Service Information in the Provision of Support Service Solutions: A State-of-the-art Review

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Abstract

The transition from the delivery of physical products to the delivery of product-service systems demands new forms of information system that are designed to support the lifecycles of both physical products and associated services. Information requirements for service solutions are dependent on the nature of the offering and the underpinning service agreement. In this paper we provide a survey of current practice, highlighting examples of best practice, and review literature in information support for service support solutions. Results are being used to inform the definition of a blueprint for future service information systems. Early conclusions will be reported.

Keywords:

Service Information, Support Service Solutions, Product-Service Systems, Industrial Practices

1 INTRODUCTION

In the move to product service systems, the delivery of engineering excellence demands the delivery of excellence in both physical products and associated through-life services. Emerging service products strive to deliver availability and capability to customers. As with physical products, the delivery of service excellence begins in the very early stages of the service lifecycle when contracts are developed and agreed. A key to the delivery of service excellence lies in defining contracts that are feasible for delivery. Once a contract has been agreed the service product is developed and then delivered. Access to high quality information (complete, correct, minimal and available to the right people at the right time a form that they are able to use effectively) is key at each phase of service development and delivery: contract definition, service definition and service delivery.

This paper highlights key findings from a state-of-the-art review on the current state of service information. Reviews of key developments in the academic literature and a web-based survey of current industrial practice in information provision for services were carried out. Results of the literature review re summarised in Section 2 and an overview of a number of industrial cases highlighting areas of best practice are presented in Section 3. Finally, in Section 4, key lessons learnt are outlined.

2 STATE-OF-THE-ART REVIEW OF ACADEMIC LITERATURE

Each broad phase of a service lifecycle (contract definition, service definition and service delivery) has its own requirements for information. A fourth phase, end of life, might well be key in that it is where learning from a service could be collated in a form that can be used to inform future generations of service products. As with all information systems, they need to be designed to maximize the chances of them being fit for purpose. An early challenge in the development of information systems for service rather than artifact based products lies in the differences between physical and service products; these are summarised in Section 2.1. An overview of what constitutes service information is provided in Section 2.2.

Traditional approaches to the design and development of engineering information systems involve analyzing engineering processes to identify information requirements and then satisfying these requirements by bringing to bear knowledge and expertise on the representation of products and the realization of information solutions. Different kinds of service information are needed at different phases of the service lifecycle. For example, LCIA[1] provides a framework for the development of information systems needed to support the delivery of service contracts; as such, it can be used in the establishment of requirements for contract and service definition processes. Service definition results in a definition of a service to be delivered, for example in the form of a service blueprint [1]. Key elements of a service blueprint are the information resources that sit at the bottom of the blueprint, providing information needed to deliver the service effectively, and the process definitions that can be used in the elicitation of requirements for these information resources. The establishment of information support systems requires understanding of the processes that are to be supported: for example, LCIA during contract and service definition and those captured in the service blueprint (or equivalent) for service delivery. A common early activity is to establish service information requirements, both in general and for specific service products; literature related

[1] LCIA – Logistics Coherence Information Architecture – www.modinfomodel.co.uk

to service information requirements is outlined in Section 2.3. Once requirements have been established, information systems are developed. Information classification (Section 2.4) is an approach used to deliver as much commonality as possible across information system solutions; this reduces the need to build multiple solutions to the same problem (so reducing maintenance costs associated with the information system itself) and is an enabler for the delivery of high quality information. Literature on information quality is reviewed in Section 2.5.

2.1 Key characteristics of service products

Intangibility, inseparability (or simultaneity) of production and consumption, heterogeneity (or variability), perishability and non-ownership are five key characteristics that have been traditionally used to distinguish between physical and service products [2]:

- **Intangibility:** Services are predominantly performances of actions rather than objects that can be perceived using any of the physical senses.
- **Perishability:** Services must be consumed as they are provided. In general, they cannot be saved, stored, returned or carried forward for later use or sale.
- **Non-ownership:** Largely as a result of their intangibility and perishability, customers do not obtain ownership of services; rather, they experience the delivery of the service.
- **Inseparability of production and consumption:** Service products are typically produced and consumed at the same time - consumption cannot be separated from the means of production.
- **Variability:** Service product quality is subject to variability because services are delivered by people to people. Two dimensions of variability have been identified [2], [3]
  - the extent to which delivery standards vary from a norm, and
  - the extent to which a service can be deliberately varied to meet the specific needs of individual customers.

Parallels between these variabilities and those of physical products can be drawn. The extent to which a delivered service varies from a norm is akin to the extent to which a dimension on a physical product varies with respect to its nominal dimension and tolerance band. On the other hand, the variation of a service to meet the needs of individual customers has parallels with mass customisation and the delivery of customised products.

Engineering information systems to support the lifecycles of product-service systems need to accommodate these distinctions without compromising the need to preserve commonalities between physical and service products.

2.2 Service information

Information has been described as ‘the lifeblood of the organization’ [4] and ‘the most valuable resource in industry today’ [5] but it is also recognized that information is an often undervalued resource because it is difficult to manage. However, if properly managed, the value of information can grow over time. Information is important in service development and delivery as a means of enhancing decision-making processes. Information per se has no direct value but the impact of improved information quality can both reduce costs and enhance service performance. In the context of product servicing, information can provide details about the condition and usage of the product. In a service delivery context, on the other hand, information provides the contractual requirements of the customer to enable service delivery decisions to be made.

For this paper, service information refers to all the information that is required to support the taking of decisions and actions in a service environment. A service information system is a system (which may itself be a collection of systems) which provides the information required to take key decisions and actions in a service environment [6].

2.3 Service information requirements

Information requirements have been discussed extensively in terms of engineering design and information system design. Indeed, in the context of engineering design Court [7] asserts, ‘a large volume of research has been undertaken in establishing these (information) requirements, but many have failed to identify exactly what they are. Much research has proposed to discuss these requirements but only provide details of the commonly used sources of information’.

With such a background, it is unsurprising that the information requirements for service specification and delivery are, equally, not well understood. McFarlane [8] asserts that the information requirements for service support solutions are multifaceted and highly dependent on the nature of the offering and the underpinning service agreement. McKay [9] observes that the transition from product to product-service system delivery requires that engineering information systems change to meet new demands to support product data needed for the effective delivery of lifecycle services, including data generated through the whole life of the product, and the rationale behind decisions that were made through life. This is because over the extended time-span of a product’s lifecycle, as opposed to its realisation, the people who created support for this information are increasingly likely to be unavailable to provide comparable support for the definition of both service as well as physical products delivery.

Defining information requirements is perhaps the most neglected aspect of the information management process. Berkeley and Gupta [10] survey information required to deliver quality services involving high customer contacts. They classified information required for delivering quality services into three broad categories: input information, process information and output information. Input information refers to the information that are needed before the service is actually being delivered. Process information is the information actually required by the service provider and the service recipient while the service is actually being delivered. Finally, output information refers to information that is available after the service is delivered and as results of the service. Output information can be exploited for future use (e.g. as input information for the next cycle of service delivery, to judge the extent to which the service met customer expectations and needs or to inform the design of the next generation of services) [10].

Zeithaml et al. [11] identify five quality gaps that may occur in delivering services. One of the major reasons for service failure is an inability to bridge these quality gaps. Recommended by Zeithaml et al. [11] and distilled by Lovelock and Wirtz [1] are a number of managerial strategies that should be taken to close the service quality gaps. Several of them are related to proper management of service information.

Perspectives on requirements of through-life information of product-service systems in delivering quality service can be found in [12], [13], [14] and [15]. Using the product data framework proposed by McKay et al. [16], it can be argued that effective through-life support services of products requires both product data (i.e. product specification data, product definition data and data related to actual product) and service data (i.e. service specification data, service definition data and data related to actual service) be made available across the product life [14].

At each of the different stages of the lifecycle of a complex engineering product, the needs of the various stakeholders involved are different and distinct. From the viewpoint of general information provision, each of the different stakeholders (with different sub-problems and goals) in a product's lifecycle has different knowledge requirements [15]. Also, since these stakeholders have a variety of information needs, it is likely that they would make different demands of a knowledge and information management system, such as Product Lifecycle Management (PLM) [15]. In order for knowledge management systems to provide efficient lifecycle support it is necessary to understand their knowledge requirements and the information flows between different stakeholders. A major challenge lies in the generation and maintenance of the flow of appropriate information across and within diverse communities of stakeholders.

Designing, servicing, maintaining and upgrading a product are all knowledge intensive activities. However, the information on which these activities depend is often informally captured and may become pertinent information as the design process and lifecycle of the product continues [15]. Often potentially valuable lifecycle information is typically created, gathered and owned by a range of organizations and stored in ways that renders it inaccessible to potential beneficiaries. Also, the quality of this information is not consistent and is highly dependant on the individual agent.

McKay et al. [12] argue that the strategy of establishing future-proofed product information to support future lifecycle processes will fail in situations where the information requirements of the processes are not anticipated far enough in advance, usually during product realization when the majority, if not all, of product definition data is created. To address this weakness, McKay et al. [12] propose an integrated product, process and rationale model that allows, throughout the life of the product, the definition of product structures (with associated process enterprise and life-cycle rationale information) that can be superimposed onto relevant aspects of existent product definitions. The product structures can be suited to the lifecycle stage and people concerned rather than predefined earlier in the lifecycle; the inclusion of process enterprise and rationale information allows the context within which information was created to be captured in a way that is comparable to design data.

2.4 Information classification

Classification of information provides a means of determining the appropriateness of the information required as the types of information are directly related to the activities that use the information. There are two macro-types of information required in order to reduce the risk to the service provider of moving towards performance-based contracts. The first of these is provider related and aims to quantify how well the service performed against the contractual specification. This information enables the provider to understand where changes to the internal processes are needed in order to deliver the service to its specification. The second of these is customer related and links with the customers' perception of the service quality.

Examples of the first macro-type of information which is provider related are Service Level Agreements (SLAs) and Key Performance Indicators (KPIs), which are usually used to provide performance metrics and gauge the adherence of the service delivered to the contractual requirements. SLAs are specific to identified features of the overall service and, while they provide an indication of the performance, may not give a complete representation of customer satisfaction.

The second macro-type of information related to the customer seeks to gain an understanding of the service quality, or perceived service quality (as distinct from quality of service), which may also be described as satisfaction or quality delivered and involves a comparison of expectations with performance. Johnston and Clark [17] describe this, from an operations perspective, as an indication of whether the service specification is being met, and, from a customer perspective, as a mismatch between the customer's expectations of the service and their perception of its delivery.

Classifications of information can be based on internal and external use or sources or into the categories of functional and organizational information [18]. This provides different players, from the service providing organization, with the information required for them to carry out their function. This concept proposes other characteristics relating to the information accuracy, detail, time interval to which it relates and timeliness. Functional information, for example, must be accurate, detailed and provided over short time intervals whereas management information will be less accurate, less detailed and cover a longer time frame.

2.5 Information quality

The quality of information is subject to the use of the information [19] and, therefore, the use and quality will define the value of the information. The extent to which a dimension of information quality is important will depend on the purpose for which the information is used. Garvin's [20] five perspectives on quality can be used to understand elements of service information quality. Berry and Parasuraman [21] suggest quality dimensions for service information based around how relevant, precise, useful, in context, credible, understandable and timely the information is to the user. Wand and Wang [19] propose a set of information quality dimensions which include reliability, timeliness, currency, completeness and consistency. Parlikad and McFarlane [22] also consider similar dimensions in the context of RFID evaluation. Berry and Parasuraman [21] assert that information quality test for these dimension are not absolute and improvement of information quality is a journey of trial and error, experience curve effects, user feedbacks, and new knowledge.

Raghunathan [23] investigates how the quality of both the information and the decision-maker impact the quality of the decision. The work shows that the decision quality will only improve with higher information quality when the decision maker has knowledge of the context and problem variables. This is reinforced by the fact that there is a greater significance to information than the knowledge in itself conveys. This is derived from its association with other existing knowledge and implies a dynamic organization of knowledge based on that which is known already [24]. This is supported by the description that information is data with a context.

2.6 Summary of academic developments in service information

It is widely recognized that a key to the delivery of excellence through service products lies in the availability of high quality information related to both the service being delivered and the artifacts through which service performance is realized. Key differences between physical and service products (reviewed in Section 3.1) influence the requirements of service information systems. A number of authors have written in service information (Section 3.2) and associated requirements (Section 3.3) in general but establishing a detailed understanding of the information requirements for specific service products still demands understanding of the processes that are to be supported, for example, LCIA for contract and service definition and service blueprints for service delivery.

In assessing the quality of service delivery, two kinds of information have been identified in the literature: information related to customer perceptions of the service and information that allows service performance to be quantified in terms of performance indicators (Section 3.4). Finally, in Section 3.5, literature on information needed in service delivery which heavily influences both performance and perceptions of service delivery were reviewed.

3 SURVEY OF CURRENT INDUSTRIAL PRACTICE

This section presents key findings from a survey of six industrial cases; the survey was based on information in the public domain either in the literature or on the world-wide web. Table 1 captures uses a common framework to provide an overview of the service systems surveyed. One of the main objectives of the survey of was to identify areas of best practice in delivering support services. Key observations are grouped into three main categories: emphasis on requirements capture and service design (Section 3.1), feedback loops to enable evaluation (Section 3.2), and maintaining competitive advantage (Section 3.3).

3.1 Emphasis on requirements capture and service design

Clear and unambiguous requirements and service process definitions lay foundation for efficient management of service information. Rolls-Royce MRMS®[2] (Mission Ready Management Solution), ABB Full Service®[3], Civilian IT Service Provider and BT's 'Shaping New Markets in the Digital Networked Economy'[4] (SNM-in-DNE) programmes emphasize the need to capture requirements and use systematic ways of defining service processes and offerings.

Rolls-Royce captures and communicates customer requirements through SABRe (Supplier Advanced Business Relationship). SABRe is mandatory for all the suppliers and partners who provide products or service that impact upon Rolls-Royce and its customer requirements. SABRe enables Rolls-Royce to assure quality of the products or services delivered to the customers against the contracts by formally communicating Rolls-Royce's requirements (plus those of the customers & regulatory bodies) and expectations to the supply chain, both in terms of performance and improvement.

ABB's Full Service® provides a methodology for defining service processes and offerings. Using collaborative efforts between ABB and the client and following a stage gate process map, Full Service® methodology enables ABB to screen customer's requirements & business opportunities, identify feasible solutions, develop partnership, define service, define implementation steps of the defined service and manage contracts.

In the case of the civilian IT service provider, an area where practice was seen to be of a high standard was the well defined service design process. This involved detailed work between the customer and the supplier at several stages with formal sign off following these phases. The supplier puts a significant amount of effort into mapping the customer's output requirement to the service providing company's input requirement in terms of types of information required. The aim of this is to minimize the gaps between the specification process output and the delivery process input. In addition, where the customer specifies services from additional service providers, the organizations liaise early in the design specification phase to ensure that the offerings are compatible and combined to provide the service required by the customer.

BT's 'Shaping New Markets in the Digital Networked Economy' programme emphasizes on the importance of in-sourcing and shared risk and responsibility. While on the one hand in-sourcing provides the service provider an opportunity to identify the service needs of the customer better, on the other hand it allows the customer to be a part of the service design and development process and hence, to influence it to the desired ends. For truly strategic partnership and collaboration, the risk and responsibility need to be shared. This is a pre-requisite towards seamless sharing of service information.

3.2 Feedback loop to enable evaluation

Another area of good practice identified from the survey of the industrial cases was the presence of feedback mechanisms in the service development process. This enables better evaluation of the service processes and offering against contracts.

In the case of the financial service provider, the introduction of what is termed the control centre, drives the use of a capability contract position and drives the development of the IT service as a strategic objective for the company. It enables a full feedback of the performance throughout the service process. The challenges ahead for the service providing company regard the sustainability of the system in place and its scalability with the growth of the company or the inclusion of third party providers in the service supply chain.

3.3 Competitive advantage

Service information strategy should be formulated so that it can help service provider gaining competitive advantage over its rivals. Delivery of responsiveness, customization of service offerings and assurance of quality/excellence in delivered service were identified as some of the key factors that can augment competitive advantage of the service provider.

Delivery of responsiveness

In service operation, the delivery of responsiveness (especially, its call-to-repair or call-to-support commitments to its service customers) and global availability of service levels to its Care Pack Service Customers provides HP huge competitive advantage against its rivals for the similar kinds of support services.

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[2] www.rolls-royce.com/service/defence/default.jsp

[3] www.abb.com/service/us/9AAC125937.aspx?country=GB

[4] www2.bt.com/static/i/media/pdf/cinema_visa_cs.pdf

Title	*Contract Type*	*Nature of Offering*	*Frequency of Delivery*	*Planned or On-demand*	*SLA/KPI*	*Multi- / Single Provider*	*Formal Process Description*
Civilian IT Provider	Availability of service design provision.	Provision of IT services; e-mail systems, servers, relocation of company's IT, etc.	Ongoing with duration of availability contract	Service request is on demand. Delivery is ongoing.	Time to key stage gates such as agreement of requirements and issue of formal proposal. Case by case SLAs with specific contracts.	Often other providers are involved in service design and delivery	Formal process for the design of the service exists.
Financial Service Provider	Availability	Service offering deals with issues related to the issuing and acquiring of debit and credit cards	Ongoing with duration of availability contract	On-demand	SLAs are reviewed monthly. The contract specifies the business rules which drive the SLAs.	Elements of the service may be outsourced by IT but the main service provision is controlled internally	Formal process for the design, delivery and evaluation of the service exists
BT's SNM-in-DNE	Availability	Technology to enable financial service	Five years	Both	SLA/KPI in place. Measured by the customer.	No	Process description exists
Rolls-Royce MRMS®	Either discrete maintenance /coordinated partnership/ availability/ capability	Ensuring operational readiness for air defence	On an ongoing basis for the duration of the contract	On-demand basis for discrete maintenance. As planned for availability and capability.	SLAs/KPIs depend upon individual contract. Typical KPIs are time, cost, quality and responsiveness.	RR global business units with their suppliers, partners, and representatives provide the service	Formal process description exists for a range of services
ABB Full Service®	Capability	Maintenance and improvement of production equipment of industrial plants	Delivered on an ongoing basis for the duration of the contract	Services are delivered as planned	SLAs/KPIs are contract specific. A frequently used KPI is overall equipment effectiveness.	ABB is the only provider of the Full Service	A stage-gate process model includes five principal stages. Formal process description exists for all of them.
HP Care Pack Services	Either discrete maintenance / availability	A spectrum of support services to maximize uptime and availability of IT products	Delivered for the duration of the contract	As planned (proactive) or on-demand (reactive) depending upon service contract and choice of service pack	Typical SLAs/KPIs are response time, ease and flexibility, technology coverage (i.e. end-to-end consistency), global availability of service level, and competitive pricing	Multiple providers - often HP authorized representatives and providers (who are sometimes HP's competitors) are involved in delivering services	HP Care Pack Services include 30 standard offerings (or service levels) for an entire IT infrastructure. Process description exists.

Table 1: An overview of the service systems surveyed.

Customization of service offering

In ABB Full Service®, ABB and the client jointly screen customer's requirements & business opportunities, identify feasible solutions, develop partnership, define service, and define implementation steps of the defined service. The joint effort by ABB and the client in these key stages and the presence of an effective backstage IT support service mechanism act as key enablers for delivering highly customized services for industrial plant maintenance.

Assurance of quality/excellence

In aviation industry, assurance of the quality of the products or service extremely critical. For Rolls-Royce, SABRe acts as the key tool to assure quality/excellence of the products or services delivered to the customers against the contracts. SABRe is the outward facing element of Rolls-Royce's quality management system. Through SABRe, Rolls-Royce formally communicates its requirements (plus those of the customers & regulatory bodies) and expectations to the supply chain, both in terms of performance and improvement. The requirements in SABRe are about how suppliers interact with RR through their quality systems rather than the detail of what supplier quality systems "should" be like.

4 SUMMARY OF FINDINGS

In this section, some key lessons from the survey of current industrial practice and review of literature are drawn out as being of potential interest to the industrial collaborators:

- The existence of a clearly defined process for the design of the service will provide clarity in the objectives of the delivery phase. Also, it is a good practice to become systematic in the way services are designed and developed.
- Having feedback mechanisms into the service development process may help to early diagnose and address gaps and shortcomings in the service offering.
- The use of measurable KPIs which provide an evaluation of the service against the specification is key to determining the performance.
- For services depended on partnership relationships, it is critical to focus on relationships between the customer and supplier organisations and accept heterogeneity in the supply networks that deliver the service. Also it is important to ensure that goals of customer are aligned with goals of the supplier and if goals are not aligned then to stop early.
- Maintaining alignment of the in-house IT provider with the business "mission critical" processes is shown to improve the delivery process.
- The creation of a control centre provides a key point of contact to manage incidents and prioritize the order in which these should be sorted.
- Classification of information could enable quick analysis of the potential scale of service solutions early in the service development process.
- The notions of 'seamless sharing/transfer of service information', 'in-sourcing' and 'shared risk and responsibility' and also the importance of driving a 'shift in comfort-zone' (i.e. shift from cash-based to cashless-based economy and attitudinal changes needed by the customers and other service players) of both the customer and the provider for any major transformation in the delivered service could be of potential interest to the industrial collaborators.

5 CONCLUSION

The following areas of good practice have been identified as being of potential interest to the industrial collaborators, in moving to the delivery of product service systems (shown in Table 2 below).

	Good Practice	Supporting Evidence
Do	focus on relationships between customer and supplier organisations	RR do this through SABRE – the requirements in SABRE are about how suppliers interact with RR through their quality systems rather than the detail of what supplier quality systems "should" be like
Do	accept heterogeneity in the networks that deliver PSS	
Do	be systematic in the way PSS are designed and developed	ABB have a stage gate process Civilian IT provider has a clearly defined development process
Do	ensure goals of customer are aligned with goals of the supplier …	Screening in the ABB process checks this …
Do	… and if goals are not aligned then stop early.	… and the subsequent stage gate provides a stop point if needed
Do	provide a range of service offerings to suit the needs of different customers	HP do this in their care packages
Do	have measurable KPIs	BT provides an example of this.
Do	build feedback mechanisms into the service development process	Financial sector provider does this
Do	… unless you make them so generic that they are useless	As models become more general they become more difficult to test, which impacts their reliability
Do	classify information	It could enable quick analysis of the potential scale of service solutions early in the PSS development processes
Do not	assume that there is one set of information requirements for all services …	There is no evidence to suggest there is one set of requirements. There isn't one set of requirements for all physical artefacts so why would we expect there to be one for all services?

Table 2: Areas of good practice and supporting evidence.

These are being used to inform the definition of Service Information Requirements and a blueprint for Future Service Information. With this in mind, the following initial information requirements for the development of information support for product service systems have been identified:

- When establishing requirements for a given service offering, it is advisable to consider customer-supplier dyads and the needs and capabilities of existing information systems in each organisation.
- As in the development of information systems for physical products (e.g., in the ISO10303 development methods), key information flows from which requirements are typically elicited might be extracted from PSS development process definitions. In later lifecycle stages, analogous process definitions might be beneficial to the identification of information requirements.
- PSS information requirements need to be aligned with the strategic intents of both customer and supplier, and with their delivery capabilities (current and planned). Information systems development might be usefully phased against these capabilities.

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