A process model for developing integrated product-service offerings

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Abstract
Manufacturers are increasingly seeing the benefits of adopting a servitization strategy, however, literature reports that they face challenges developing new product-service offerings. Although a number of approaches have been proposed, they fail to distinguish the characteristics of products and service, they are typically sequential and exhibit variations in the level of detail proposed. Overcoming these knowledge gaps, a new development process model is proposed, consisting of 19 distinct processes. The process model was tested and recommendations for improvements are reported.

Keywords: Product-service system (PSS), product-service development, process model

Introduction
Driven by the highly cyclical nature of their increasingly commoditised product offerings, many capital goods manufacturers are seeing the benefits of exploiting their large installed based by offering services (Wise & Baumgartner 1999, Olivia & Kallenberg 2003). The transition to offering integrated product-service systems (PSSs) is known as servitization (Vandermerwe & Rada 1988, Baines *et al.* 2009).

Previous research has reported that manufacturers face three challenges adopting a servitization strategy: service development, organisational strategy and organisational transformation (Baines *et al.* 2009). Whilst there has been some research identifying how manufacturers can create integrated product-service offerings (Alonso-Rasgado *et al.* 2004, Pawar *et al.* 2009), this is largely anecdotal and does not propose formal processes for their development. Yet, research outside of the servitization field has reported that "it seems to be worthwhile to explicitly organize the process of developing new services" (De Jong & Vermeulen 2003, p.844) with the most successful firms being those that have formal processes (Kelly & Storey 2000, Brentani 1991). This paper reports on the creation of a formal process for the development of integrated PSSs.

Literature review

Although limited research has been conducted within the servitization field to propose processes for developing integrated product-service offerings, the related PSS field is more mature in this area. However, although a PSS consists of both product and service elements, much of the PSS development literature does not make reference to either the new product or new service development literatures. Many authors argue for separate new product and service development approaches, claiming that the unique characteristics of services (intangibility, heterogeneity, inseparability and perishability) mean that their development is different from products (Kelly & Storey 2000, Ian Stuart 1998).

Given these inconsistencies a review of the product, service and product-service development literatures was conducted and three observations emerged:

The design stage for product elements is different from service elements

Early approaches to service development were based on the product development process reported by Booz, Allen & Hamilton (1982), proposing that service development was not different from product development. Scheuing & Johnson (1989) were the first to report a service development process different from products, identifying four distinct outputs from the design stage: service design, process design, system design and marketing programme design. Whilst the product development literature also proposes marketing programme design, other outputs include: product design and production development (Roozenburg & Eekels 1995). This difference emerges from the inseparability characteristic of services where production and consumption occur simultaneously (Lovelock & Gummesson 2004).

This difference is less well understood within the PSS development literature where the stages of the development process are broadly consistent with the stages of product development. However, whilst the distinction is not made clear at the stage-level, MEPSS (van Halen *et al.* 2005) proposes tools to model

- the resources providing the PSS;
- the user interaction with the PSS and delivery organisation; and
- the functionalities of the PSS.

These tools are attempts within MEPSS to encourage PSS development teams to design the service system, the service process and the service concept respectively. Whilst MEPSS proposes tools for considering the specific nature of services within the development process, it does not propose corresponding tools for considering products.

PSS development is typically sequential

Of the 11 reviewed PSS development processes, nine are presented as being sequential. However, both Brezet *et al.* (2001) and Engelhardt *et al.* (2003) propose dedicated evaluation stages in order to "guarantee a process of continuous improvement" (Brezet *et al.* 2001, p.17). Additionally, Kar (2010) proposes activities consistent with evaluation - e.g. analyse business case, gather feedback, monitor and provide support. The concept of assessing products and/or services whilst in-service in order to deliver incremental improvement is also reported by the cyclic PSS development process proposed by Mont (2001) and the cyclic service development processes proposed by Tax & Stuart (1997) and Johnson *et al.* (2000). Although represented as a cycle, these

processes are essentially sequential where the output from the evaluation stage forms the input to the first stage of the next development process.

Recent research has reported that existing approaches do not reflect industrial practice - in addition to the incremental feedback loop linking the end of an evaluation stage with the first stage of the next development process, there is iteration between other stages within the PSS development process (Clayton *et al.* 2011). This suggests that the PSS development process is not sequential as reported by the majority of the existing literature.

Variations in the level of detail

Many of the processes proposed within the PSS development literature do not report specific activities that development teams have to execute in order to successfully complete the reported stages (e.g. Mont 2001). This reflects the early research within both the product and service development literatures where only the stages within the development processes were reported. However as the development processes proposed within the product and service literatures have become formalised, greater levels of detail have been reported.

The transition within the product and service development literatures towards being represented using formal process modelling techniques has not been reflected in the PSS development literature.

Research design

The observations presented in the previous section highlight that, although numerous processes for developing integrated PSSs have been proposed, they fail to

- take into consideration the characteristics of both the product and service elements within the design stage;
- they do not reflect industrial practice by enabling more iterative and incremental development; and
- no formal process modelling techniques have been used to represent the PSS development process.

The research presented within this paper was driven by a desire to fill these knowledge gaps by answering the following research question:

RQ: What does a formal product-service system development process model, that reflects industry practice, look like?

Addressing the research question involved the authors in three phases of research. During process model design, literature were analysed to specify the requirements for the PSS development process model. Process model development involved creating an initial version of the PSS development process model; representing it using a formal modelling language. Finally, process model testing involved evaluating the PSS development process model on an industrial application. The evaluation was conducted within a global transportation manufacturer (RailCo) in order to identify possible product-service offerings that could create a step change in its UK services business performance. 20 participants were involved in the evaluation (ranging from senior directors to mid-level managers) which was undertaken over the course of six full day and four half-day workshops. The results were used to refine the proposed PSS development process model.

Process model design

Requirements for the PSS development process model can be specified as:

Requirements for the process model structure

The purpose of identifying the requirements for modelling processes is to ensure that the process model is an effective representation of reality, efficiently created (Table 1).

Table 1: Process modelling requirements (Holt 2009)

Requirement	**Description**
Complete information	The process model must represent the required level of detail
Realistic	The processes modelled must reflect the practices executed in reality
Partitioning	Related processes must be grouped within the process model
Process iteration	The process model must describe how processes are carried out and re-used
Complexity and interactions	Relationships between elements at all levels within the process model must be visualised
Traceability	It must be possible to trace all artefacts back to the original project requirements
Tailoring	The generic process model must allow specialisation
Multiple views	To gain a full understanding of the process it must be represented from multiple perspectives

Requirements for the content of the model

Work by Clayton *et al.* (2011) has reported that the PSS development process followed by industry consists of project initiation, analysis, idea generation and selection, design, production, articulate the value proposition, prototype, implementation and evaluation. In addition, Clayton *et al.* (2011) reports the high level of iteration between the phases, suggesting that PSS development is nonlinear.

Complementing these findings, Baines *et al.* (2009) argues that the design of services requires manufacturers to take greater account of competition from outside their traditional domain, such as from their own suppliers, distributors and customers; consider the risk of performing activities previously undertaken by customers, where marginal risk incurred might outweigh the profit potential; and develop communication strategies that describe the value proposition to the customer and their role in value co-creation.

Given these findings, the PSS development process model must be made up of distinct processes that fulfil these reported requirements.

Requirements for the process modelling technique

The choice of modelling language must fulfil the requirements identified in the previous sections and be a formal modelling language (Table 2).

Based on the analysis, the SysML was chosen as an appropriate modelling language and implemented within Atego™ Artisan Studio©.

Process model development

The PSS development process model consists of seven different views; represented using a number of diagrams within the SysML (Table 3).

Table 2: Choice of modelling language

Language	**Description**	**Fulfil reqts**	**Formal**
Flowcharts	A schematic representation of algorithms or processes	N	N
Business process modelling notion (BPMN)	A general process modelling language	N	N
Integrated definition methods (IDEF)	A family of modelling languages including IDEF3 for business process modelling	N	Y
Systems modelling language (SysML)	A domain-specific modelling language for systems engineering that is defined as a profile of UML (Unified Modelling Language - a general purpose modelling language that is the standard for specifying software intensive systems)	Y	Y

Table 3: Seven views of the PSS development process model

View	**Description**	**SysML representation**
Requirements	Specifies the overall aims of the processes within the process model	Use case
Stakeholder	Represents the classification of the different types of stakeholder role involved in the process	Block definition diagram
Process structure	Shows a high-level representation of the basic structure of, and the terminology used throughout, the process model	Block definition diagram
Process content	A set of diagrams that show the activities and artefacts of each process	Block definition diagram
Process behaviour	Describes the behaviour of each process, documenting the order of execution of activities	Activity diagram
Process instance	A set of diagrams that represent the execution of individual processes	Sequence diagram
Information	Identify the key artefacts from the process model and their inter-relationships	Block definition diagram

The PSS development process model consists of 56 diagrams, representing the seven views. The initial PSS development process model consists of 19 distinct processes arranged around two process groups: management and PSS development (Figure 1).

Each process is made up of activities, artefacts and roles. Activities are executed by roles and produce or consume artefacts (Figure 2). In the process behaviour views, swim lanes represent the roles responsible for each process. Each swim lane is responsible for the activities within it and the order of execution of the activities is shown. Artefacts are either produced (shown as inputs into activities) or consumed (shown as outputs from activities) and typically take the form of information.

The processes within the process model are combined during a PSS development project. This combination can be linear, reflecting existing PSS development processes reported by the literature, or nonlinear; where variation depends on internal and external constraints imposed on the PSS development project.

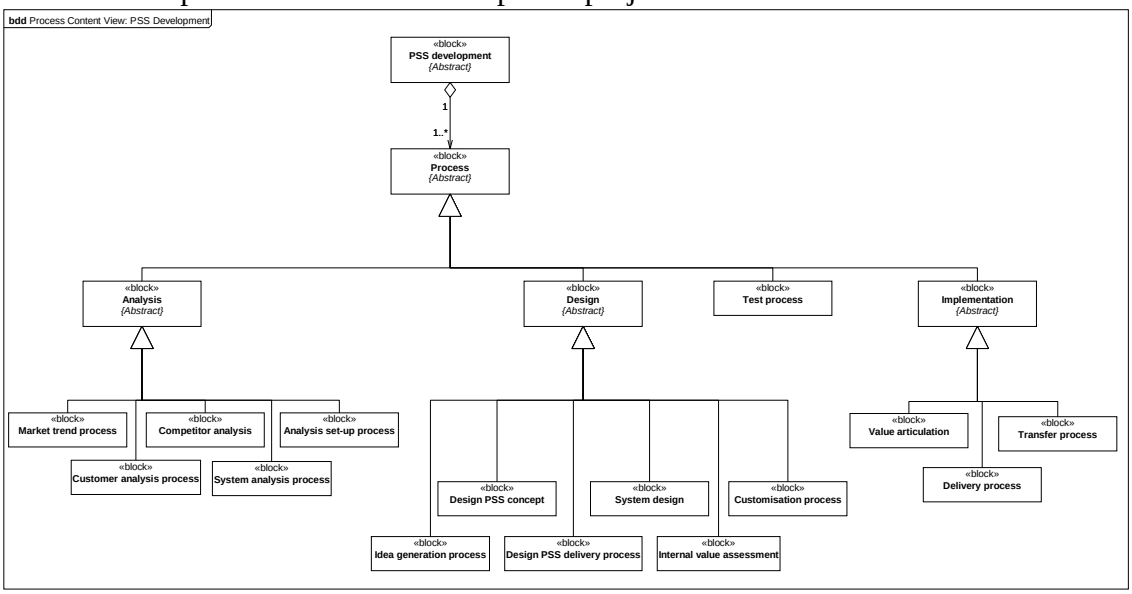

Figure 1: Process content view for PSS development process group

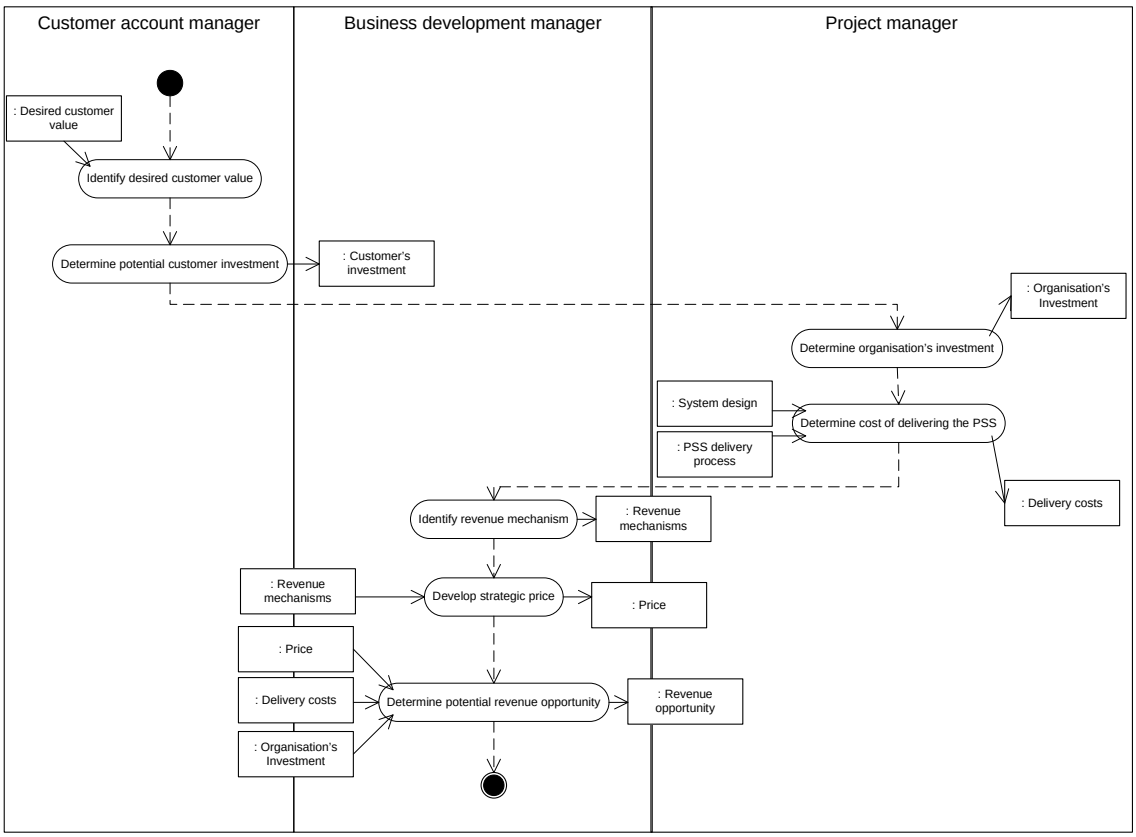

Figure 2: Process behaviour diagram for internal value assessment process

Process model testing

The process model was evaluated through its application to a new product-service development project within the UK division of a global transportation manufacturer (RailCo).

Reflecting previous research, the actual PSS development process is highly iterative and nonlinear – represented by the re-use of a number of processes (Figure 3).

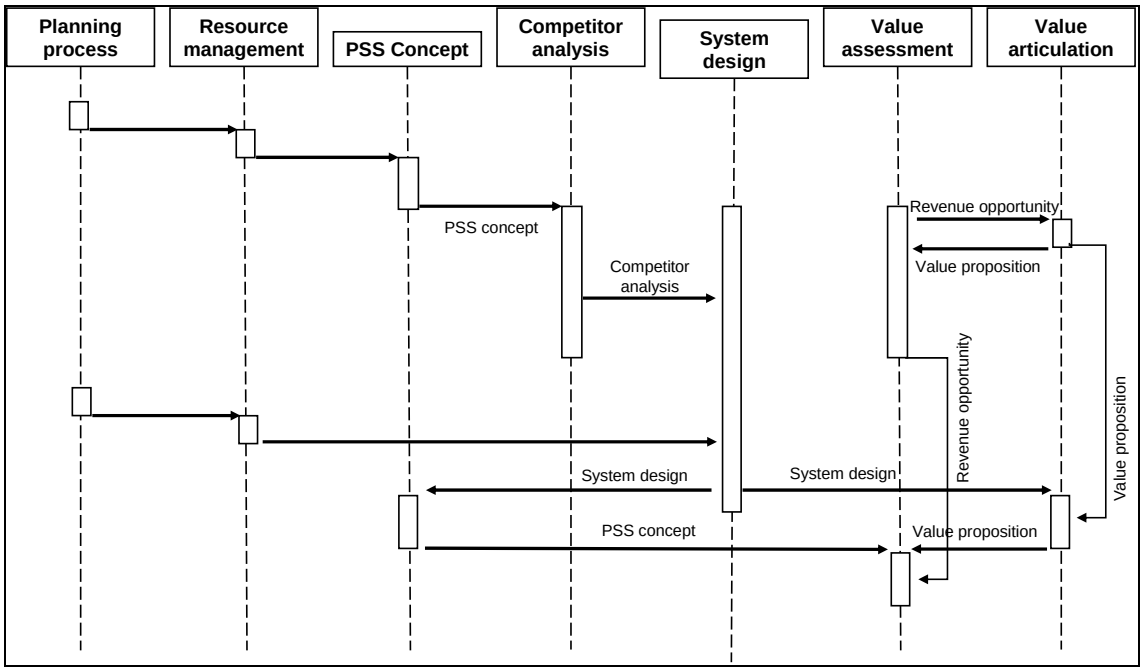

Figure 3: Example process instance view from application in RailCo

During process model testing not all activities were completed, or artefacts produced (e.g. Figure 4 where activities or artefact in bold were not executed or produced).

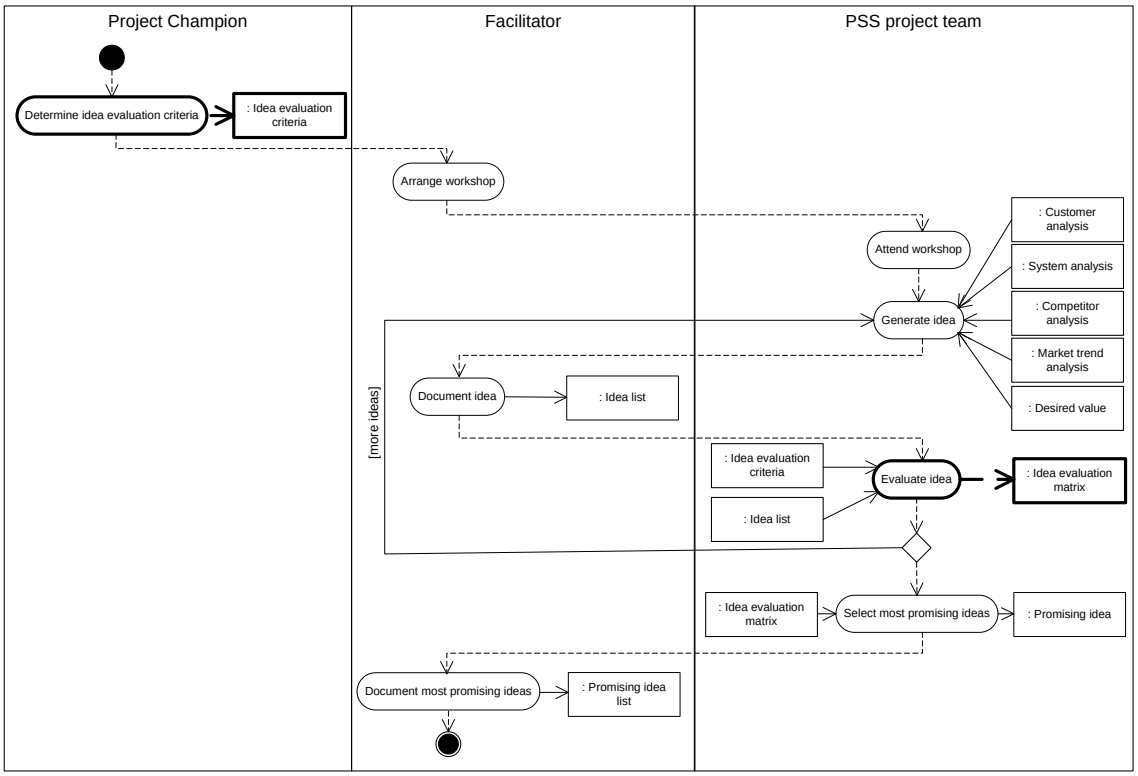

Figure 4: Process behaviour view from idea generation process within application in RailCo

Of the 19 processes within the process model, six were not executed: market trend analysis, design PSS delivery process, customisation process, delivery process, transfer

process and gate review process. In addition, a number of activities within the processes were not completed including: determine what the opportunity is worth to customer (customer analysis process), define service quality measures (design PSS concept process) and design service system for variations in deliver (system design process).

The testing also identified an activity performed by RailCo's that is not represented in the PSS development process model: risk analysis.

Findings indicate that the PSS development process model should include a risk analysis process similar to that reported by Baines *et al.* (2009). When applying the processes within the process model organisations are able to re-use processes, however, they do not necessarily execute all of the activities within each process. Where organisations choose not to complete all activities, they need to be aware of the impact of this. The information view potentially offers a mechanism for providing this awareness, showing how the absence of artefacts may hinder the creation further artefacts.

Conclusion

The research reported within this paper has proposed a new approach to the creation of integrated product-service offerings: the PSS development process model. Existing approaches to PSS development

- fail to recognise that the design stage for product elements is different from service elements;
- report PSS development as sequential; and
- report variations in the level of detail within the proposed approaches.

The PSS development process model overcomes these weaknesses, proposing a representation of PSS development using a multi-view approach implemented in the SysML.

To assess the PSS develop process model, it was evaluated during application to a new product-service development project within the UK division of a global transportation manufacturer. The findings indicate that the process model needs amending to include a risk analysis process. Additionally, the process model enables organisations to represent their PSS development processes in an iterative and nonlinear manner, through the concept of process re-use. Finally, the testing determined that organisations do not complete all activities within each process or create all artefacts.

Given that the research has been evaluated using one case study, further research is needed to: verify that the processes proposed are applicable in alternative scenarios and validate that the PSS development process model can be used to create PSSs in more cases. Additionally, further research is also needed to evaluate whether the activities not completed, and artefacts not produced, are detrimental to the quality of the resulting PSS and whether the PSS development process model delivers more value to organisations than existing approaches.

Acknowledgements

This paper would not have been possible without the financial support given by the UK government via EPSRC and industrial sponsors. Neither would it have been possible without the support of the industrialists who were involved in the process modelling and testing phase. The authors thank them for their time, knowledge and invaluable insights.

The authors would also like to thank Atego™ for the free use of their software and for their time advising the researchers.

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