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The Impact of Contract Type on Service Provider Information Requirements

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Why this paper might be of interest to Alliance Partners:

This paper explores the role of information in the servitization of manufacturing. Companies are moving from discrete provision of equipment and spare parts to long-term service contracts, which depend on a very high level of availability and quality of information throughout the service life cycle. This work focuses on whether, for a proposed contract based around complex equipment, the information system is capable of providing information at an acceptable quality and requires the Information Requirement to be examined in a formal manner. A service information framework was applied to methodically assess Information Requirements for different contract types to understand the information gap between them. Results from case examples indicate that this gap includes information required for the different contract types and a set of contract-specific Information Requirements. Furthermore, the control, ownership and use of information differ across contract types as the boundary of operation and responsibility changes.

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ABSTRACT
This paper is concerned with the role of information in the *servitization* of manufacturing, which has led to 'the innovation of an organisation's capabilities and processes as equipment manufacturers seek to offer services around their products' (Neely 2009, Baines et al. 2009). This evolution has resulted in an information requirement (IR) shift as companies move from discrete provision of equipment and spare parts to long-term service contracts guaranteeing prescribed performance levels. Organisations providing such services depend on a very high level of availability and quality of information throughout the service life cycle (Menor et al 2002). This work focuses on whether, for a proposed contract based around complex equipment, the Information System is capable of providing information at an acceptable quality and requires the IRs to be examined in a formal manner. We apply a service information framework (Cuthbert et al. 2008, McFarlane & Cuthbert 2012) to methodically assess IRs for different contract types to understand the information gap between them. Results from case examples indicate that this gap includes information required for the different contract types and a set of contract-specific IRs. Furthermore, the control, ownership and use of information differs across contract types as the boundary of operation and responsibility changes.

1 INTRODUCTION

Changing market and customer pressures have led to a number of equipment manufacturers seeking to offer services around their products (Neely 2009). An important element of this service focus is around the information required (IR) for the provision of different types of service contract (Ng & Ding 2010). These contracts, ranging from discrete spares and parts provision to performance-based services, specify the level of accountability of the customer and provider and act to moderate the output performance delivered to ensure that the service satisfies the needs of the customer (Susarla et al 2010). In satisfying the customer needs, these contracts depend on the continued availability and quality of information throughout the design, delivery and evaluation of the service (Menor et al. 2002).

While a number of models exist for the design and development of services, these rarely focus on information as a key enabler in the provision of service contracts (Cuthbert 2009). Nevertheless, Ostrom et al, in their paper on research priorities for services, highlight both the importance of information for service innovation as well as the sharing of information within the multi-organisational networks of service providers (Ostrom et al 2010). The need for a formal approach to information in service provision is of greater importance when the service is centred on a complex piece of equipment, as the IR to operate such equipment is in itself complex and needs careful management (McFarlane & Cuthbert 2012). Of particular interest within this work is whether, for a proposed contract, an existing Information System (IS) is capable of providing the information, required for a service contract, at an acceptable quality. Within this work we focus, particularly, on the specification, use and control of IRs for the successful fulfilment of a service contract noting that this is likely to be dependent on the nature of the service and the underlying contract.

Within this work, we introduce and apply a service information framework for the assessment of IRs for contracts, and present the output of two different contract types (from a set of nine UK defence-focussed support services, Cuthbert 2009) to understand the gap in information between them. The results from these industrial cases indicate that the IRs for different types of contracts will include information common to each contract type as well as some additional information specific to the contract type. Furthermore, the collection, ownership and usage of this common information will differ with contractual set-up. The paper argues more broadly that there are further challenges surrounding information provision across differing contract types.

This paper provides three main contributions to the literature in the area of IRs for service provision. Firstly, the application of the service information framework provides a means of assessing the IRs to support the service operation. In many cases, the information required will be distributed across multiple organisations; the customer, provider or third-party providers. Secondly, where the existing information system is not capable of providing for the IRs, an assessment of a proposed (new) information system is required to determine whether it can adequately support the IRs for a particular contract. Thirdly, the assessment of IRs enables an organisation to assess, from an information perspective, the most suitable contract type against which the service may be delivered.

2 BACKGROUND

The background provides an overview of the changes which have taken place within manufacturing, where such organisations have tended to servitize. This is described in the particular context of complex engineering assets. Associated issues of increased longevity of the customer–provider relationship, the accompanying contracts, and the associated information risks are highlighted. The different contracting models employed within a Complex Engineering Services (CES) context are described, and an approach to modelling IRs in a Complex Engineering Services environment is presented.

2.1 Complex Engineering Services

The trend to servitize manufacturing has seen firms move beyond pure manufacturing and offer services and solutions delivered through, or in association with their, often, complex engineering equipment (Neely 2009). In many cases, such organisations offer *complex engineering services* which are defined as ‘*the long term provision of a set of technical capabilities based on a complex engineering system to a customer at a contractually defined performance level’* (McFarlane & Cuthbert 2012). These have also been described in terms of the transformations of people, materials and equipment, and information which all form part of the value offered to the customer (Ng et al. 2010).

In a number of cases, organisations no longer gain their main source of revenue from the sale of, for example, complex engineering equipment (Apte et al. 2008, Spohrer & Maglio 2008) which, once sold, may have historically been upgraded or maintained by the manufacturer on a case-by-case basis. Instead, the provider often establishes a long-term relationship with the user or customer which can continue for several years as the manufacturer provides the through-life servicing of the Complex Engineering Equipment (Gruneberg et al. 2007). Boeing, for example, gains revenue from GoldCare which provides an airline-specific set of

Maintenance, Repair and Overhaul (MRO) support functions for the 787 Dreamliner (Boeing 2010).

The longer-term nature of such relationships and the new type of offering provided exposes the provider to a higher level of risk and uncertainty from customer demand (Martinez-de-Albéniz & Simchi-Levi 2005, Wise & Baumgartner 1999). In situations of increased uncertainty, contracts need to be constructed in a way which minimises risk (Fitzgerald & Willcocks 1994). A key factor in reducing risk is linked to the timely availability of information to support service decision making (Hicks et al 2002, Domberger et al. 2000). However, this is potentially compounded by the changing ownership, control and use of information as the distribution of service-based activities changes (Detlor 2010).

The new business models built around these complex engineering assets and the associated changes in risk and customer–provider relationships have resulted in the boundaries of responsibility and accountability between the provider and user moving further towards the domain which would traditionally have been considered that of the user. For example, in the case of the UK defence industry, the Ministry of Defence has entered into partnering arrangements with BAE Systems plc and Rolls Royce plc. These arrangements use industry-managed, co-located teams of industry, contractor and military personnel to carry out repair and maintenance activities on fast jet pulse lines (NAO 2007). This new domain is one which the provider is unlikely to have full control over and will certainly lie outside their traditional boundary. These services, in a complex engineering context, have given rise to the need for different types of contract (Ramachandran & Gopal 2010).

2.2 Differing Contract Models in Complex Engineering Services

The provision of services centred around complex engineering systems are referred to as Complex Engineering Services (CES). Within this context of CES, service contracts are increasingly seen as a requirement for successful service relationships as they formalise the business relationship between the parties involved by defining the deliverables, entitlements and outcomes (Böettcher & Gardini 2008). From a legislative perspective, contracts need to include specified service levels, penalty clauses, arrangements for adapting to changing circumstances in the future and early termination provisions (Fitzgerald & Willcocks 1994) and they need to be precise, complete, incentive-based, balanced and flexible (Barthélemy 2003). Three key legislative areas identified for contracts include (1) information enabling the provider to comply with equipment-worthiness regulations, (2) information relating to the terms and conditions of employment of current and inherited staff, and (3) information in the form of documents/training material to enable the user to operate and maintain their assets optimally and safely (Cuthbert 2009). These information categories constitute 'core' information required by the contract, as illustrated in Figure 1.

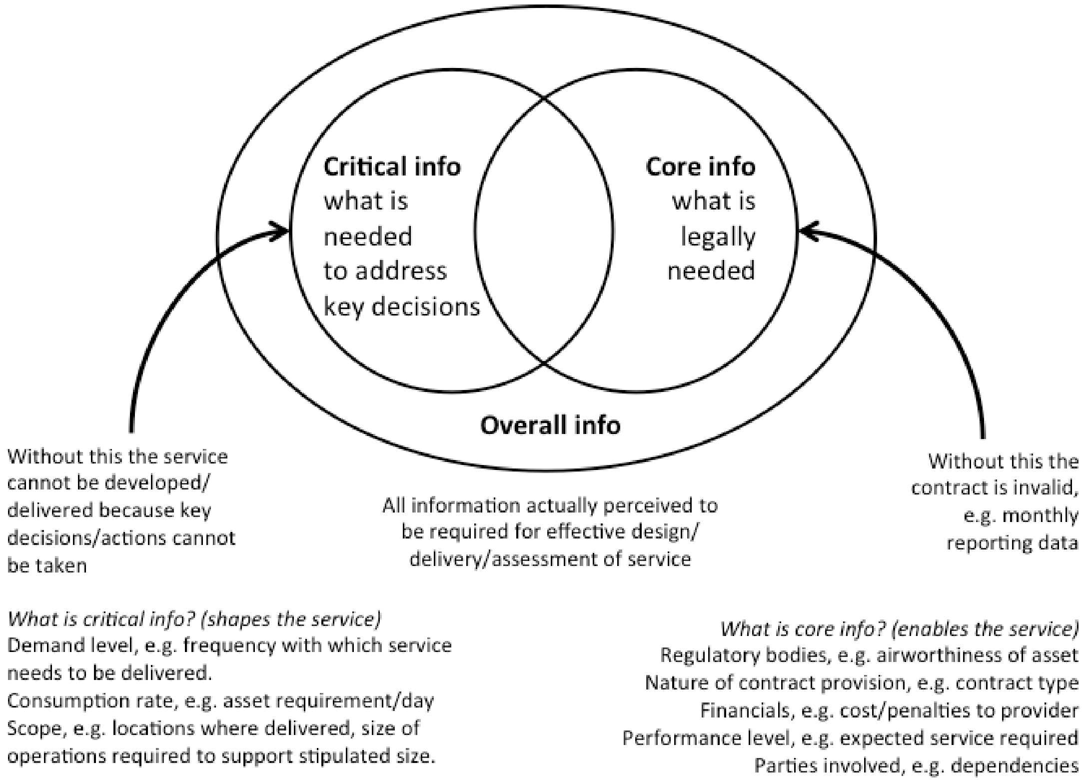

Figure 1 – Core and critical contract information.

Differing contract models in CES are seen to be used. Within the UK defence industry, as an example, the types of contract used typically include spares and repairs, spares inclusive, availability and capability and are described in Table 1Table 1 .

Model	Description	Examples
Spares and repair (S&R)	Industry is contracted for supply of assets. Subsequently supplies spare parts for repair and overhaul of assets.	Spey engines which power the Royal Navy's Type 23 Frigates (NAO 2007).
Spares inclusive (SI)	Parts supply as for S&R contracts. Overhaul/repair conducted by joint supplier/customer teams.	Contractor MTU Aero Engines and the Luftwaffe have developed the contract to undertake maintenance of Typhoon engines (NAO 2007).
Contracting for availability	Performance-based agreements with contractual performance guarantees. Supplier is equipment design authority, responsible for repair, overhaul and delivery of "fit for purpose" equipment.	Many MRO contracts focus on outcomes rather than tasks involved (Ng & Ding 2010). The Rolls Royce "power by the hour" contract sell flying hours rather than aeroengines (Slack 2005). RB199 Operational Contract for Engine Transformation (ROCET) is the Royal Air Force Tornado fleet availability contract (NAO 2007).
Contracting for capability	Supplier is responsible for delivery of a capability, e.g. aircraft able to fly a set no. of hours carrying a set no. of passengers including required support/spares/repair.	Rolls-Royce Total Care whole engine package. Boeing Gold Care whole aircraft packages (NAO 2007).

Table 1 – Contract types used within the UK defence industry (informed by National Audit Office 2007).

Table 1 indicates that provider responsibility ranges from the timely provision of parts and repairs to full responsibility for the performances of an asset in use. As businesses have evolved over the years, there has been a tendency to move towards the provision of fewer, higher value contracts which provide performance-based services as indicated in Figure 2.

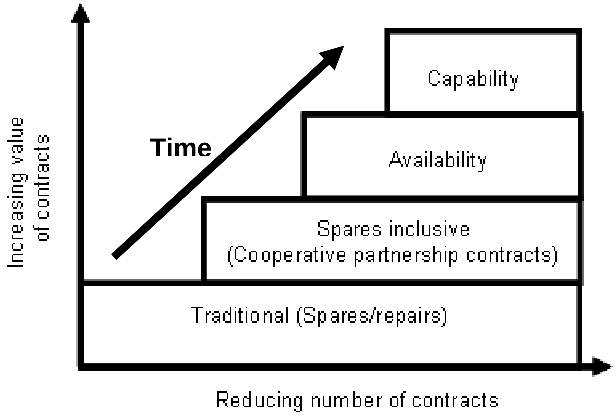

Figure 2 – Support options matrix (informed by modinfomodel 2009).

In taking on fewer, higher-value contracts, organisations are potentially more exposed to the possible hazards of a given contract. In order for the manufacturer-turned-service-provider to mitigate these hazards, or risks, posed to them by providing such services, and to achieve satisfaction of the service through the associated contract, it is important to understand how the information will enable or possibly disrupt the service contract delivery. Furthermore, for different contract types, the information requirements will potentially differ such that a new set of information may be required. This may be information which the user historically collected and used but which will now be required by the service provider (Cuthbert 2009). Equally, this may be information which the customer/user has not previously deemed necessary to record. Information considered critical to the new provider may have seemed of little consequence to the user, pre-contract, when they were effectively providing their own service. As such, the transition in the types of contract will imply a different type or level of IR by the provider of the service, and this information may, or may not, be available. Two things which need to be understood are, firstly, which information is required and used to ensure different contract types are met, and secondly, for this information, who controls this information and is responsible, under the terms of the contract, for ensuring that it is made available (Detlor 2010).

Added to the different IRs associated with each type of contract is a differing level of information exchange for different contract types (Figure 3) (Shuttleworth 2006). The majority of information will lie with the customer for spares and repairs contracts, and with the provider for capability contracts (Cuthbert 2009). In these instances, the level of information exchange between parties will not be too significant. Conversely, in the context of spares inclusive and availability contracts, there is more likely to be information which will need to be shared between the different parties involved. For example, in the case of spares inclusive contracts, the maintenance and upgrade of assets will be carried out by joint provider–customer teams (National Audit Office 2007). Information will be required to coordinate the resources and their skill levels to the task and the availability of the equipment and the asset for the work to be carried out. Availability contracts are likely to be less reliant on these types of information and more concerned with information relating to the use and state of the deployed equipment to ensure that service tasks may be completed within the constraints of the contract. Consequently, this will imply a greater need for information to be shared and exchanged between the customer and provider (Klein & Rai 2009) which, in itself, presents a set of potential issues as this information may be costly to acquire, transfer and use in a new location (von Hippel 1994).

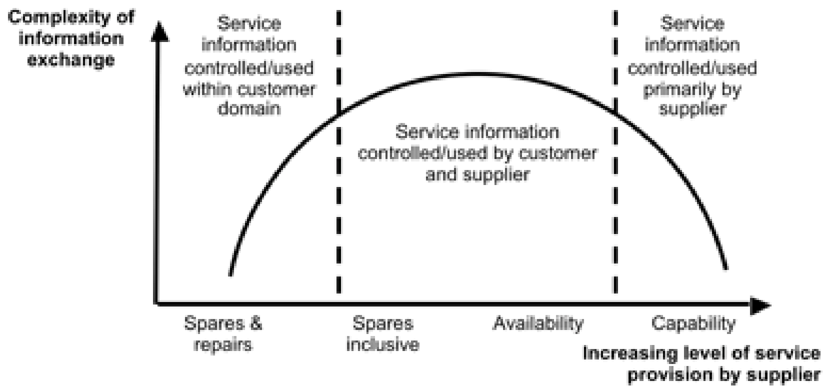

Figure 3 – Change in information control/use and complexity of exchange (from Shuttleworth 2006).

The greater complexity is indicated in those contract types where information control or usage is often ambiguous. We also mention that complexity is clearly increased in circumstances where the 'owner' of the information is not the 'user' of the information. The control of information will initially lie with the collector of information, and will then pass to the owner. We define control as the organisation responsible for collecting and storing the relevant information in its Information System, and user (or 'usership') as the organisation which requires this information as it makes decisions and takes actions in the service environment. This raises the question of who is responsible for making the information available to other parties (Shuttleworth 2006) and how this provision can be ensured (Broadbent & Weill 1997).

From the above references, we observe that the following factors contribute to information complexity:

- acquisition of information;
- reliable communication and storage of information;
- sharing/exchange of information;
- processing of information.

This transition, in the nature of contract use and the changes around the associated information, suggests a need to examine IRs in a structured and detailed manner within the context of differing contract types.

2.3 Modelling information requirements in a Complex Engineering Services environment

A number of models have been developed to aid the design and assessment of services (Johnson et al. 2000, Ramaswamy 1996, Parasuraman et al. 1985, Zeithaml & Bitner 2000, Sakao & Shimomura 2007). Each of these models is effective in examining aspects of the service process. Because no existing model fully satisfied these requirements, an alternative model, the so-called '12-box service model' (Cuthbert et al. 2008) has been developed to assist in identifying the IRs at different stages of the design, delivery and evaluation of services in a CES context. Its application may be in the context of new or existing services and will provide an indication of the IRs for each. For example, in the case of new services it will indicate a full set of IRs, while for existing services, any areas of weakness in information which need to be addressed will be highlighted. It is set up in such a way that the stages of definition of the service are represented on one axis and the stages of the service life cycle, namely the design, delivery and evaluation, are represented on a second axis. The stages of the service life cycle are then traversed in numerical order by the underlying processes and information flows. The model is simplified into a three-by-four matrix, as shown in Figure 4 (Cuthbert et al. 2008) and described more fully in McFarlane & Cuthbert 2012.

	Service Operation	Service Offering	Service Specification	Service Need
Design	4 Technical information to plan & develop the delivery of the offering	3 Technical/ architectural/legal information to design offering	2 Information to formalise service contract	1 Conceptual information about customer requirement
Delivery	5 Technical info to run service/ infrastructure	6 System level functional information to fully supply service offering	7 Information with respect to service use	8 Information from provider enabling user to exploit service
Evaluation	12 Operational information on performance of service infrastructure and operations	11 Info relating to the effectiveness of service offering and its SLA metrics	10 Information to illustrate the perception/ expectation of the service – vs SLA	9 Information to determine fulfilment of customer need

Figure 4 – Developed service information model;
a three-by-four matrix of information types required in service development
(developed from Cuthbert et al. 2008).

The process by which the 12-box model is applied uses a three-phase approach. The first phase determines contractual requirements, constraints and information sources, while the second phase identifies key decisions, supporting IRs and the availability/owner/user of the information. The third phase of the approach analyses the populated model to highlight gaps in the information and the IS provision to determine the contract information capability (McFarlane & Cuthbert 2012).

In this background section we discussed the change in the Complex Engineering Services domain, and how this has given rise to longer-term relationships which are monitored and supported through different contracting models. For the different contracting models and service requirements, the IRs also change. Indeed, the collection, ownership and use of information also change as the boundary of operation between the customer and the provider changes. To help us understand the IRs in a Complex Engineering Services environment, an approach to modelling these has been presented, representing a means of understanding the IRs in a way, seemingly, not achieved by other models. Within the main section of this paper we examine key issues in contract information complexity and propose an approach for examining IRs for different service contracts.

3 CONTRACT TYPE AND INFORMATION

Within this section we will describe the issues around IRs to meet contract stipulations. As the IRs differ for different contract types, the variation in IRs for each contract will also be presented.

3.1 Information requirements for differing contract types

The change towards the provision of Complex Engineering Services has led to a change in the relationships and responsibilities for different aspects of service provision. With the introduction of different contracting models to support these, the IRs to support the service operation will now differ, and this is likely to have a significant impact for the provider, introducing potential risks to the operation. The process of determining the IRs for a service contract is, therefore, critical. Examples of this include determining whether a particular contract is feasible, whether existing information systems are capable, or whether further information system investment is required. The application of the approach we develop here to different contract types will show that there are differences in the IRs from contract to contract.

General differences in the IRs from contract to contract are largely attributable to the new responsibilities taken on by each party involved in the service operation. Independent of the contract type, information is said to provide a positive impact on the performance of the provider and the customer as they gain from improved management of assets, reduced costs of operations and enhanced productivity (Klein & Rai 2009). In a spares and repairs contract the provider is unlikely to have much, if any, information recorded about the post-sale use, condition or deployment of the asset (Parlikad & McFarlane 2007). Such information, if recorded, would historically have been kept by the user–maintainer or a sub-contractor. The main information, to which they would have access, would relate to the manufacture of the asset. Spares inclusive contracts would have similar IRs to the spares and repairs contract although more access by the manufacturer to the post-sale asset, and some information in relation to it, would be enabled. Availability contracts demand a more significant shift in the information used by the provider as the manufacturer/provider must be kept well abreast of, for example, the use, condition and location of the deployed or post-sale asset. Capability contracts are potentially the antithesis of the spares and repairs contract from an information perspective as the provider is likely to be the dominant user of information as they take on sole responsibility for the maintained assets. The service and contract, in many cases, will be designed concurrently with the 'capability-enabling' asset and the IRs will be generated within the provider domain.

3.2 Information collection, ownership and usership in different contract types

Having presented some initial differences in the IRs from contract to contract, we note that there are important issues, as a consequence of these different IRs, which relate to the collection, ownership and use (referred to as 'usership') of information.

3.2.1 Collector

The collector of information plays a key role in influencing the information timeliness (of collection as opposed to provision to a third party), accuracy, completeness of the information and hence aspects of the quality of information. The collector will maintain control of the information until it has passed to the owner of the information. As the type of contract moves from spares and repairs towards capability, the provider may collect more data from, what was originally, the customer domain.

3.2.2 Ownership

Once the information is within the owner's domain, the owner gains control of the information. It is then at the owner's discretion to share the information. Whether the information is stored in an information system, or manually recorded in a logbook, the location of the information is unlikely to change between the different contracting models. What will change, however, is the information which is required and used by the different parties providing these different types of contract. The owner of the information will influence the timeliness (of information provision) and its accessibility.

3.2.3 Usership

The information user (as opposed to the service user) will have a set of IRs in order to satisfy the service operation. As the contracting models move from the more basic spares and repairs contracts, towards the performance-based availability and capability contracts, much of the usership of information will move towards the provider's domain.

On the basis of the different collector, owner and user of information, the different areas of the service model (Figure 4) may be shaded to indicate whether the IRs lie within the domain of the customer, the provider or both. Figure 5 shows simplified versions of the service model (Figure 4) with shading to indicate the division in the control (in this case with the owner) and use of information between the customer and provider across the four types of contract. This shading is based on the output of a more extensive set of nine case studies carried out within the UK defence industry (Cuthbert 2009) and highlights areas of mismatch between the control and use of information. Within this framework the customer is represented to the right-hand side, and the provider is represented to the left-hand side. In this case, the information is attributed to the customer or to the provider.

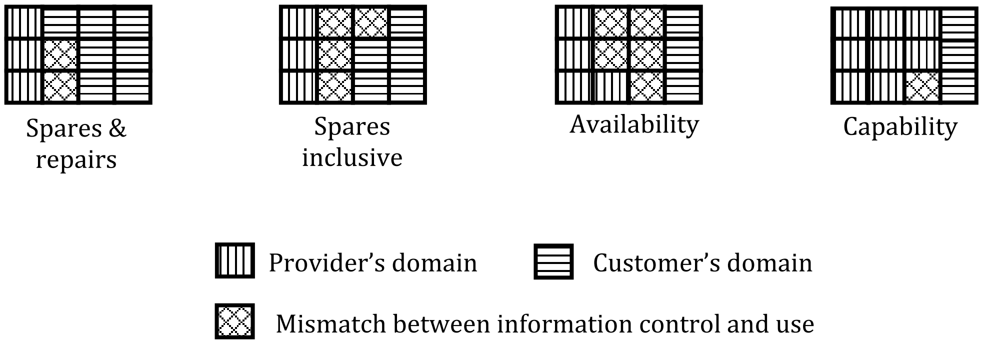

Figure 5 – The distribution of information between provider and customer, highlighting mismatches between information control and use.

From Figure 5 it can be seen that, for a spares and repairs contract, information use tends to be more prevalent within the customer domain, apart from those areas specific to the provider's products. In contrast, for capability contracts, the reverse tends to be true and the customer concentrates on the specifications and their fulfilment. For both spares inclusive and availability contracts, where the responsibility and accountability around the contract is shared, information is used by both the customer and the provider and a mismatch can be seen between the control and use of this information. This is due to the fact that both parties have specific responsibilities relating to the service (Cuthbert 2009). Comparing the spares inclusive or availability contracts with spares and repairs contracts, the provider will have more responsibility for servicing the complex engineering assets and, therefore, will require more information about the use and condition of the post-sale asset. An example of this includes particular failure patterns encountered in the servicing of the asset. Such information may not be used or recorded by the customer in the context of spares inclusive contracts as this responsibility lies with the provider. However, in a spares and repairs contract the customer, and not the provider, is likely to be aware of this. Similarly, comparing the spares inclusive and availability contracts with capability contracts, the customer will use less information as the provider has full responsibility for delivering the required capability to the customer. In the case of the capability contract, the provider will be contracted to provide a particular capability, e.g. aircraft able to fly a set number of hours carrying a set number of passengers including required support/spares/repair (National Audit Office 2007).

Figure 5 may be overlaid on Shuttleworth's diagram (Figure 3) (Shuttleworth 2006). The addition of these schematics highlights the mismatch in information use and control for each of the contract types. It illustrates that, at the extremes (i.e. the spares and repairs and the capability contracts), there is a relatively low level of information exchange between the owner and user while the level of information exchanged for the spares inclusive and availability contracts presents increased complexity. For example, a simple part replacement will depend upon the timely and accurate reporting of faults by the customer/asset user. Such information may be logged while the asset is deployed and this may not be conveyed to the provider until long after the event. Such an event will then rely on provider information to plan the required maintenance activity (asset availability, spare parts, resource, infrastructure etc.) and may have a knock-on effect on the planned maintenance of other assets within the same fleet as resources are diverted from scheduled activities. In such cases, the contract performance is dependent on the alignment of the information between the provider and customer (Ng & Ding, 2010). Further to these issues is the matter of what information would be needed, over and above their current level of information, in order for a provider to change the type of contract provided. The change in the shading for each box indicates areas where different information may be required. Such a change in contracts supporting the service provision would require a transition by the provider, which will be one of routes A to D, as shown in Figure 6. It may even be the case that some are transitioned in the opposite direction if the service is to be simplified or if the customer wants to in-source particular functions. Many of these routes will highlight gaps in information which need to be filled. Route A will require incremental changes in the provider's information, routes B and C will require more significant steps in information, and route D will require a complete overhaul of the provider's information capability. These transition routes and their corresponding information issues need to be borne in mind when transitioning between contract types for a particular service.

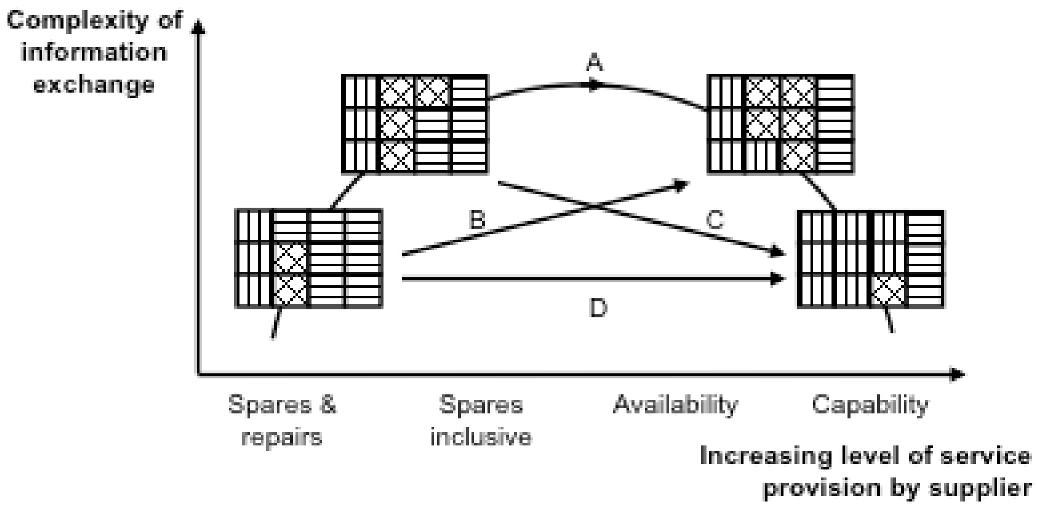

Figure 6 – Information control and use with transition routes between different contract types.

3.3 Procedure for establishing information requirements for different contracts

With these issues in mind, we now propose guidelines for the way in which the 12-box service model (Figure 4) is applied to a number of contracts to determine their IRs (Cuthbert et al. 2008). The process by which the model will be applied uses the three-phase approach for each contract in parallel. Throughout the process there are then comparison points to understand the key IR differences and the key controllers of the information (see Figure 7).

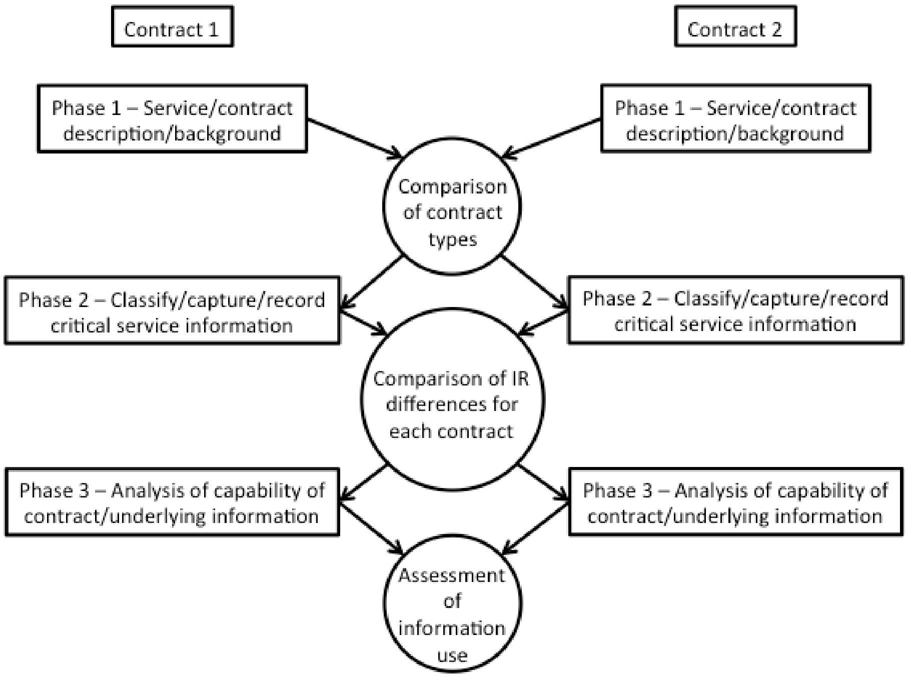

Figure 7 – Adapted three-phase process for contract comparison.

The three-phase approach (McFarlane & Cuthbert 2012) is used to assess the two contracts being compared and to understand the contractual requirements and constraints. Phase 1 determines the service description for each contract. The output of phase 1 from each contract is then compared to understand and outline the key differences between the contracts being compared, and the likely sources of information.

Phase 2 of the three-phase approach is then applied to each contract. This stage captures the key decisions and IRs for the services provided. Following this phase, the IRs for both of the contracts are compared under the adapted three-phase approach. The output from the stage provides an indication of which IRs are used for which type of contract, and where there are IRs common to both contracts or specific to one contract only. An example of the adapted 12-box model output for the side-by-side comparison of the two contracts is shown in Table 2.

Phase 3 then analyses the capability of the contract and the underlying information systems/services for each of the contracts. The comparison stage following this assessment shows where the information is used for each of the contracts, and how the domain of use changes for the different contract types studied. The output from this is a representation of the areas of information used to support the service, as shown in Table 2.

The application of the 12-box service model in this case will show the IRs and decisions of the two contracts, the results of which may be used to highlight any gap between the IRs for the different contract and areas of contract-specific information needs. The output will provide an indication of any differences in information needs for two or more given contracts and may also provide an indication of how reliably this information is made available to the contract provider. It will also indicate the collection, ownership and usership of the information.

4 CASE EXAMPLE: MOBILE DEFENCE EQUIPMENT PROVISION

In order to illustrate the use of the framework for different contract types, an example from the UK defence industry is presented. The case study is taken from a broader set of nine case studies (Cuthbert 2009) and is based on a service, provided around a mobile piece of complex engineering equipment, which was originally provided on a spares and repairs contract and which has now transitioned to a spares inclusive contract.

4.1 Background to case study

The product around which this contract was established has been in commission since the mid-1990s. At this point there was no contract for maintenance of the assets and the customer carried out any testing and maintenance of assets which was deemed necessary. They also managed their supply chain and ordered spare parts.

About five years later, a spares and repairs contract was set up around this asset. This initially involved the supply of assets by industry, and subsequently the provision of spares and maintenance on a case-by-case basis. The new contract differs in the provision of the maintenance where repair, upgrade and overhaul are carried out by joint provider–customer teams. As illustrated by this case study, information has been central to the organisation's ability to effect this transition.

This study provides an unusual illustration of the transition between contract types where the service is maintained between the existing customer and provider. The nature of the information needed for the spares and repairs contract included information about the spares demand which, by now, the provider had collated with a good deal of accuracy from their internal information system. Other information which would have been beneficial to the contract would have related to its logistics and transportation which, provided by the customer, was slow and problematic.

This contract was re-negotiated after a further five years and a spares inclusive contract was established. This new contract was set up using relevant and accurate provider-recorded information from the spares and repairs contract which included, for example, the historic spares demand and supply. The nature of the information needed for the spares inclusive contract went beyond the requirements of the spares and repairs contract and included information about the key performance indicators which guaranteed equipment readiness and availability. Information about the upgrade and maintenance of the assets, which was a combined activity carried out in conjunction with the customer's personnel, provided a less reliable and less readily available source of information. In fact, this information was very poor as the customer had failed to record accurate information whilst carrying out these activities under the previous contracting arrangement.

4.2 Case study approach

In order to understand these differences in IRs between the spares and repairs and the spares inclusive contracts, the procedure for comparison of contracts, described previously, was applied. For the set of case studies, a UK defence organisation was chosen which provides complex engineering spares, maintenance and equipment against a range of discrete and performance-based contracts. A key driver in choosing this organisation was the opportunity to compare multiple contracts provided to different end users by a single organisation. Within the organisation, three semi-structured interviews were carried out with the executives and operations managers to extract key IRs for the two contracts. This approach, using the 12-box service model, provided a structured method for determining background information and extracting the key decisions, IRs and information availability for a given service contract.

The differences in the IRs between the spares and repairs and the spares inclusive contracts are predominantly in the territory of the maintenance and upgrade activity taken on by the provider for the spares inclusive contract. With this additional responsibility may also come a degree of accountability. For example, this may require additional information, in relation to the safety of the asset, to prove compliance to regulatory bodies. The control and use of the available information was also identified. By applying this model the information gap between the current state spares and repairs contract and the future state spares inclusive contract will be highlighted.

4.3 Case study results

During the provision of the spares and repairs contract, a significant level of information is gathered by the provider about the service and the customer's use of it. Although further information is required for the spares inclusive contract, the information which is already available to the provider through the spares and repairs contract is of high integrity, enabling the provider to move into this new contract with a reduced level of risk arising from the information availability and quality as this is already of a known quality. Borek at al. (2011) show how the availability and quality of information can have a significant bearing on resulting decisions and actions, and can be used to help mitigate the potential risks. Table 2 shows the populated service information model for the spares and repairs and spares inclusive contracts indicating the information required and used.

Stage	Operation	S&R Use	SI Use
Design	Dependencies of contract (eg KPIs with other providers/customer)	|||	|||
Design	Manpower/skill level available to carry out planned service	|||	|||
Design	Regulations (e.g. X-worthiness) to ensure tools, equipment etc are in place to carry out service appropriately.	|||	|||
Design	Which partners have access to which info	N/A	≡
Design	Existing IS structure/capability	N/A	≡
Design	Equipment to be maintained	N/A	≡
Design	Where assets are in current maintenance cycle	N/A	≡
Design	Planned costs of maintenance	N/A	|||
Design	Current maintenance schedules	N/A	≡
Design	Likely plan for maintenance operation	N/A	≡
Design	Maintenance infrastructure	N/A	≡
Design	Restrictions (e.g. security level of information)	N/A	≡
Delivery	Actual costs to support asset	|||	|||
Delivery	Actual manpower/materials available to carry out maintenance	≡	|||
Delivery	Deployment of assets to determine what maintenance is likely to be required	≡	≡
Delivery	Location/condition of spares/fleet	≡	≡
Delivery	Current stock levels and unrepaired assets in system (available to be repaired if required).	≡	|||
Delivery	Maintenance carried out by subcontractor or customer	N/A	≡
Delivery	Daily state of fleet - what is serviceable/unserviceable/under repair/deployed	N/A	≡
Delivery	Availability of asset itself for maintenance	N/A	≡
Delivery	Design upgrades required on asset which need to be planned into the service delivery	N/A	|||
Delivery			
Delivery			
Evaluation	Maintenance carried out compared with that which was planned	≡	|||
Evaluation	Asset forecast, use and location (to determine maintenance/capability needs)	≡	≡
Evaluation	Trends in failures/spares used/assets which failed	|||	|||
Evaluation	Maintenance carried out to be fed back into the design and delivery stages for continuous improvement	N/A	|||
Evaluation	Causes of parts/asset failure - why did these happen?	N/A	≡

Stage	Offering	S&R Use	SI Use
Design	Predict spend during contract	|||	|||
Design	Historic info on use of fleets	≡	≡
Design	Historic info on maintenance activity	≡	≡
Design	Where Line Replaceable Units (LRUs) are assigned for maintenance	≡	|||
Design	Current condition of assets/parts	N/A	|||
Design	Feedback from evaluation to improve the service	N/A	≡
Design	Cost model to ensure that it will meet customer's affordability	N/A	|||
Design	Current location of assets/parts	N/A	|||
Design	Configuration control	N/A	≡
Design	IT offerings used/needed	N/A	≡
Design	Current subcontractor arrangements	N/A	≡
Design	Personnel (existing) arrangements	N/A	|||
Delivery	X-worthiness rules/regulations	≡	≡
Delivery	Actual labour/tools/parts spend/support costs	|||	|||
Delivery	Actual consumption in supply chain	|||	|||
Delivery	Changes/issues (real time) whilst deployed.	N/A	≡
Delivery	Suppliers on status of spares within repair loop	N/A	|||
Delivery	Customer conducted planned or corrective maintenance	N/A	≡
Delivery	Materiel state of repair on return from deployment	N/A	|||
Delivery	Labour/parts/tools required to carry out task	N/A	|||
Delivery	Log of asset use/utilisation or where it has been sent if removed	N/A	≡
Delivery	Usage of the system at a component level with failure analysis	N/A	≡
Delivery	Main faults which have occurred and required fix	N/A	≡
Evaluation	Cost of service - time/money spent versus the budget	|||	|||
Evaluation	Issues (pending penalties with other contracts etc) to evaluate the best use of resources at a given time	N/A	|||
Evaluation	Events before/during/after asset breakdown to assign accountability and evaluate appropriateness of service	N/A	≡

Stage	Specification	S&R Use	SI Use
Design	Range and scale of spares (Classification of assets & associated spares to determine criticality levels & prioritise those stocked)	|||	|||
Design	Support costs for supporting asset	≡	|||
Design	Historic asset performance	≡	≡
Design	Existing contracts from which to extrapolate to model	≡	≡
Design	Customer's current performance level received	N/A	≡
Design	Spares/materiel use (not demand)	N/A	≡
Design	Future capability requirement/deployment	N/A	≡
Design	Current asset configuration/materiel state of repair	N/A	≡
Design	Spares provision from other OEMs	N/A	≡
Delivery	Asset disposition/where has the asset been?	≡	≡
Delivery	Actual spares usage	N/A	≡
Delivery	Sortie deployment - why wasn't the sortie achieved?/what went wrong?/was the sortie needed at all?	N/A	≡
Delivery	Real time info (regularly updated) from customer with information about asset to help plan maintenance activities	N/A	≡
Delivery	Changes made to the configuration by the service provider	N/A	|||
Evaluation	Measure and populate the KPIs	≡	≡
Evaluation	Indicate where/why KPIs were not met	≡	≡
Evaluation	Independent cust/supplier evaluation surveys	N/A	≡
Evaluation	Determine appropriateness of KPI with respect to contract and need	N/A	≡

Stage	Need	S&R Use	SI Use
Design	Assets/hr needed	≡	≡
Design	Ongoing customer need	≡	≡
Design	Military effect needed	≡	≡
Design	Systems/capabilities which need to be operational	≡	≡
Design	Fleet deployment (geographical)	≡	≡
Design	Asset non-usage time during which maintenance can be carried out	N/A	≡
Design	Customer budget	N/A	≡
Delivery	Technical data to enable customer to carry out some of the maintenance whilst deployed	≡	≡
Delivery	Front line actual use of asset	N/A	≡
Delivery	Customer needs to understand what information needs to be recorded.	N/A	≡
Delivery	Train customer personnel to best use capabilities	N/A	≡
Delivery	Current materiel state of the asset as a result of the delivered service, and any concessions/design changes which may impact use.	N/A	|||
Evaluation	Feedback from user (e.g. air command) not just the IPT (middle man who defines the contract needs)	≡	≡
Evaluation	Actual success against customers mission	≡	≡
Evaluation	Demonstrate (to customer who is recording) value of recording info.	N/A	≡
Evaluation	Demonstrate credibility as a supplier	N/A	|||
Evaluation	Surveys by customer/partners/supplier	N/A	≡

Supplier ||| Customer ≡

Table 2 – The information required and used for a spares and repairs (S&R) and spares inclusive (SI) contract.

4.4 Case study analysis

The analysis of the case studies covers the main areas, introduced earlier in the paper, which relate to the availability of required information, the information complexity factors, and the challenges for an organisation in transitioning from one contract type to another to enhance their service provision to a customer.

From the case studies, it can be seen that there is a significant level of information which is used for both the spares and repairs contract as well as the spares inclusive contract. Within this section we examine the IRs for the different contract types and then review the information complexity factors, or the differences in the collection, ownership and use of information. Finally, we look at the IR outputs from these two contract types, and examine the contract transition challenges from an information perspective.

4.4.1 Initial information requirements

From this case study material, examples of information used for the spares and repairs contract which were well established within the contract include:

- *a knowledge of the service need and capabilities*; impacted by providers failing to understand customer needs and customers failing to articulate their needs, possibly due to not understanding the potential service capabilities;
- *historic information* on spares, asset performance, asset use and maintenance. In this case the contract was previously provided by the same provider so the historic provider-owned information exists in a reliable and accurate condition. In other instances this could be customer-owned and less reliable;
- *support costs and predicted spend*; from a spares perspective;
- *supply chain*; a knowledge of where Line Replaceable Units (LRUs) are situated within the supply chain, level of spares ordered/current stock and the number of unrepaired items;
- *performance metrics for supply of parts*; including information on the current service performance level received by the customer.

4.4.2 Information requirements for the transition to the spares inclusive contract

The above areas indicate available information which was seen as integral to the spares and repairs contract. In moving towards a spares inclusive contract, additional information used within this contract was identified from the application of the framework to the case study and include:

- *modelling/forecasting information*; including failure trends of components, spares usage and information about failed assets;
- *regulations*; service providers must take responsibility for the maintenance and service provided around the assets to ensure that information is available to them to understand the requirements of regulations and deliver against them, and that information is available to the regulatory bodies;
- *dependencies*; including key performance indicators (KPIs) between parties involved and manpower available from the customer for joint maintenance activities;
- *current service level for spares and maintenance*; the incumbent is aware of the previous performance level of the contract.

Furthermore, the use of information differs for the two contract types. These results (Table 2) correspond with Figure 5, which indicates the distribution of the use and control of information for different service contracts.

4.4.3 Information complexity factors

The information complexity factors, noted previously, are important in the context of our results. The discrepancy in the collection, ownership and usership of information for the spares inclusive contract, in particular, shows the importance of information sharing and exchange between the customer, provider and other parties where there is a dependency on information for delivering the service. The collector of information carries responsibility for the processing of information as it is input from, often, manually recorded data entry to an organisations Information System. Indeed, the collector of information has control at this stage until the information is passed on to the owner. Where information is shared, information needs to be in a format which will allow different Information Systems to process this. Furthermore, the shift in the usership will impact the formality with which IRs are specified and recorded and, therefore, the quality of the information.

The important element to note here is that, for this example, the two stages of the provider's provision differ only in the contractual set-up as both contracts are provided for the same asset to the same customer by a single provider. The different types of contract dictate different service provision requirements and, hence in each case, the contract type used impacts the information used for that type of contract. For example, if a customer requires 99% availability as a performance target then, based on these exploratory studies, there is likely to be some similar information which will be used regardless of whether there is a spares and repairs, spares inclusive or availability contract in place. However, there will also be some information which is specific to the particular type of contract. The spares and repairs contract would not require the provider to have any knowledge of the consumption of spares by the customer but just the spares demand while the spares inclusive contract provided for the same asset, the spares demand would need to be known by the provider in order that they may plan and forecast the consumption and the cost of providing the service.

4.4.4 Risk and Information Requirements

IRs are often subject to a process of interpretation as relevant and appropriate information needs to be distinguished from multiple sources/systems (Odasso et al. 1996; Schenk et al. 1998, Borek et al. 2011). Within the context of this work, the risks are associated with the possibility of making incorrect decisions in the design, delivery and evaluation of services. Lawrence illustrates how the availability and informativeness of information can influence the decision making process and the level of risk taken on by a decision maker (Lawrence 1999).

The nature of the service contracts which are provided, such as those of the case example, are such that the information supporting them is often distributed as it is collected, owned and used by different parties. Within each stage of the service life cycle for the case example shown, are key decisions which must be taken. These each rely on the availability of required information, examples of which are shown in Table 3.

	Decision	Examples of information required
Design	Provider needs to decide whether they fully understand the customer capability requirements	Assets per hour, current and future operational capabilities/systems, budget
Delivery	Decide how to optimise running system to maximise profit/minimise cost	Actual cost of service (manpower, materials etc), performance achieved, future requirements of service provider
Evaluation	Decide appropriateness of service based on satisfaction of customer	KPI reporting, evaluations surveys, feedback from user, KPI/service need alignment, service cost

Table 3 – Examples of key decisions and the information upon which they rely.

4.4.5 Contract transition challenges

The information sets derived for the two types of contract, which were subject to the case study, demonstrate a high level finite set of categories for IRs. To highlight the differences between the contracts, the IRs are summarised in Table 4.

IR Categ-ories	IR issues (from supplier's perspective) for the illustrative example		Transition challenges
	Spares and repairs	Spares inclusive	
1 – Service need	Requirement for a clear knowledge of the service need and capabilities	Requirement for a clear knowledge of service need. Service scope is complicated by involvement of both customer and supplier in the maintenance operation and the need for further information in relation to this. In this instance, a working knowledge exists due to previous spares and repairs provision by the incumbent.	Need to define a clear demarcation of roles between customer and supplier. Ascertain additional information to be acquired for maintenance.
2 – Historic information	Information required in relation to spares, asset performance/use and maintenance activity.	Information requirements from the spares and repairs contract provides a basis from which the service profile may be developed. Further to this, information about the deployed asset is required, including information about changes made by the user so that appropriate decisions may be made during the maintenance cycle.	Reliable recording/timely transmission of maintenance info for asset whilst deployed should be sought. In context of the UK defence industry the bandwidth for transmission of information is often limited so needs to be justified as a key need.
3 – Support costs	Financial information about previous support costs/predicted spend from spares perspective required at outset.	Information relating to the spares spend will be required, as for the spares and repairs contract. Further to this, information is required in relation to maintenance costs but these are not available at outset of contract.	Maintenance previously carried out by customer. Information on previous support costs will be required to effect transition.
4 – Info Modelling	Modelling of spares demand (not usage) only.	Modelling/forecasting information required on component failure trends, spares usage, failed assets etc in order to predict likely spares usage as consumption will be managed by the supplier, rather than the customer, within this contract.	Information on usage of spares to determine loading of supply chain. Information needed from customer and OEMs.
5 – Current serv. level	Information required about the service level may not be known.	Information required about the service level may not be known.	None
6 – Supply chain	Information required on condition/location of spares to enable spares provision on request. Only available on spares demand.	Information is required, but not available on actual spares use (not demand). Information is needed to anticipate the likely upgrade and maintenance required.	Need to model the likely demand to anticipate the required supply. This will require historic information from the customer.
7 - Dependencies	Information required to indicate which other parties are involved in the supply of this service. This contract shows a lack of information on spares provision from other suppliers.	Information on maintenance infra-structure, "reverse" KPIs from customer to supplier are required. Info also required to indicate other service providers involved. This information would enable an understanding of what information may be provided/accessed and what information needs to be shared with other parties involved.	Clear understanding of which parties are involved and in what capacity. Appropriate information then needs to be accessed/ accessible between organisations.
8 - Regulations	Regulatory information is outside supplier domain for this type of contract.	Information is required on regulations as this impacts maintenance tasks carried out jointly between the supplier and customer. Associated information must be made available to regulatory bodies etc.	Determine the information and regulatory bodies associated with this work. Identify format, frequency, auditing of information required to ensure compliance with regulations?
9 – Perf. metrics	Information is required on performance metrics/levels received by customer at outset of contract.	Information on the previous contract is known as the spares inclusive provider is the incumbent (in this instance).	To identify the key metrics to provide representative measures of the service. To determine the IRs from the customer and other providers to populate metrics.

Table 4 – Summary of information issues and requirements by information category for spares and repairs and spares inclusive contracts.

Table 4 indicates some of the differences, from the provider's perspective, in the IRs for the spares inclusive contract compared with the spares and repairs contract, determined through the application of the '12-box service model'. It also provides some transition challenges from an information perspective, in order to transition from a spares and repairs to a spares inclusive contract type. The progression from the spares and repairs to spares inclusive contract will require the provider, increasingly, to access the customer operations in order to gather data. Furthermore, the provider will be reliant on the customer to gather, hold and share data required to deliver the service. The continued provision of such information forms a key element in the service and any interruption in its provision poses an area of risk to the provider. For most of the IR categories presented, a set of core information is required for both contract types. In most instances, additional information is then required by the provider as they move into the spares inclusive contracting domain. This corresponds with the first part of transition path 'A' indicated in Figure 6. Examples of such information relate to the actual consumption of spare parts, the maintenance, upgrade and regulatory compliance of the equipment concerned, and the additional involvement of the customer in the activities undertaken as part of the spares inclusive contract. Furthermore, the table indicates that within the 'current service level' and 'performance metrics' IR categories, the IRs for both the spares and repairs and the spares inclusive contracts do not differ. What is not evident from the application of this model to a number of frameworks is an indication of the location of the information and, therefore, the corresponding complexity in the exchange of information and the transition between contract types for the provider. Also, an assessment of which information is critical to the contract has not been determined within the application of the model.

5 Discussion

The approach used within the case study is an adaptation of that presented by McFarlane & Cuthbert (2012). Within this section, we provide some discussion around the benefits and drawbacks of the approach taken.

5.1 Benefits

A key benefit of the approach taken is that the full life cycle is covered by the assessment used. Within this context, the focus is purely on understanding the key decisions and information requirements of the provider in order to design, deliver and evaluate services. Once these have been established, the approach then makes a comparison of these elements between two such contracts. This then helps to highlight any problem areas for information provision between two contract types which may be necessary if, for example, a service provider is required to "upgrade" their service provision.

5.2 Drawbacks of approach

The main drawbacks of the approach are that it potentially gives a general view of the information requirements for a given service contract, and represents information trends for each of the 12 boxes of the model at a high level. However, the information issues at a higher level of granularity may show some different issues.

As with the original approach upon which this is based, the cases only show information issues from a provider perspective and, hence, the same information may also be used by the customer but not recorded as such within this assessment method. Furthermore, the information ownership represented has been based on that perceived from interviewees and therefore may be subjective.

5.3 Practical observations

The approach taken highlights areas of business risk from an information perspective. Some practical observations are that:

- the information captured within the process is interviewer/interviewee dependent;

- interviewer/interviewee perspectives, relating to information availability, may vary, e.g. the information is sometimes inconsistent in terms of how available or accessible it is perceived to be;
- the approach only looks at information requirements;
- information problem areas are highlighted at a high level;
- solutions, or approaches to solving highlighted problem areas, are not provided.

6 CONCLUSIONS

This paper presents an approach to extracting service IRs within service providing organisations as well as a number of the information issues related to CES contracting. The approach is focussed on the information elements of the service life cycle and the definition of the service process for two different, and successively provided, contract types. The output from the application of the approach provides a clear distinction between the core IRs for both types of contract and the additional IRs for the increasingly provider-driven contracting arrangements. It also highlights some of the information complexity issues introduced earlier in the paper, and the potential challenges of transitioning between different types of contract.

6.1 Contract information requirements

For a given service operation, the information required by the provider and the customer will be distributed between both parties, as well as other third-party providers. In the example studied, it is apparent that organisations tend to support multiple services provided against different types of contract. The particular study presented shows an example of a UK defence industry-based organisation ‘upgrading’ its service provision from a spares and repairs to a spares inclusive contract. This is one of many services provided by the organisation and, in supporting these different contracts, the organisation needs different sets of information as shown in Table 4. The provider’s task changes and involves many of its operations being carried out within the domain which was traditionally regarded as that of the customer. With this change in the provider’s scope comes an increased level of responsibility for assets being serviced to ensure, for example, that they comply with regulations. This increased remit presents a need for a more formal IR specification which will, firstly, mitigate an increased level of risk to the provider and, secondly, have implications for the information systems employed by the provider for different contract types. What is seen in the example is that some IRs are often common to different contractual set-ups while other IRs are specific to a particular contract type depending on the responsibility and accountability of each party involved.

6.2 Information distribution

The type of contract supporting the service operation will also impact the domain within which the required information will be owned and used as well as how it is controlled, acquired, communicated, stored, exchanged or processed. These are referred to as the ‘information complexity factors’ and may impact the consistency of the information availability and quality. In the case example, the usership and control of the information is identified illustrating clear differences between the two types of contract studied.

While information is required, the control of this information will differ from the ‘usership’ of the information and may not necessarily be available to all parties. What still needs to be determined is which information is critical to the service and the contract, and the impact that this would have should it be unavailable. An example of this is regulatory information enabling the provider to demonstrate compliance which would be critical in some contractual set-ups but not others, depending on the accountability taken on by the provider. Furthermore, the performance level required will impact how much critical information is available, or made available, to the provider. A reduced set of critical information may lead to a lower service performance, but this may still be within the allowable bounds of the contract. These results suggest the existence of a trade-off between contract type, performance and availability of critical IRs.

6.3 Contract transition

These information requirements, availability and complexity factors have an impact on the ability of an organisation to transition between contract types. The indications from the case example are that core information is used within each information category across different service contract types. Additional information is then required for the spares inclusive contract across most of the other information categories. This suggests that information, over and above the core information, is needed to transition between the spares and repairs and spares inclusive contracts and that the provider will need to access other domains to gather data. For organisations transitioning between contract types, it is key that they are assisted by appropriate information systems with built in flexibility to deal with the change in the information needs by the provider for the different contract types. The system would need to be able to effect changes swiftly, identify the critical information for the different contractual set-ups and ensure information availability from internal and external sources.

Future investigations, beyond the immediate scope of this paper, would be to verify this UK defence industry-based work by applying it within other (non-defence) sectors where the results are likely to be broadly applicable.

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Biographies

Rachel Cuthbert is a Doctoral Researcher and Research Associate in the Distributed Information and Automation Laboratory (DIAL). Her research focuses on service information requirements for complex engineering systems, and she is currently focussing in her PhD on the performance of information systems in supporting the delivery of availability service contracts. Rachel is involved in the KT-Box Programme and Cambridge Service Alliance.

Rachel received her MA/MEng degrees in Engineering from Cambridge University in 2000. She received an EPSRC-funded place on the Advanced Course in Design, Manufacture and Management at the Institute for Manufacturing, Cambridge University, which she completed in 2001. Rachel gained significant industrial experience, between 1995 and 2007, from her work in research & development, manufacturing and supply chain roles within different engineering sectors in the UK and overseas. Since 2007 Rachel has been a Research Associate within DIAL. She was awarded her MPhil, entitled 'The information requirements for service development', in May 2010. Rachel is a Chartered Engineer and a Member of the Institution of Mechanical Engineers (2004).

Duncan McFarlane is Professor of Industrial Information Engineering at the Cambridge University Engineering Department, and Head of the Distributed Information & Automation Laboratory within the Institute for Manufacturing.

Duncan completed a BEng degree at Melbourne University in 1984, a PhD in the design of robust control systems at Cambridge in 1988, and worked industrially with BHP in Australia in engineering and research positions between 1980 and 1994. He then joined the Department of Engineering at Cambridge in 1995 as a lecturer in the area of industrial automation systems.

Duncan has been involved in the design and operation of automation and information systems for the industrial supply chain for 20 years and his research work is focussed in the areas of distributed industrial automation, reconfigurable systems, RFID integration and valuing industrial information. Most recently he has been examining the role of automation and information solutions in supporting the service and construction sectors.

Andy Neely is Founding Director of the Cambridge Service Alliance and Deputy Director of the Advanced Institute of Management Research. He is widely recognised for his work on the servitization of manufacturing, as well as his work on performance management. He holds joint posts at Cambridge University and Cranfield School of Management. Previously he has held appointments at London Business School, Cambridge University, where he was a Fellow of Churchill College, Nottingham University, where he completed his PhD and British Aerospace. He was elected a Fellow of the Sunningdale Institute in 2005, a Fellow of the British Academy of Management in 2007, an Academician of the Academy of Social Sciences in 2008 and a Fellow of the European Operations Management Association in 2009.