Smart Contracts for Global Sourcing Arrangements

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Abstract. While global sourcing arrangements are highly complex and usually represent large value to the partners, little is known of the use of e-contracts or smart contracts and contract management systems to enhance the contract management process. In this paper we assess the potential of emerging technologies for global sourcing. We review current sourcing contract issues and evaluate three technologies that have been applied to enhance contracting processes. These are (1) semantic standardisation, (2) cognitive technologies and (3) smart contracts and blockchain. We discuss that each of these seem to have their merit for contract management and potentially can contribute to contract management in more complex and dynamic sourcing arrangements. The combination and configuration in which these three technologies will provide value to sourcing should be on the agenda for future research in sourcing contract management.

Keywords: Global outsourcing · Contracts · E-Contracting · Smart contracts · Semantic standards · Cognitive technology

1 Introduction

Sourcing is difficult. Unfortunately, one thing that many sourcing arrangements have in common is a lose-lose scenario. A recent story on Dell's and FedEx's eight-year contract situation illustrates this. In 2005, Dell and FedEx wrote a 100 pages contract with numerous "Supplier shall" paragraphs to manage all possible issues in Dell's hardware return-and-repair process. During the following decade, both parties complied with obligations outlined in the contract. It was even re-negotiated at three occasions. Dell was unhappy with the lack of proactivity from FedEx - no innovation. FedEx was unhappy with the detailed processes description that had to be met - very expensive. At the end of the contract - none of the parties were happy, but none of the parties afforded to cancel or not to continue the relationship [1]. However, this is not a unique story in the history of sourcing arrangements and the contracts governing the relationship.

Contracts have existed since ancient times of trade and barter. Our current conceptualization of contracts can be traced back to the mid-1700s and the industrial revolution.

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In particular, the growing British economy and the adaptability and flexibility of the English common law led to the development of modern contract law. Mainland Europe, with its more rigid civil law, was slower in developing a legal framework governing the role contracts. Not until the 20th century and with the growth of global trade and sourcing agreements there was a need for international contract law. Today, we have a number of global conventions, such as the Hague-Visby Rules and the UN Convention on Contracts for the International Sale of Goods, that regulate trade and contracts.

So, what is a contract? Ryan defines a contract as "a legally binding agreement which recognises and governs the rights and duties of the parties to the agreement" that addresses the exchange of goods, services, money, or promises of any of those [2]. With time contracts and its interpretation has evolved. Most recently, a new type of contracts have emerged - so-called e-contracts [3]. The development of e-contracts has followed the emergence of digital signatures and electronic identification [4]. E-contracts, enables that the promise of goods, services, or money can be controlled and monitored by digital technologies and potentially automated [3]. Furthermore, the International Association for Contract and Commercial Management (IACCM) concludes in a recent report that the future of contracts will focus more on relationships instead of costs. Therefore, we expect that contract management will evolve to include a degree of "intelligence" and become "smarter" while becoming more relationship oriented.

A lot of the research on smart contracts related to cryptocurrencies [5–7], but have broadened its scope and include topics such as internet of things (IoT) [8], banking ledger [9], and global shipping [10]. However, there is still not much research on the use of information technology in sourcing contracts. One reason could be the complexity in sourcing agreements, where a contract could last for many years, spanning continents, involving multiple actors, etc. Therefore, our aim is to explore the role of information technology in sourcing contract management.

The remainder of this paper is structured accordingly: In the following section, we review contracts types in sourcing arrangements. In the third section, we broaden our review to issues and challenges in sourcing contract management. Thereafter, we look into the information technology developments for contract management systems including the recent emergence of smart contracts. In the fifth section we provide a synthesis and our assessment of the use of these technologies for sourcing contracts. We conclude the paper by combining and discussing our findings.

2 Contracts in Sourcing Arrangements

Outsourcing arrangements are agreed upon and governed by contracts. Contracts can vary from short and straight-forward to voluminous and highly complex, cf. Dell and FedEx. There are some main different types of contracts. The most common are Firm Fixed Price Contracts and Cost Reimbursement Contracts. In the first type price not subject to any adjustment on the basis of the contractor's incurred costs - this is the simplest form of contracts and imposes a minimum administrative burden. The second type gives the supplier payment of allowable incurred costs, to the extent prescribed in the contract. This opens up for some interpretation and negotiation. The different

types of contracts are determined by factors like the regulatory framework, complexity of the outsourcing services specified, total value, duration of the contract, the number of partners involved, and incentive or penalty clauses included. The variety in contracts follows the logic of Roman-based law: usus (right to use a good), fructus (right to what a good produces), and abusus (right to sell a good). Thus, clearly, the contract governing a multi-year multi-million sourcing deal is likely to differ greatly from the contract specification of a relatively simple and largely standardizes micro-service. Still sourcing contracts have much in common as well.

Sourcing Contract Templates, such as the sourcing contract template compiled by the Dutch Platform Outsourcing, give an overview of elements that should be present in a balanced and mature contract. This template was created by a committee of both vendor and client representatives and aimed at medium size to larger organizations and medium to complex services sourced [11]. The full table of contents can be viewed in the appendix. While some of the typical contract elements are relatively static, others require continuous monitoring and management. Think of contract changes, contract performance monitoring and auditing, and the enactment of penalties and bonus/malus schemes based on compliance and service level agreements.

The role of contracts changes throughout the four phases of global sourcing arrangements:

- Pre-sourcing collaboration: A global sourcing arrangement begins when an initiator start exploring the possibility to source services or resources externally via a tender process. In this phase the scope of the collaboration is defined by assigning roles to each company involved, inviting potential companies, and defining the business requirements. During this phase a draft contract or contract frame could be present, but often this phase is largely informal supported by trust and a sense of common purpose.
- Sourcing arrangement creation and consolidation. After a sourcing arrangement is established, procedures are formalization and rules and obligations are described in a contract. This also includes specific pricing agreements, incentive/penalty clauses and duration and renewal conditions. At the end of this phase, the selected services and/or resources should be implemented and made ready to be used.
- Sourcing arrangement delivery. In this phase, the sourced services or resources are executed. The contract should be managed and monitored. That is, actual execution and delivery performance should be monitored against the agreements defined in the contract. Contract rules should be executed when execution events trigger these. Incentives/penalties should be paid or charged as defined in the contract. Before the end date, the contract should be evaluated and renewed, or termination should be initiated.
- Partnership termination or succession In this phase a re-assertion of the contract is organized by the initiator and sourcing partners. Eventually this leads to termination of the contract, straight forward renewal or renewal after adaptation.

3 Challenges in Sourcing Contract Management

Sourcing and contract management is not easy. A case study on IT offshoring at Shell Global IT functions, clearly illustrates the central role a contract plays in a sourcing relationship [12]. Based on interviews with internal and external experts the study reveals that a contract is instrumental in governance of a sourcing relationship. It is input to joint processes between customer and vendor including performance management (is service delivery in line with the contract), financial management (is cost allocation and pricing in line with the contract), and escalation and relationship management (are measures taken in case of anomalies in line with the contract). Clearly the contract is also central in the contract management process. The Shell case also shows that interactions between the many roles in a sourcing relationship are better manageable if well-defined contracts are in place. Think of interactions between purchaser (client) and contract manager (vendor), service manager (client) and delivery manager (vendor), and innovation manager (client) and competence manager (vendor). Moreover, risk management and compliance benefit from well specified contracts. This included risks of confidentiality and compliance to legislation.

The main results of the Shell case are confirmed in a survey by McKinsey [13] that who reviewed 200 live sourcing contracts of over 50 companies, analysing three main dimensions: general terms and conditions, commercial terms and conditions, and governance structure. The review showed several frequent issues that hindered both supplier and customer. Some remarkable results of the McKinsey study, related to Sourcing Contract Management, are; (1) Purchasers and providers faced unclear definition of quality of service and limited tracking and control of business and financial targets (60%). (2) Few incentives for joint innovation (90%). (3) Limited collaboration (90%). (4) Key performance indicators had not been defined (75%), (5) No value-based negotiation on price and no mutual incentives and gain-sharing initiatives (67%).

Companies are often involved in multiple sourcing arrangements. Each of these arrangements may include multiple partners and a mix of services and resources (multi-vendor sourcing). “However, the lack of expressivity in current SLA specifications and the inadequacy of tools for managing SLA and contract compositions is relevant.” [14]. Outsourcing contracts span hundreds of pages of legal contractual language that describes the delivered services and their performance. As the terms and conditions use a variety of metrics usually specified in natural language, it becomes increasingly difficult to monitor the performance of the contract [15].

Empirical research into IT outsourcing contracts has revealed that a large variety exists in their structure. Moreover, perhaps counter-intuitive, their length and complexity tends to grow as contract partners gain experience [16]. The contracts are unlikely to be synchronized, i.e. a variety of contracts in different phases of their life cycle need to be managed. In many cases contract management cannot keep up with the increasing dynamics and complexity of the arrangements. This leads to insufficient monitoring and execution of contracts, no insight in compliance, incorrect payments, ignoring the rules specified and violation of renewal or termination conditions. Most contracts are still defined in natural language and no support for automatic negotiation of smart contracts is provided [17]. Contract management of sourcing arrangement can thus become a time consuming and complex endeavor.

Many of these issues require organizational measures and practices to improve the sourcing relationship contracting, Still, there also seems to be ample opportunity for emerging technology for contract management to address the issues described above, reduce the risks in sourcing of services and increase the value. While the research into e-Contracting has made considerable progress over the last decades, there is no comprehensive proposal that covers the full e-contracting life cycle [18].

4 IT for Sourcing Contract Management Systems

4.1 Contract Management Systems

Contract Management Systems are emerging that support the phases of sourcing arrangements and managing the lifecycle of contracts. Clearly, the possibilities of contract management systems are much more powerful if the contracts that are managed are e-contracts or smart contracts and not simply digital scans of printed documents. Recent, Contract Management Systems software is stand-alone program or series of related software programs for storing and managing agreements with sourcing partners. Its overall purpose is to streamline administrative tasks and reduce overhead by providing a single, unified interface to manage new contracts, capture data related to the contract and document authoring, contract creation and negotiation. The contract management system can then follow the contract as it goes through the review and approval process, providing documentation for digital signatures and execution of the contract, including post-execution tracking and commitments management. Most contract management systems are designed from the perspective of the buyer and have thereby a cost focus. This view is criticized by [1] since a contract fundamentally deal with at least two parties - buyer and seller. However, the contract management systems providers do not view or see a contract management system as a platform business or as a two-sided market.

Various standards, architecture and tools have been supported to facilitate the contract management process. These include automated support for identifying service providers and for negotiation and offer building. Business architectures have been proposed to build upon e-contract SLA standards. A study by [18] describes the design of such an environment that supports contract management processes such as price offering and billing, compliance, arbitration and mediation, reporting, and termination and archiving and eventually also support for negotiation and merging of subcontractors terms and conditions.

On the technology side, there is a historical progression from paper to digital format with varying degrees of possibilities of re-negotiation. In its simplest form a digital contract is just a tick off box at the end of a page or an app. For instance, when a company signs up for a Dropbox account to store or share different files. The other extreme is a contract management system that supports all activities related to pre-sourcing collaboration, sourcing arrangement creation and consolidation, sourcing arrangement delivery, and partnership termination. Clearly, the role of information technology varies between these extremes of digitalizes sourcing contracts from keeping track of approval to contract life-cycle management.

4.2 Semantic Standards for Contract Management

E-contract is any type of contract formed in the interaction between two or more parties using electronic means. The parties may be human or digital agents (computer software). This includes even contracts between two digital agents that are programmed to recognize the existence of a contract. See for instance the Uniform Computer Information Transactions Act that provides rules regarding the formation, governance, and basic terms of an e-contract. E-commerce is the legacy of most research and conceptualizations of e-contracts.

Based on nine contracting templates, a study by IBM research developed a Generic SLA Semantic Model for the Execution Management of e-Business Outsourcing Contracts [19]. They also use actual service agreements and based on these, develop a semantic model of a service contract that includes data common data elements (see Table 1). As the area of e-Business hosting is relatively well-understood, the study manages to standardise common service level agreements and measurement data, and based on these, define refund/reward specifications that can be automatically executed. The researchers also report they have successfully developed a contract management system based on the semantic model and a service specification language that would reduce the financial risk of service-level violations [20].

Table 1. Typical elements in an E-business service contract source: [19]

Description of service
Functional requirements of the service system
Start date and duration of service
Pricing and payment terms
Terms and conditions for service installation, revisions, and termination
Planned service maintenance windows
Customer support procedures and response time
Problem escalation procedures
Acceptance testing criteria, i.e., quality requirements that must be met before the service can be deployed for production use. These criteria could be stated in terms of, for example, benchmark-based transaction throughput performance, business-oriented synthetic transaction processing performance, fail-over latency, service usability, service system configurations (e.g. computer main memory size), etc.

More recently, and with the advent of cloud computing, studies have addressed contracting of cloud services. Advances have been made in viewing services as dynamic compositions and striving for machine readable SLA's based on standardised quality attributes and contract elements. The design of a tool named DAMASCO (DAta MAnager for Service COmposition) that offers SLA evaluation and assessment capabilities to IT professionals during the design phase is an example of such a study [14]. The authors propose an extension to the Web Service Agreement (WS-Agreement) standard proposed by the Open Grid Forum (OGF) to define agreements and their contexts

between providers and consumers, as well as a set of service attributes (e.g., name; context; guarantee terms; constraints), to obtain a flexible template for IT service contracts. A contract is composable of sub-contracts and includes standard specifications of items such as cost, duration, service quality and penalty.

4.3 Cognitive Technology for Sourcing Contract Management

An alternative to striving for more formal specification of SLAs is using text-mining techniques to elicit SLAs stated in the contract in natural language and evaluate their performance using data from service performance logs. A study by [15] is an example of such a study, proposing Fitcon - a contract mining system that detects service level agreements from contracts, tracks the delivery performance against them and predicts the health of long-term contracts. The study develops a framework to automatically extract SLAs and SLA metrics from contract documents, using IBM's Watson Document Conversion Service (DCS). Next SLAs and their performance are mapped to internal standards. Terms and conditions are extracted using a Natural Language Toolkit that works on top of DCS. The approach was tested on actual client contracts and evaluated with subject matter experts, demonstrating promising results.

Thus, the availability of a widely agreed, standardized model that would enable to apply templates to every type of contracts and SLAs, and to categorize contract terms to be used in different services domains is still a significant need [14].

4.4 Smart Contracts and Blockchain Applications for Sourcing Contract Management

More recently the secure storage of contracts in distributed ledger technology (DLT) or blockchain has been proposed to allow for open access by partners involved in the arrangement. Moreover, a DLT architecture can store mutually agreed upon transactions in a safe and decentral manner. For instance, a decentralized and blockchain based platform for temporary employment contracts is proposed in [21]. Their platform design address ensures temporary employees with the fair and legal remuneration (including taxes) of work performances and respect for the rights for all actors involved in a temporary and offers the employer support for processing contracts with a fully automated and fast procedure. The full transparency and immutability that blockchain offers would enable compliance checking of the rights of both of the worker and of the employer. Their proposed decentralized infrastructure makes use of the Smart Contract feature included in new generation block chain architectures such as Ethereum. The Smart Contract is stored in the blockchain and opens the possibility to store and execute contractual agreements without dependence on a regulator. The design by [21] proposed a work ledger, that is used to register work offers to which workers can apply. Agreements and work hours are also stored in the ledger. Smart contracts are used to check certification of workers, allow governments to check compliance to legislation, manage the relationship and transfer value automatically. The study describes an application of the concept to agriculture but does not include an implementation nor a field test. While many details still need to be addressed, the idea could also apply to international contracting of service workers in outsourcing arrangement without an intermediary platform or a sourcing

vendor. Smart contracting could thus be used to reduce the coordination costs involved in resource-based sourcing contracts.

A related development is the verifiable storage of degrees, credentials and certificates of professionals using blockchain and smart contracts. Especially in time/resource-based contracts, verification of the qualifications of professionals could enhance trust in the sourcing relationship. A conceptual architecture and prototype to this end is developed in [22]. They use the Ethereum blockchain and Smart contracts written in Solidity to manage the issuing of certificates to learners. Certification authorities validate or revoke these, and smart contracts verify that only accredited certification authorities can manage certification rights. Similar proof of concepts have been implemented by specific universities such as University of Nicocia, MIT, and University of Twente [23]. Using blockchain and smart contracts have also been piloted by companies such as SAP for their professional courses. Combined with educational domain standards (e.g. openbadges.org) such infrastructures may evolve into trustable global infrastructures that allows companies to verify qualifications and make the verification steps part of their contract.

A study by [17] applies the idea of Smart contracts to managing dynamics in cloud services. They propose a formal contracting language that should allow a contract to be updated automatically to include new requirements such as increased service capacity needs. This language is used to manage automatic adaptation, consistency check, and verification and change management of contracts. In addition, the authors propose a mechanism for autonomous negotiation based on the joint utility of client and cloud provider. The study is innovative in that it does not strive to achieve an exact match between client requirements and provider offerings. They focus on modelling the dynamic aspects of SLAs, i.e. under what conditions can SLAs change such as a pricing increment for enhanced response times of services. The smart contract proposal here focuses more on the automatic reconfiguration of the contract rather than on a blockchain architecture.

A smart contract application proposed by [24] even goes a step further. They implement a distributed peer-to-peer cloud storage platform DStore using smart contracts for the storage lease and automating the transfers. This offers a secure and effortless storage cloud that also facilitates financial settlement based on actual usage. Their proposal eliminates the role of third parties thus offering efficiency gains, especially when the demand for storage space is dynamic.

5 Assessment of Technologies for Sourcing Contracts

Based on the properties of the three technologies discussed, we provide an assessment of the potential of each of them to address contracting requirements (Table 2).

In Table 2, We indicate a clear and promising match between requirements and the features of the technology with a (+), and leave cells empty were we do not see a clear application of the technology. Where more research is needed to identify the match, we place a "?". The assessment presented in Table 2 illustrates that no single technology can address all requirements for Smart Contracts in isolation. The three emerging technologies should be combined and further developed to meet the demands of complex and evolving sourcing arrangements.

Table 2. Our assessment of the potential of reviewed technologies to address contracting issues

Contracting phase	Requirements for Contract Management Technologies based on current issues	Semantic Standards	CognTech	Block chain Smart Contr
Contract Definition and updating	Can value based negotiation be supported?	+	+	+
	Can contracts and subcontracts be linked and aggregated?	+		?
	Is service quality well defined, e.g. as precisely defined SLAs?	+		
	Can KPI's be defined?	+		
	Can terms and conditions be precisely specified?	+		?
	Can incentives for joint innovation be defined?	?		?
	Can renewal/terminal conditions be specified?	?		?
	Can multiple roles access the contract and update/change the contract according to their rights?			+
Contract Execution and Monitoring	Are collaborative processes in defining and updating the contract supported?			+
	Monitoring if service delivery in line with the contract?	+		+
	Monitoring if cost allocation and pricing in line with the contract?	+		+
	Are business and financial targets tracked?	+		+
	Can mutual incentives and gain-sharing initiatives be implemented?		+	
	Are measures taken in case of anomalies in line with the contract?	+		+
Contract Compliance and Health	Can the health of the contract be assessed?		+	
	Can business and financial targets be predicted?		+	
	Can Confidentiality be managed?			+

The next challenge is to evaluate to what extent these technologies, possibly combined, can relieve the sourcing contract issues and improve contract management practices and performance. We are currently working on theorizing on how a particular type of IT artefact - namely Contract Management Systems - can deploy a combination of semantic, cognitive and smart contracting technologies.

6 Conclusions and Future Research

We started out by revisiting the role of contracts in sourcing relationships. the literature on this area is vast, so we centred our introduction around the type of contracts currently in use during the phases in the life cycle of a contract. Clearly, sourcing contracts are a core element of a sourcing relationship and are of eminent importance. Next, we reviewed issues with sourcing contracts reported on in the literature. Remarkably, while both

clients and vendors in sourcing relationships often have very mature knowledge of IT and process automation, the sourcing contracts in place and the contract management process are usually not deploying and technology beyond traditional document management.

At the same time, various information technologies have emerged to support contract management. We evaluated the potential use of these technologies and systems in improving contracting for global sourcing arrangements. In this paper we illustrated this by reviewing three technologies: (1) Semantic standards, (2) Cognitive technology (3) Smart Contracting and Blockchain. These technologies have all received increasing attention over the past few years.

However, while they have been applied to (micro) IT-outsourcing, they have not been discussed and compared in the context of complex and long-running sourcing contracts. Pilots are mainly reported on in computer science-oriented conferences and journals and usually make use publicly available sourcing contracts or relatively standardized e-business or cloud sourcing arrangements. In Sect. 4, we provide an initial assessment of the match of the three technologies survey on smart contract requirements. We believe further work on this question is needed to advance the use of technology in sourcing contract management.

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