</tr>
<tr>
<td>product line engineering</td>
<td>&quot;How can potential benefits and challenges of software product line engineering be managed in practice?&quot;</td>
<td>field interviews and document study</td>
<td>conf, 2009, [16]</td>
</tr>
<tr>
<td>defect management</td>
<td>&quot;In which way can software product management be performed in a SCRUM development context?&quot;</td>
<td>case studies, small Dutch ISV and international ISV</td>
<td>conf, 2009, [17]</td>
</tr>
<tr>
<td>company context, quality goals</td>
<td>&quot;Does the method [lightweight elicitation of quality goals] work in practice and if not, how should it be improved?&quot;</td>
<td>case studies, 4 cases</td>
<td>conf, 2009, [18]</td>
</tr>
<tr>
<td>company context, key success factors</td>
<td>-</td>
<td>surveys, 178 projects</td>
<td>journal, 2007, [2]</td>
</tr>
<tr>
<td>reference framework</td>
<td>-</td>
<td>field interviews and discussions with experienced product managers</td>
<td>conf, 2006, [19]</td>
</tr>
<tr>
<td>reference framework</td>
<td>-</td>
<td>field interviews, literature reviews</td>
<td>conf, 2006, [3]</td>
</tr>
<tr>
<td>company context, decision making</td>
<td>-</td>
<td>field interviews, document study</td>
<td>journal, 2010, [20]</td>
</tr>
<tr>
<td>software configuration management</td>
<td>-</td>
<td>case studies in the three small-sized Finnish companies</td>
<td>conf, 1997, [21]</td>
</tr>
<tr>
<td>software configuration management</td>
<td>-</td>
<td>case studies in the three small-sized Finnish companies</td>
<td>conf, 1997, [22]</td>
</tr>
<tr>
<td>software configuration management</td>
<td>-</td>
<td>case studies in the three Finnish companies</td>
<td>conf, 1998, [23]</td>
</tr>
<tr>
<td>release planning, project management, agile project management</td>
<td>-</td>
<td>case study, telecom project</td>
<td>conf, 2006, [24]</td>
</tr>
<tr>
<td>management practices</td>
<td>-</td>
<td>case study, telecom project</td>
<td>conf, 2007, [25]</td>
</tr>
<tr>
<td>finance</td>
<td>-</td>
<td>case study, a project in the experimental physics</td>
<td>conf, 2008, [26]</td>
</tr>
<tr>
<td>company context, decision making</td>
<td>-</td>
<td>case study in a large company</td>
<td>conf, 2009, [27]</td>
</tr>
<tr>
<td>company context, decision making</td>
<td>-</td>
<td>case study</td>
<td>conf, 2010, [28]</td>
</tr>
<tr>
<td>software product line engineering</td>
<td>-</td>
<td>case studies, two companies</td>
<td>conf, 2010, [29]</td>
</tr>
<tr>
<td>company context, quality goals</td>
<td>-</td>
<td>case studies, two companies</td>
<td>conf, 2010, [30]</td>
</tr>
<tr>
<td>improvements in software product management</td>
<td>-</td>
<td>case studies, seven companies</td>
<td>conf, 2010, [31]</td>
</tr>
<tr>
<td>improvements in software product management</td>
<td>-</td>
<td>case studies</td>
<td>conf, 2010, [32]</td>
</tr>
<tr>
<td>finance</td>
<td>-</td>
<td>own experience in the company</td>
<td>conf, 2009, [33]</td>
</tr>
<tr>
<td>project management, distributed environment</td>
<td>-</td>
<td>-</td>
<td>conf, 2008, [34]</td>
</tr>
<tr>
<td>project management, distributed environment</td>
<td>-</td>
<td>-</td>
<td>conf, 2008, [35]</td>
</tr>
<tr>
<td>project management, distributed environment, value chain approach</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
B. Units of analysis

The analysis of the papers revealed 16 units of analysis. Two of them served as contextual units of analysis for other units of analysis:

1) release planning [24]
2) company context
   a) key success factors [13],[14]
   b) decision making [27],[28],[36]
   c) quality goals [18],[30]
3) software configuration management (SCM) [21]-[23]
4) finance [26],[33]
5) defect management [37]
6) reference framework [3],[19]
7) project management
   a) value chain approach [35]
   b) distributed environment [34],[35]
   c) holistic approach [25]
   d) agile project management practices [15],[16],[24]
8) software product line engineering (SPL) [15],[29]
9) improvements in software product management [31],[32]

When the units of analysis were identified and systematized, we compared how it fits with the Software Product Management Framework suggested by Kittlaus and Clough [4]. The framework presents the major functions involved in product management with tasks to participate in or to orchestrate [4]. The tasks are divided into two levels: corporate level and product (family) levels which are differentiated by the level of authority and strategic impact to the company business. In total, there are nine functions in which product manager participates: Market Analysis, Product Analysis, Product Strategy, Product Planning, Development, Marketing, Sales and Distribution, Support and Services. The first two functions (Market Analysis and Product Analysis) are the sources of the raw qualitative and quantitative data for a product manager who makes decisions regarding the product based on this basis. Product Strategy and Product Planning are the core functions of product management which include business-oriented tasks. Other four functions (Development, Marketing, Sales and Distribution, Support and Services) do not directly related to a product manager and thus he/she needs to collaborate with the respective departments about decisions concerning these functions.

The identified articles during the systematic mapping study can be divided into two groups. The first group includes articles about software product management as a separate discipline. These articles consider possible approaches to software product management and its improvements as well as development of frameworks and tools for understanding the processes and functions of product management. In our taxonomy these studies are presented as reference framework, improvements in SPM, and software product line engineering. Company context could be included into this group too, because these studies focus on the context of the company affects the product management processes inside the company. The second group includes studies about the departments orchestrated by a product manager (Development, Marketing, Sales and Distribution, Support and Services). These studies consider a special function of product management and discuss issues in software product management within this separate function.

Figure 1 shows the relationships between the major functions involved in product management and the units of analysis identified in systematic mapping studies. Only two units of analysis (Finance and Release planning) are related to the core product management functions [4]. Three other units of analysis are related to the Development function which is orchestrated by a product manager. In this regard, a product manager can only collaborate with this function but not manage it. The same way of collaboration is related to Marketing, Sales and Distribution, Support and Sales, but we did not find studies in these areas. The top four units of analysis in the figure are related to research in software product management as a discipline and these studies include general aspects of product management in software industry which are not specific for the presented functions.

Comparing this framework with two others developed by Ebert [2] and van de Weerd et al. [19], we observe similarities as well as differences. Ebert considers product management processes and competencies in connection with life-cycle phases. He identified 18 processes and 10 competencies related to product management based on the experience of product managers from different industries worldwide [1]. The reference framework for software product management, on the other hand, includes four process areas with sub functions related to internal and external stakeholders [19]. These process areas are portfolio management, product roadmapping, requirements management, and release planning. Although several product management components such as strategy, portfolio management, and roadmapping are considered in these three frameworks as core components of software product management, the boundaries and relationships between other components appear fuzzy and they are handled differently by these frameworks.

VI. DISCUSSION

This section addresses research questions defined in the beginning and discusses areas where further research is needed. We also consider trends in the studies of software product management as well as limitations and threats of validity of our study.

A. RQ1: What research questions in software product management are being addressed?

The main problem identified during our mapping study was that only few articles were available on software product management. Even though a quick search on software product management in Google Scholar found about two million articles, customization of the search options for gathering more reliable result drops the number of articles to 62. The search in the scientific digital databases started with 235 articles but quickly narrowed down to 52. After the manual search, we identified only 25 articles, but even some
of these articles referred to software product management issues only indirectly. We included these articles for two reasons. First, we considered every piece of information important in an unexplored area. Second, the definition of SPM seems to be still under discussion and it is not clear which functions should be done and which orchestrated by a product manager. 19 of the 25 articles did not have a clearly presented research question and four of them presented hypotheses without any empirical confirmation. We can conclude that SPM knowledge is fragmented and even the definition of SPM is not yet well established. The research area is immature and more research is required, especially in the areas such as product strategy, product planning, and product analysis.

In the rest of this section we will summarize articles with clearly defined research questions separately. For each paper we reviewed the unit of analysis, the ways in which the results were empirically confirmed, and the main conclusions. In the last sentence of each summary we discuss the role of the paper for SPM.

Goles et al. [14] has three research questions focusing on the different employee skills in product and service companies. The units of analysis in this paper are company context and key success factors. The authors used a survey to study which skills are most important and will be important in the nearest future. The paper shows how the processes vary between different types of companies depending on the people skills. At the end of the paper, authors made a conclusion that the technical skills for the IT professionals play an important role as the understanding of the business goals of the company for creating successful products or services. The importance of people management for a company raises the question whether it should be included in product manager responsibilities.

Two articles [16],[18] discuss agile or lightweight approach to quality goals and SPM process. The units of analysis in these two articles are project management and company context which play central roles in agile methods [16]. The authors used field interviews and case studies as research methods. Vanhanen et al. [18] claim that elicitation of quality goals helps in improving the software product management process and that a well thought strategy defined before the development stage helps to avoid critical issues later on. Vlaanderen et al. [16] focus on the integration of software product management and agile practices and present a model of agile software product management which is based on SCRUM principles. The applicability of agile principles for the SPM should be studied in more detail because agile SPM covers only development activities but other activities such as marketing, customers support, and strategy formation are left out of the scope in the current version of the agile SPM.

Hanssen and Faegri [15] made an attempt to combine agile practices with software product line engineering (SPLE) and investigated the potential benefits of this approach. SPLE is an “approach to software engineering in
which a set of products is built on a common set of core assets” [38],[39]. The authors studied a mix of different practices such as agile project management, SPLE, and activities of product management in the one company as a case study. SPLE approach is claimed several benefits: “large-scale productivity gains, decreased time-to-market, increased product quality, increased customer satisfaction, more efficient use of human resources, and improved ability to apply mass customization, maintain market presence and sustain unprecedented growth” [15]. In this regard, SPLE and SPM are similar in the way of managing software as products.

Bekkers et al. [32] studied the most important situational factors of SPM. The unit of analysis was the company context in one company but many projects were taken into account in the conducted case study. According to this study, it is impossible to study software product management without taking into account the situational company context, which affects all SPM processes.

The last article with a clearly presented research question makes an inquiry into the integration of SPM with software defect management in a distributed environment [37]. The unit of analysis in this study was defect management and it was conducted in independent software vendors (ISVs) as a set of case studies. The goal of the study was to create a conceptual model helping to support “product managers in their SPM and defect management practice” [37]. The authors conclude that it is still an open question whether defects should be managed in the product or project level, and the model requires future investigation.

Overall, the reviewed studies vary a lot and they approach SPM from the perspective of business problems focusing essentially on the organization of production and strategic development of the company.

B. RQ2: What original research exists in the intersection of software product management and cloud (service) environment?

The number of empirical studies in software product management is very limited. Many articles, such as [2],[19], emphasize that SPM plays a crucial role in implementing successful products. One of the recent changes in the software industry is that many companies are shifting their business from products to services [40]. Even though the difference of environments [33],[37] may lead to dramatic changes in management processes, only few studies have been carried out in this area so far (cf. [5]). In our survey we faced two difficulties: lack of research in SPM in general and lack of research in SPM in the cloud. There are only individual and unrelated studies in these areas, often without any empirical confirmation.

C. RQ3: What areas in software product management require more research?

The functions presented in the Software Product Management Framework [4] can be divided into three groups: functions that provide market and product analytical information, core functions of product management followed by the business oriented goals of the company and functions orchestrated by product management. The existing studies consider general aspects of product management (4 of 9 units of analysis), relationships between product management and development (3 of 9 studies), finance (sometimes referred to as pricing) and release planning. At the same time, pricing is considered as a separate discipline which works in close collaboration with product management. Taking this into account, only one of nine units of analysis is related to the core functions of product management. Other studies focus on relationships between product management and development and sometimes the studies go deeply into the details of development forgetting that it is a separate discipline orchestrated but not managed by product management.

Many studies (4 of 9 units of analysis and 13 of 25 papers) concentrate on understanding software product management by developing frameworks and assessment tools for improving product management practices. The existence of these studies show that the area is immature, which produces many discussions on the content, context, and place of software product management in software development.

Software product management in the cloud environment is a broader area where the lack of research is evident. The development of an SPM theory applicable to both cloud and product companies seems challenging because SPM is tightly coupled with business processes and models of each company. Still the intersection of these two areas offers great opportunities for research because there is evidence that the number of services will grow [40] and we have to know how to manage this kind of development with a new set of problems and conditions. Thus studying the differences and similarities of traditional and cloud SPM is an unexplored area for future research.

D. Trends in Software Product Management

We conducted the actual search procedure twice, first in November 2010 and then half a year later in May 2011. During this time thirteen new papers had been published. Four of these papers were removed from the further considerations for the following reasons: the paper was written in German language, the paper included software product management in its keywords but then it was missing from the full-text, the paper presented a service for managing products (an experience report from Microsoft), and the paper was an introduction to the Fourth International Workshop on Software Product Management. The nine articles on software product management were published at the proceeding of one conference, IWSPM. Five of the articles were full research papers, one was an industry paper, and three were short papers. For our purpose we chose only full research articles that added five more articles to the systematic literature review half a year earlier.

From 1998 to 2006 only few new papers were published on software product management. In the late nineties product management was studied in relation with software configuration management [23]. Since these were the earliest publications we found, we can consider this as a basis of software product management. In 2006 a new wave of
interest to software product management started and after that the concept has been studied from many viewpoints, such as agility, success factors, and company context.

The latest trend in software product management research appears to be an observation that the maturity of product management in the organizations is low and it requires more research. The papers concentrate on the problems of improving software product management in an organization by providing special tools and frameworks such as the SPM maturity matrix [31],[32]. It helps in assessing the current situation and gives guidelines for necessary activities for achieving the next level of maturity in product management.

E. Limitations and Threats to Validity

Our study has several limitations:
- We used only six digital libraries in our research;
- The used libraries cover only scientific articles;
- We did not include books about product management.

By increasing the number of digital libraries we could get more studies to review, but as we already found out with the ABI/Inform and ACM libraries, most of the studies would be duplicates. Thus, it seems that it would not improve the set of articles significantly [7],[10],[11].

The chosen databases include scientific articles and, at the same time, have limited coverage of industrial experience reports from practitioners like product managers. Even though industry reports are very helpful in defining the starting points of a study, they were excluded from the present study in favor of scientific articles to assure replicability of the studies.

We did not include books about product management in the survey. In software engineering primary studies are typically published in scientific journals and conferences rather than in books.

The study has several threats to validity. The first threat is search conditions. The problem is that digital databases do not have the same options for searching. Therefore, we adapted the queries for each digital database to conduct the search as similarly as possible. In addition, search engines in the digital databases work differently and we cannot be sure that all articles were found. We mitigated this risk by using several digital libraries hoping that the papers will be found at least by one search engine. The next problem connected with the previous is the publication bias. There is a chance that we missed relevant articles because our search queries are based on the general words such as services and cloud. We mitigated this risk by reviewing the conferences proceedings before the pilot search in the digital databases. The last threat is related to data extraction process. It could be done in many ways, so we described how we did it as detailed as possible. Anyway, it is impossible to fully mitigate this threat because the procedure of data extraction and classification is conducted by researchers who influence the results.

VII. Conclusion

To start research in an area that does not even have clear definitions is challenging. In the beginning of our review we expected to find unexplored topics which are related to the software product management practices in the cloud environment but we soon found out that even the traditional software product management has not yet been studied extensively and many fundamental questions are still open. Lack of standards and common definitions can confuse a newcomer. Ebert [2] states that a body of knowledge similar to Project Management Body of Knowledge (PMBoK) [41] is required for product management as well as formal education certifications such as Project Management Professional (PMP). However, in addition to such long-term goals it is important to have short term goals like defining what software product management is and what is included in the set of its key functions. Software product management in the cloud and the differences between traditional and cloud software product management form a special issue that may, after a closer study, improve our understanding of the nature of SPM.

The reviewed studies showed that a definition of SPM is unclear and sometimes authors mean very different things when they talk about SPM. This conclusion is supported by van de Weerd et al. [3] who state that the existing frameworks are immature and require additional research. Most of the hypotheses found in this systematic literature review require empirical confirmation. Based on that we can say that software product management has not been studied fully and this area offers many opportunities for research.

The importance of conducting studies in software product management cannot be overestimated because SPM offers tools and practices for achieving business goals as well as increasing the predictability and profitability of developing software products and services.

REFERENCES
