Continuous Software Portfolio Performance Management

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Abstract. Product portfolio decision making is the process of coming to decisions regarding resource division along multiple software products. This process is part of portfolio management, and is an essential task in managing a software company. However, product portfolio decision making is an implicit process, and product managers are too occupied with tactical and operational decision making to execute strategic decisions regarding portfolio management. Academic research has not yet provided a model to adapt intuitive and opportunistic portfolio decision making to an explicit and data-driven cycle. The goal of this research is to make portfolio decision making explicit by modeling this process in the Dutch software industry. Case studies at 6 small to medium-size software companies in the Netherlands evaluate the initial Software Portfolio Decision Making (SPDM) model. We present the SPDM model after adaptation to the findings in the case studies. Using this model enables software companies to move from an intuitive decision making process towards data-driven explicit decision making.

Keywords: Software Product Management, Portfolio Management, Strategic Decision Making

1 Introduction

Software product management is the discipline and role that governs a product from its inception to market/customer delivery to generate biggest possible value to the business, stated by Ebert [1]. The product manager operates at varying levels, ranging from the smallest abstraction level, requirements management, to the largest abstraction level, portfolio management [2]. Software portfolio management, the perspective of dividing resources among several software products, is vital to business operations. Academia has already investigated management of a single product, such as Lehtola [3], Weiss [4] and Bosch [5]. However, need arises for theory about portfolio decision making across software products.

Portfolio management is part of strategic decision making and is beyond the day-to-day business operations. Jansen et al. recognize that companies lack abilities in portfolio decision making, regarding sunsetting software products [6]. We find that in practice, portfolio management is overlooked by product

managers as they are occupied with operational and tactical decision making. The act of focusing on operational and tactical decisions without clearly defining strategic goals can lead to missed opportunities, and the downfall of a software firm. This emphasizes the business need of portfolio management and explicit portfolio decision making.

Portfolio management is one of the business functions of the SPM competence model created by Bekkers et al [7]. For the business function of portfolio management, this paper investigates decision making. Decision making is defined for this research as "the entire cycle of findings inputs for decision making, making the decision and executing the outputs of this decision." Software portfolio decision making in the context of this paper does not focus on what the optimal software portfolio is, as this question is too large to answer. Instead, we focus on making optimal portfolio management decisions, given the circumstances of the firm. The business need and absence of academic guidance in portfolio decision making lead to the following research question:

How can decision making regarding the software portfolio be conducted?

Answering this question provides initial steps in the guidance of software firms in selecting software products and maintaining a competitive software product portfolio. Employing a cyclic process for software product portfolio decision making creates the opportunity to make data-driven decisions. Olsson [8] finds that data-driven decisions that use post-deployment data as input lead to more effective product development. Incorporating the use of data from products in the field is a practice that companies need to be establish as central to their work, stated by Bosch [9].

This paper starts with the current research on portfolio management in section 2. Section 3 describes the research method of theoretical model creation and case study evaluation. By applying the process model of benefits management described by Ward [16] to software product management, this research creates a cyclic model of portfolio decision making in section 4. The Software Portfolio Decision Making (SPDM) model is then tested and evaluated by case studies in the Dutch software industry. The case studies are conducted to investigate the used software portfolio decision making method, the formalization of the process, and the models used. Section 5 and 6 reveal the case study results and lessons learned. In the discussion, we present the SPDM model and we end with the conclusion about the SPDM model and software portfolio management in practice.

2 Portfolio Management in Theory

Software portfolio management is an under-investigated topic when compared to product portfolio management in general. This section discusses portfolio management for non-software products and the applicability of this theory to the software industry. McNally [10] has investigated decision making in product portfolio management. His research finds that balancing new radical products

and proven concepts is crucial in successful firm performance. Furthermore, firms hinder innovation when they solely focus on aligning products with their strategic plan. Lastly, McNalley concludes that personality traits of managers are relevant in managing the product portfolio.

Cooper [11] analyzes 200 firms to discover how production firms manage their portfolio. Firms are clustered into four groups according to management's view of portfolio management. Benchmark businesses, firms that employ a formal, explicit method for managing their portfolio are most effective at portfolio management. These businesses rely on clear, well-defined portfolio procedures, consistently apply their portfolio method to every project, and management is involved in the approach.

Both McNally [10] and Cooper [11] reveal how firms use portfolio management to meet their business goals. However, both articles discuss portfolio management in production firms, and software production is different than producing non-software products. As Cusumano [12], states, producing software is different than other products. Software products have high development costs, but the cost of manufacturing and distributing extra copies is low. Furthermore, van de Weerd [2] explains that software products change or update easily by using patches or release updates. Therefore, the existing theories of portfolio management are not applicable to software portfolios, and software firms may take different approach than non-software firms.

3 Research Method

The first step in investigating software product portfolio management is the creation of an initial framework by applying the Process Model of Benefits Management described by Ward [16] to portfolio decision making. This research evaluates the software portfolio decision making (SPDM) model by using a case study theory testing approach. The case study contribution is two-fold. The case studies allow this research to investigate software portfolio management in practice. Afterwards, we adapt the SPDM model to the case study findings and present the final model. This leads to a theory based and empirically tested model of software portfolio decision making.

This paper takes a case study approach to investigate portfolio decision making. This approach provides in-depth explanations, as stated by Yin[13]. The case studies consist of an initial interview that investigates software portfolio management. The interview approach is semi-structured, to allow for follow-up questions. We abstained from a grounded theory approach because software portfolio management is implicitly embedded in the company's processes. Software portfolio decision making is not formalized or written down in protocols. Instead, managers make portfolio decisions according to their insights. Conducting case studies without a previously defined model may miss essential aspects of portfolio decision making because of a lacking interview structure. After the initial interview, we invited the interviewees for a follow-up meeting. The goal of

the follow-up meeting was to present the initial results and cross-validate these findings.

As this research has an exploratory aim, the case studies are not used to fully understand portfolio decision making of a certain group of companies. Instead, we focus on globally understanding portfolio decision making throughout the software industry at every level of maturity and size. Therefore, the case studies focus on six Dutch software companies of varying size and expertise. For exploring software portfolio management, six case studies is deemed sufficient.

Out of the 250 firms that are closely related to the department, we have selected ten medium-sized product software firms with multiple products with an email request. Out of these ten, six agreed to participate in this research. One of the case studies subjects is a venture capitalist specialized in investing in software companies. The interviewees are involved in decision making for the software portfolio, to ensure the relevance of the results. Table 1 shows the overview of the interviewees and interviewed companies. The interviewees are coded with an interview number.

To structure the interviews, an interview protocol is created based on the activities that are described in the initial model[1]. Every process is broken down into multiple questions. In this way, the interview protocol covers every process of the SPDM model. the interviews are conducted by two interviewers similar to Bechhofer [14]. Having two researchers conducting the interview enhances the validity of the results [14]. Furthermore, the researchers have a varying background. The follow-up questions were asked from multiple backgrounds, which provides more information.

The transcribed interviews are taken together per question in result tables, which is based on the EA technique tables of van Steenbergen [15]. The result tables are structured per question, and in the columns, the interviewees' answers are given[2]. Additional results which are not captured in the questions and the result table are noted elsewhere and are discussed in the lessons learned section, or provided as a quote at a relevant question or process in the results.

Table 1. Case studies' context

Company nickname, Interviewee number	**AgriComp, i1**	**VentComp, i2**	**ERPComp, i3**	**CEComp, i4**	**RetailComp, i5**	**DataComp, i6**
Market of operation	Agricultural software	B2B Software focused Venture capitalist	ERP software	Customer experience	Several different markets	Data analytics
Gross yearly revenue (Million Euros)	2	0	122	9	460	5
Position of interviewee	Commercial Director	Partner	CTO	CMO	Strategic Product Manager	Business Manager
Time in IT sector (Years)	33	7	19	22	11	5
Time at current profession (Years)	18	1	6.5	1	3	5

[1] The interview protocol is available at: http://bit.ly/2FTBSd5

[2] The transcriptions and result tables are available upon request.

4 Initial Model Creation

Ward [16] defines Benefits Management as the identification, definition, planning, tracking and realization of business benefits. A benefit is an advantage on behalf of an individual or group of individuals [17]. The Process Model of Benefits Management assists in organizing and managing potential benefits arising from the use of IT [16]. Using this model creates a rationale for strategic applications, by clarifying the trade-off between benefits [17].

We propose the initial Software Portfolio Decision Making (SPDM) model by applying the Process Model of Benefits Management to software product portfolio decision making. The application of the Process Model of Benefits Management to create strategic decisions based on the trade-off between benefits make this model relevant to portfolio decision making. Portfolio decision making also concerns strategic decision making where multiple stakeholders and products are considered.

The SPDM model describes decision making practices for the portfolio of an organization. This model focuses on using product data for supported decision making. We assume that the quality of portfolio decision making increases by data-driven decisions. This is based on the hypothesis that rational, data-driven decisions, where the product manager excogitates the effects, lead to better outcomes than intuitive decision making.

We describe the phases of the SPDM model below. The model has changed context from benefits management to portfolio decision making, which requires adaptation of several phases. The phases of the SPDM model are:

- In aiding and supporting a company's next decision, the product manager should access the historical performance of products and decisions, similar to the *Review and Evaluate Results Stage* of the Process Model of Benefits Management. In the **Data Gathering** process, the product manager retrieves information about the products from the data sources. The product manager brings the information together to create an overview of the products.
- The **Data Reduction** process is the act of reviewing what is important for the next cycle of portfolio management. This is based on the *Potential for further Benefits Stage* of the Process Model of Benefits Management. The product manager selects key indicators based on the strategy and vision, to guide the portfolio to the company's long-term goals. Key indicators are product properties, used to based the next decision upon, such as forecasted revenue or market opportunities. The strategy and vision of the company are used as it is the path that the company presumes to be most successful.
- **Modelling** is the process where models are created from key indicators. Models can be any visualization that attempts to clarify the comparison between products, such as graphs, presentations, SWOT's or matrices. To compare products or features, The firm should use a model that compares on multiple key indicators. Modelling can be performed with or without tool support, and with varying tools such as an excel data comparison, or more

extensive models such as the BCG Matrix[18], Gartner's Wave[19] or Porter's five forces model[20].
- In the **Pattern Recognition** process the product manager interprets the models, and compares the product's characteristics. He focuses on recognizing a pattern in the models. A pattern is a phenomenon that affects business results. Examples of patterns are: this product's sales are lower than expected this month, or the recurring revenue stream is rising.
- In the **Insight**, the product manager finds the cause for the recognized pattern. The Insights process generates concrete advice for decision making. In this way, finding the cause of a certain pattern allows a firm to steer away or towards this pattern with decisions. For example, when a product manager recognizes a decline in sales of a product caused by a cut in marketing budget, the root of the revenue loss is found and he can take steps to increase the revenue.
- The most important phase in the SPDM model is the **Decision Making**. In the decision making process, the company decides which investments in the portfolio are made in the next period. This is in the form of a long-term roadmap, or short-term accepted projects. Decision making is a process done by the management board to steer the portfolio in the next period. The product manager has already decided the direction in the Insights process.
- The final process in the SPDM model is the **execution**. The management applies the decisions to the operations of the company. For example, the firm carries out additional investments in a development team or the merge of two software products. This process provides new data for the Data Gathering phase, allowing for a new decision making cycle. The execution is an extensive step which requires a vastly different approach, depending on the decision made. Therefore, this step is out of scope for this research.

The SPDM model structures the activities performed by forms to make portfolio management decisions. The next section describes how the phases of the SPDM model are carried out in practice. We adapt and evaluate the SPDM model in the discussion section, based on the case study findings.

5 Results

In this section, we link the results of the case studies to the goal of this research. The interviews have taken place in October-December, 2017 and each interview lasted approximately 90 minutes. The "reunion" meeting took place in January 2018.

Decision Making - In the decision making process, decisions reshape and focus the product portfolio. One of the leading questions in this process is what an optimal portfolio looks like. The interviewees reveal three visions:

- The **ad hoc view**, in which every product is adapted to its own market. Focusing the entire product portfolio is impossible as "*you should focus every product in its own way*", stated by i1 and i6.

– The **complementary view**, where the optimal portfolio consists of complementary products. Customers should understand the distinction between products. When products do not overlap, there is no redundant development and no competition between products. Every product has its own salescycle and marketing team. i2 and i4: *"customer understanding of your product portfolio is a bellwether of the optimization of your product portfolio."*
– The **product line view**, where the complete portfolio is considered as one product consisting of components that are independently managed. This product line is adaptable to varying markets. In this way, development will never have to do develop an overlapping feature twice. i3 and i5 have this vision. ERPComp uses their optimal product portfolio vision in their own product, as ERPComp has a single product line used in every market where the company participates.

The yearly planning cycle is a part of the decision making process. In the yearly planning cycle, the company determines the choices and opportunities across its products. This is done product portfolio-wide, and not per product. The planning meeting frequency differs in the case studies, and is performed yearly, half-yearly, or whenever a major decision has to be made. For the interviewed companies, several stakeholders have a voice in the decision making process. In every case study, the CEO and CTO play an important role in decision making. The companies that have the function of the product manager and product owner also involve these actors in decision making. The role of sales and marketing was unclear in decision making. Some companies involve representatives of sales and marketing in the yearly planning cycle and some companies don't. i3 explicitly states: "*Sales must not be involved in the planning, as the company can not be sales oriented.*"

The management boards make decisions in multiple ways. In the case studies, two different strategies have been found. Data-driven decision making goes through the steps of gathering data about the products, formalizing models about the products' performance, interpreting the models and creating a strategy based on these models. The other strategy is entrepreneurial intuition-driven decision making, where the management makes decisions based on entrepreneurial intuition, gut feeling or instinctive feeling. The interviewed companies employ both strategies simultaneously.

Data Gathering - In the Data Gathering process, the product manager gathers product information for measuring performance. Companies measure performance of products differently. i1: *"We measure product performance by revenue, recurring revenue and percentage recurring revenue of total revenue.*" ERPComp also focuses on customer usage of the products. RetailComp measures the strategic relevancy of products to both the company and the clients.

Companies use varying sources to retrieve data from. Table 2 lists data sources used for retrieving product data. Internal data sources are within the sphere of influence of the company. There are three kinds of internal data sources. First, operational sources are sources that are company wide and required to keep the firm operational, such as the accounting system. A firm has project sources

that are created for a specific product or project, such as the Business case or the market analysis. Finally, the human internal data source is the input of employees of the firm. The external data sources column consists of data sources that are out sphere of influence of the company.

Table 2. Data Gathering sources

Internal data sources		**External data sources**
Operational sources	ERP-system	Competitors
	Accounting system	Customers
	Budget	External market research
Project sources	Project management system	Research from financial institutions
	Market analysis	Market Standards
	Product database	
	Business case	
Human sources	Entrepreneurial intuition	
	Employee's opinion	

Data Reduction - The product manager defines concrete properties and indicators before he decides what is most important for the next update. Product performance should be in line with the company's strategy and vision. Therefore, the product manager uses the strategy and vision as a primary source of guidance for products. In practice, decisions are rarely fully aligned with the strategy and vision of the company. Therefore, the data reduction is not based solely on the strategy and vision.

Key indicators are product properties, used to base the next decision upon. The product manager collects these indicators from the data sources. Every company uses different indicators. Table 3 lists the key indicators found in the case studies. The indicators are split in internal and external indicators. The internal indicator list consists of economic, technical, human and market indicators, depending on the nature of the indicator. Economic indicators are related to the cash flows of the product. Technical indicators are related to the development of the product. Human indicators are indicators that have the employees as a source. Market indicators reflect on the own share of the market.

Companies base a distribution key on entrepreneurial intuition and past performance. Firms measure customer satisfaction in multiple ways, depending on the branch, company size, budget and time constraints. Customer satisfaction is measured by questionnaires, workshops with key customers and other feedback methods.

In selecting key indicators for data reduction, the relevance of the company's strategy and vision is questioned. i4: "*the key indicators are only aligned with the CEO's vision and strategy, as the CEO is the final authority in the decision making process.*" The vision of i5 is that product portfolio management starts with formulating a strategy and vision. "*Alignment with the firm's strategy and vision is then essential in managing your product portfolio.*"

Companies perform the data reduction in two ways. Managers that apply data-driven decision making select key indicators to make decisions. Data re-

duction for entrepreneurial intuition-driven decision making does not formally select key indicators to reduce the data.

Table 3. Key indicators found in case studies

Internal indicators		**External indicators**
Economic indicators	Profit	Market size
	Profit forecast	Market growth
	Revenue	Number of competitors
	Forecasted revenue	Products specifications when compared to competing products
	Budgeted revenue	Market saturation
	Revenue Growth	Customer satisfaction
	Revenue split	
	Costs	
Technical indicators	Number of issue tickets	
	Response time on tickets	
	Number of lines of code	
	Number of developed scrum features	
Human indicators	Number of FTE's	
	Number of absence days through illness	
	CEO's affection for certain product lines	
Market indicators	Market opportunities	
	Number of features used per branch	
	Number of customers	
	Number of end users	
	Position of the customer	
	Profit for the customer	

Modelling - Companies employ several different modelling techniques. Both industry-wide and in-house developed models find their application in understanding product performance. Often, firms use multiple models. AgriComp, VentComp and CEComp apply an in-house created model. The advantages of in-house models are that it is adapted to the situation at the company, and that the interviewee is more familiar with the model than an industry-wide model. The industry-wide models are divided into two categories. The first category is structured models, where the product manager creates a comparison between products with a limited number of key indicators. Examples of structured models are the BCG Matrix or a SWOT analysis. Unstructured models have limitless input of key indicators, but require more input from the product manager. Examples of these models are the Five Forces Model or the Gartner Wave and Hypecycle.

Pattern Recognition and Insights - After creating models of the products' performance, the manager finds the pattern and insight in this model. i1 uses entrepreneurial intuition in the Pattern Recognition and Insights processes. This CFO interprets the in-house created model, to recognize patterns of interest. He compares this to his own experiences to create insight to share to the rest of the board. For example, from previous experience, the CFO knows that the revenue per co-worker should be between 100.000 and 120.000, and the declarability of consultants should be 70-75%. Deviation from these numbers is a cause for making decisions to change business performance. ERPComp applies Pattern Recognition and Insights by using a tool that reviews product portfolio

performance. The tool compares the products' performance against business as usual or a predefined forecast and brings focus on key indicators that are not performing as expected. Other firms apply the Pattern Recognition and Insights processes in an intuitive and more implicit practice.

6 Lessons learned

In this section, we compare the results to previous knowledge to reflect on the impact of the findings. Several findings were unexpected, or contradictory findings that require further attention. These findings influence the decisions that a software company makes about their portfolio, and are not directly related to a process of the SPDM model.

A Mixture of Data-Driven and Entrepreneurial Intuition - The companies in the case studies employ data-driven mixed with entrepreneurial intuition. Data-driven decision making creates data-supported decisions based on product performance. This approach leads to clear rational decisions. However, modeling imperfections result in suboptimal decisions. Furthermore, models have a limited number of inputs.

La Pira [21] defines entrepreneurial intuition as creating opportunities and exploiting these opportunities without regard to resources currently controlled. an entrepreneurial intuition-driven decision making strategy leaves room for out-of-the-box opportunities that are not found in models, and this strategy improves decision making speed. However, a product manager that does not use model support can misestimate product performance. Furthermore, a biased opinion or a specific product affection leads to suboptimal results. For example, when the founder and CEO makes portfolio decisions, the results tend to align with the products that he founded the company with. The CEO gives other products with potential a lower priority, as he has a bias towards his own products and favors them over other products.

Furthermore, i4: *"You use models in an attempt to convince the CEO that his founded products do not fit the market anymore. The CEO loves his products so much, that he will only use the pattern when it aligns with his own vision"*, which indicates the bias of stakeholders in the decision making process. Even when models are used, their effectiveness is not without question.

Tools support parts of Portfolio Decision Making - AgriComp and ERPComp are applying integrated tools in product portfolio management. These tools assist in or automate parts of the Data Gathering, Data Reduction, Modelling, Pattern Recognition and Insights. For example, ERPComp utilizes a tool that retrieves data from the data sources. After entering the key indicators, the tool visualizes the data in models and assists in the Pattern Recognition and Insights.

Opportunism in Smaller Software Companies - Smaller software companies may take an opportunistic approach, as their existing customer base provides insufficient funds for a steady income stream. The company falls back on an opportunistic approach, where the manager accepts projects for their short-

term profitability over the contribution to long-term goals. i6: *"We do realize that aligning your development to your roadmap is better for long-term performance, but we also have to keep the lights on."* Focusing on customer-driven products or features over aligning the products with the company's strategy and vision leads to a smaller focus on the strategy and vision. However, this may be crucial for the firm's short-term survival. Choosing for alignment of the portfolio with the company's strategy and vision, may result in a lower short-term revenue, because the firm develops projects without a paying customer. Still, focusing on aligning the portfolio with the company goals is vital to a firms long-term survival, to avoid a fragmented and opportunistic product portfolio. This indicates that organization maturity is a major determinant for portfolio decision making.

Partnering with Launching customers for major products enhancements - One way of overcoming the difficulty of having to choose between customer-driven requirements and strategy and vision-driven requirements is by using launching customers. In the interviews, the concept of a customer helping in creating an entrance in a new market became clear. A launching customer is an agreement between the company in focus and one of their customers. The customer has a specific wish which is also on the roadmap for the company. The presence of the wish of the customer enables possibilities and market entrances that were not present without this collaboration. This is in a market or niche where the developing company is not yet familiar in, and gives a new direction to the product portfolio. The trust of the other company allows the developing company to use opportunities that were not possible without the collaboration. This collaboration is beneficial for the developing company. On one side, the company is implementing a feature for a customer and is being paid for this customer-specific request. On the other side, the implementation of the request also satisfies the other customers, or opens up a new market. This satisfies other (potential) customers. In this way, three stakeholders, the company, the launching customer, and other customers are benefiters. Therefore, projects initiated by a launching customer increase both the alignment with customer-specific requests, and market wide requests. Figure 1 shows how partnering with launching customers leads to an increased alignment with both customer specific requests and market wide requests. At ERPComp, managers give Projects with a launching customer priority over other projects. i5: *"projects with a feature that is currently not on the planning are added when a customer is willing to invest to create this opportunity."*

7 Discussion

This section reflects on the results and lessons learned. We start this discussion with the adaptation of the SPDM model to the case study findings. Afterwards, the impact of the research method is discussed.

SPDM Model Adaptation - The case studies provide a partial confirmation of the SPDM model. figure 7 shows the final SPDM model. Companies apply the Decision making, Execution, Data Gathering and Data Reduction sim-

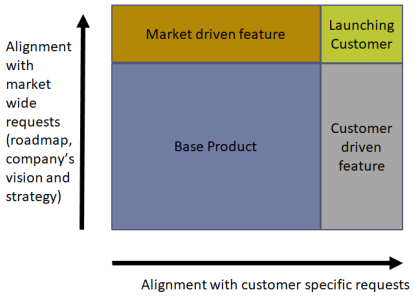

Fig. 1. Collaboration with a launching customer improves both alignment with customer-specific requests and alignment with market wide requests

ilar to the expectations based on theory. However, the processes are simpler and less distinct. Furthermore, the product portfolio decision making process is a bi-cyclic process. The case studies show a yearly cycle for long-term planning and companies simultaneously make decisions for short-term adaptations.

Recognizing a pattern and finding a cause for this pattern are intertwined processes in the case studies. None of the interviewees made a difference between the processes. For example, realizing that revenue is declining due to a reduction in one-off sales may start with the recognized pattern that revenue is declining, or with the insight that the one-off sale reduction causes a revenue decrease. The Insight and Pattern processes are intertwined and unsequenced. Therefore, we combine these steps in a process called Interpretation. In the Interpretation, the product manager interprets models to form advice for decision making.

Every firm balances between data-driven decision making and entrepreneurial intuition-driven decision making. In data-driven decision making, the manager performs the Modelling and Interpretation to create and interpret the data models. In entrepreneurial intuition-driven decision making, the Modelling and Interpretation are not performed, and the Data Reduction is a more informal process. We visualized this in the SPDM model by drawing an arrow from Data Reduction to Decision making, indicating that product portfolio management is possible without Modelling and Interpretation.

The SPDM model assumes a structured cyclic process, which may not be the case in practice. When making product portfolio decisions, a company may loop between SPDM processes. For instance, a manager that is selecting key indicators decides that he needs another data source. This suggests a loop between Data Gathering and Data Reduction. However, this was not confirmed in the case studies and requires further confirmation.

Applicability of the SPDM model - This research proposes the SPDM model, usable by software firms to formalize their portfolio management. The SPDM model is worked out to a greater or lesser extent. Data Gathering, Data Reduction, Modelling en Decision Making are processes that are covered in the

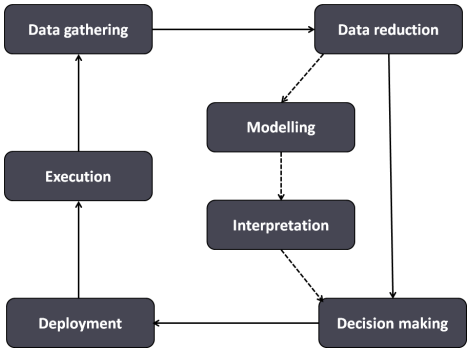

Fig. 2. the Software Portfolio Decision Making (SPDM) model

case studies. On the other hand, the Interpretation has remained implicit in the case studies. The Execution stands beyond the scope of this research but is described in literature already.

Reliability and validity considerations - The method of applying a predefined model based on researchers previous portfolio decision making experience has both advantages and drawbacks. This enables investigation in an implicit and vague process. The downside of using this method is the subjective nature of using a predefined method. Conducting interviews related to a predefined method may lead to confirmation of the method, regardless of the validity of the method. The internal validity is preserved by critically reviewing the SPDM model and reviewing model relevancy for the case studies.

The case studies provide a similar execution of portfolio management. Every case study subject has a limited degree of formality in portfolio decision making. This leads to the hypothesis that the entire Dutch software industry executes portfolio decision making in an implicit manner. If this is true, then the entire Dutch software industry may benefit in using the SPDM model to make portfolio decision making more explicit.

The reliability of the data collection method is guaranteed by limiting the variation in interviews. For every interview, the same interview protocol is used. Furthermore, every interviewee is a key actor in portfolio decision making.

Effectiveness of Data-Driven Decision Making - In this paper, one of the research goals was to investigate the degree of formalization of product portfolio management. Formalization is supporting decisions with data and models about the products. A hypothesis that flows from this research goal is that firms that collect and model data, make better decisions. However, testing this assumption is beyond the scope, because this research does not focus on portfolio management effectiveness.

i5 was not interested in formalizing decision making. Data focuses on short-term profit. i5: "*product management should focus on aligning the product portfolio with the vision and strategy, to ensure long-term performance.*"

8 Conclusion

By utilizing a case study approach, this research investigated product portfolio decision making in the Dutch software industry. This research makes this process explicit by answering the research question: How can decision making regarding the software portfolio be conducted?

The SPDM model created in this paper describes the continuous decision making cycle that enables software companies to make portfolio management decisions explicit. With the application of the process model of benefits management to SPM, this paper hopes to change portfolio decision making from an implicit and intuition-driven process towards an iterative and data-driven cycle. Implementing the SPDM model in the company's operations enables the product manager to escape the operational decision making and focus on strategic decision making for the product portfolio.

The SPDM model reveals the mixture of data-driven and entrepreneurial intuition decision making. When using the SPDM model for portfolio decision making, the role of the manager as a visionary is supplemented with models, leading to better supported decisions. Furthermore, this research hopes to stimulate software portfolio management as a research topic. Aspects of software portfolio management need further investigation and we state some below.

The scope of this research was too large to sufficiently cover the process of entrepreneurial intuition. Using managers' experience to influence future decisions is essential in decision making. The exact role of entrepreneurial intuition remains unclear. Further research could cover how entrepreneurial intuition can improve decision making.

Every company combines entrepreneurial intuition-driven decision making and data-driven decision making in portfolio management. combining the decision making methods leads to optimal business results. Academic research can focus on finding the balance between these methods, or creating a model to combine these approaches. This will extend the SPDM model and aid software companies in portfolio management.

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