Business Rules and Decision Processes in Mediated Business Coordination

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Abstract

Business coordination is a very active research area, in which the decision-making process of an enterprise is non-trivial. In this paper, we focus on coordination process that involves a third party or mediator, which we call Mediated Business Coordination (MBC). We argue that business rules play an important role in the decision processes involved in MBC. We describe the decision processes involved in MBC, show how business rules influence the decision-making of enterprises, and propose to model and simulate the decision processes using agents.

Keywords: Mediated Business Coordination, Business Rules, Decision Process, Agent

Introduction

Coordination can be seen as the process of managing dependencies among activities (Malone & Crowston 1993).

"Business providers" (companies that supply products or provide services) focus more and more on core business functions considering the efficiency of the use of labor, capacity, technology, and resources. On the other hand, "business requestors" (companies that require products or services) demand composite products or services which may not be provided by a single business provider. In order to match the supply and the demand, business providers need to cooperate with each other, while business requestors need to compare the different (combinations of) products, which make the situation much more complex.

In these situations, coordination failures may arise due to parties in a given market being incompletely informed about the demand created by the production decisions made elsewhere in the economy (Andersen 1988).

To overcome the coordination failures, a third business party (we call it a "mediator") may appear in the market that profits by helping the other business parties to achieve their goals more efficiently. However, how to behave in order to maximize profit depends on the demand of business requestors and the supply of business providers. Moreover, it depends on how to act in between the two types of parties such that mediators are always needed.

In current practice, stakeholders (both business requestors and business providers) can hardly make any decisions of whether to use a mediator or not, because the added-value for them are hard to identify and estimate. Different types of mediators exist, which causes the decision-making even harder. On the other hand, mediators have difficulties to design mediation services that meet the requirements of different stakeholders. This is because the choice of different functionalities determines the success of a mediator in the market, and the requirements based on which these functionalities are designed are hard to identify.

Therefore, the decision processes involved in such mediated business coordination are not trivial. They should be considered from two aspects: the decision process of each single party, and the influence of one party's decision on the decision-making of other parties.

In order to better understand the decision processes involved, factors that influence the decision-making should be clearly identified and investigated. We argue that business rules play an important role in the decision processes involved in MBC.

Business rules (BRs) are the logic of business decisions. They provide a foundation for understanding how a business operates. They are the core of an enterprise - they direct and influence the behavior of an enterprise (Antoniou & Arief 2002). The generally accepted definition of a business rule comes from The Business Rules Group (TheBusinessRulesGroup 2000) as "a statement that defines or constrains some aspect of business, it is intended to assert business structure or to control or influence the behavior of business".

The roles of BRs can be analyzed from two dimensions, i.e. the stakeholder and the mediator. From the dimension of stakeholders, BRs influence the decisions of whether to choose a mediator or not, and of which type of mediators to choose. From the dimension of mediators, BRs guide the choice of which services to provide, and direct how these services should function.

In the following sections of this paper, we give the definition of mediator that we use in our research, and identify the possible added-value services of a mediator. Further, we describe the decision processes involved in MBC, and show how business rules can play a role in the decision processes. At the end, we make some discussions on using agents to simulate the decision processes and conclude the paper.

Mediators and their Added-value Services

Definition of Mediator

Our research focuses on studying the roles of mediators in business coordination and the factors that influence the decision-making involved in MBC. Since the term "mediator" is being used in different disciplines such as computer science, law, and economics, it is important to clearly define what a mediator is in our research, and use this definition to restrict the area that we are going to study.

In order to give the definition of mediator, some concepts that are used in the definition should be introduced first:

- Value object: an object that has a value to its owner or to the person or the organization who wants to own it, e.g. a book, money, etc.
- Trading parties: entities who have synchronous goals of exchanging value objects with each other (they may know each other or may not) even when there is no mediator (to be defined later).
- Stakeholder: an organization or a person who is involved in using a mediator.
- Trading goal: the goal of a stakeholder to exchange value objects with other stakeholders.
- Get profits: a term that indicates to receive the return on an investment after all charges have been paid.
- More efficiently: a term that indicates one solution is better than another.

Given these concepts, the definition of mediator is given as follows:

A *mediator* is an entity that provides one or more *mediation services* among different *stakeholders* in order to *get profits* by providing these services, in which *mediation service* is defined as a service that acts between *trading parties* to make the goal of exchanging *value objects* achievable or to help them to achieve their *trading goals more efficiently*.

We use the term "mediation" as "a process that describes the business activities involved in the coordination among the three types of business parties (under our assumption), the business requestor, the mediator, and the business provider."

The Added-value Services of Mediator

Since mediators act in between trading parties, the mode of existence of mediators depends on the demands of stakeholders. Therefore, the added-value services of mediators should be identified based on the demands of stakeholders. In other words, how these services are defined depend on the underlying business rules that guide the design and execution of these services.

According to the roles of intermediaries identified in the literature (Bailey & Bakos 1997)(Giaglis, Klein, & O'Keefe 2002)(Klein & Teubner 2000), we consider the demands of stakeholders from three dimensions, which are *uncertainty*, *lack of capability*, and *unwilling cost*. In each dimension, there exist certain types of limitations of stakeholders, which are the cause of the appearance of the services of mediators.

Dimension 1: Uncertainty When there are uncertainties about the processes or about the context of situation, it is risky to continue or make predictions of the current ongoing. Moreover, if the degree of uncertainty is higher than an acceptable threshold, there is a need to get external help in order to reduce such uncertainty.

Three types of uncertainties of stakeholders are distinguished, which are *information uncertainty* (i.e. information asymmetry, information overload, and lack of information), *level of trust uncertainty*, and *profit uncertainty*.

Accordingly, the added-value services of mediator can be identified as

- negotiation,
- information searching,
- information aggregation,
- neutral trust third-party, and
- profit guarantee.

Dimension 2: Lack of Capability When stakeholders have a lack of capability, goals become hard to be achieved or even unachievable. Three types of limitations in this dimension are distinguished, which are *knowledge limitation* (e.g. lack of expertise), *location constraint*, and *constraint of information dissemination*.

The services of mediator can correspondingly be identified as

- providing expertise,
- providing (physical) communication platform, and
- advertising.

Dimension 3: Unwilling Cost For each stakeholder, there exist certain types of cost that are not willing to be dealt with. Different types of costs are distinguished, which are *time cost*, *effort cost* (including mental effort and physical effort), and *money*.

Correspondingly, the possible added-value services of mediator can be classified as

- saving time,
- saving effort, and
- saving money.

The choice of services that a mediator can provide depends on the stakeholders among which the mediator acts. On the other hand, when do stakeholders choose a mediator, and which types of mediator do they choose depend on the requirements of the stakeholders, as well as the services provided by mediators.

The requirements of each stakeholder can be described by its business rules, therefore, the services of mediators might be directed by these BRs.

Business Rules and Decision Processes in MBC

In mediated business coordination, different decision processes are involved. The decision-making of one party depends not only on its own capacity and cost, but also on the decisions made by other parties in the market. We argue that business rules play an important role in the decision process in the way of directing and influencing the operation of an enterprise.

Decision Processes in MBC

As defined in previous section, three types of parties are involved in mediated business coordination, which are business providers, business requestors, and mediators respectively. Each type of parties has its own goals and makes decisions in order to achieve these goals considering the different factors.

Business Providers The business functions defined by business providers are based on the market demand. However, due to the cost, such as resources and labor, enterprise needs to consider the efficiency in production, thus may only focus on core business functions (shift from hierarchies toward markets (Malone & Crowston 1993)). Therefore, in order to meet the various demands of business requestors, business providers need to cooperate and coordinate with each other.

In such situation, how business providers behave in the market, and how to cooperate and coordinate with the others determine their success. A business provider may supply individually to satisfy the partial demand of a business requestor, or look for business partners on its own, or choose a mediator (these solutions are not exclusive of each other). Each of the solutions has risks to a certain degree: supplying partial demand may disappoint business requestors, as a consequence, the business provider may loose market share; looking for business partners on its own may introduce extra cost, which can lead to a decrease in profit; choosing a mediator may have the risk of being locked in, and the market share of the business provider will be completely dependent on the mediator.

How to make the decision on which solution to choose is the determinant process that directly influences the success of the business provider.

Business Requestors The demand of a business requestor may not be satisfied by the supply of a single business provider. There might be several business providers involved to supply the demand. Different business providers co-exist whose supply satisfies the (partial) demand of the business requestor.

How to choose between different business providers, and how to compare among different (combinations of) solutions are the problems the business requestor has to face. As solutions, the business requestor can search for providers, do the comparison and make a choice on its own, or choose a mediator. How to choose between the solutions depends on the cost of searching, comparison, and potential risk.

Mediators Mediators exist only when there are problems between demand and supply in the market, which are the mismatch of demand and supply, or it is hard to match under certain constraints (e.g. time limit, cost, etc). Mediators profit by charging fees on the added-value services they provide to stakeholders.

In order to maximize profit, mediators must figure out the needs of stakeholders and provide corresponding services. Moreover, they should be able to follow the changing requirements.

How can a mediator succeed in the market, and how to define the added-value services completely depend on the difference between the demand of business requestors and the supply of business providers.

The Role of Business Rules in MBC

Business rules are the logic that drives business decisions. A business decision is, in essence, a business judgment made about a business concept or some attribute of the business concept (Goldberg 2007). This judgment is made based upon the business rules that underlie the business decision, which is the principal means by which business rules are implemented in the business.

Business rules can be used in requirement engineering for MBC. They help enterprises to achieve goals by putting constraints on the execution of concrete processes, such that the execution can meet the requirements of the enterprise.

Defining business rules explicitly gives the guidelines of decision-making, and helps to automate the process of decision-making (Rosca, Greenspan, & Wild 2002). In the decision processes of MBC,the existence of business rules increases the insight of the process and gives the ability to handle the decision complexity. Moreover, well-defined BRs help to understand and predict the outcome of decision-making.

As analyzed in (Zhao, Dignum, & Dignum 2007), in order to study the roles of mediator and the influencing factors of decision-making in MBC, we need to consider not only the technical aspect, but also the economic and the social aspects. Different forms of BRs can reflect the different aspects. E.g. strategic business rules, which can be modeled using business statements that state business requirements (Perkins 2000), can represent the economic and the social aspects of mediation (e.g. purchase goods from the supplier that is located close to the company products, products must be delivered within three days after receiving the payment, etc.).

The decision processes involved in MBC can be viewed from two aspects: the stakeholder aspect and the mediator aspect, which are also mentioned in previous section as the decision process of a single party and the influence of one party's decision on the decision of other parties.

From the perspective of stakeholder, business providers and business requestors need to make decisions on whether to choose a mediator or not, and on which mediator to choose. Since business rules reflect business requirements, the fulfillment of business rules can be one of the criteria that direct the decision-making of stakeholders, thus direct their business activities. On the other hand, BRs of stakeholders can guide the negotiation between business partners that may lead to different outcome.

From the perspective of mediator, which services add value to stakeholders depend on the business requirements of different stakeholders. As a consequence, the services a mediator provides are directed by the business rules defined by its stakeholders. The mode of existence of mediators is in itself an implicit rule that guides the direction of the business.

A Purchasing Scenario

In this subsection, we use a purchasing scenario to illustrate how business rules can be applied to the decision processes involved in mediated business coordination.

Assume a company R (business requestor) needs to purchase goods from some other companies (business providers). Several suppliers (business providers) provide the required goods with different prices and qualities. Company R knows some of them. These suppliers are located in different countries.

Some mediators exist and are located close to the business requestor. Each mediator has business connections with a number of suppliers, and is able to supply goods (which are ordered by mediators from the connected suppliers) to company R.

In this scenario, company R needs to consider from the economic aspect about the cost (e.g. supplier is located too far away) and the potential risks (such as a single supplier doesn't have enough capacity to supply the ordered amount of goods).

Under these considerations, company R may define business rules to prevent these. Suppose company R defines the following BRs:

1. The quote of product should be compared among at least three suppliers before purchasing.
2. The quote of product should be compared among at most seven suppliers.
3. Never make all purchases from one single supplier.
4. Purchase goods from the supplier that is located close to the company.
5. The payment can only be transferred after receiving the ordered goods.

Given these rules, suppose company R meets the following situation:

After comparing product quote of seven suppliers, company R finds out that supplier S provides goods that match its requirements most, but is located far away. Goods provided by other suppliers that are known by company R are either too expensive or with low quality. Mediator M has business connections with supplier S as well as some other suppliers (more than three), and it is located near company R.

According to business rule 4, company R cannot order goods from supplier S because it is located far away. But purchasing from other suppliers it knows is not a good-enough solution either (because of the price and/or quality of the goods).

In this situation, if mediator M can guarantee a sufficiently large list of suppliers to meet the business requirements of company R, it is obvious that company R can decide to do all purchases from mediator M. Note that, how mediator M behaves in this case influences the decision-making of company R directly, i.e. if mediator M cannot guarantee the sufficient supply or the quality of goods, company R will not do business with mediator M.

Considering from the economic and social aspects, suppliers may have business rules such as:

1. The payment must be received before products delivery.
2. Products must be delivered within three days after receiving the payment.

Given these rules, suppliers can hardly make an agreement with company R because the business rules they have defined are deadlocking. Suppose mediator M can order goods from suppliers and transfer the payment, and receive the payment back from company R later on. It is reasonable for company R and the suppliers to decide to do business with mediator M.

From the mediator's point of view, the services it provides should satisfy the requirements of its stakeholders as much as possible. In other words, the business activities of mediator is directed by the business rules of business requestors and business providers.

Based on these analysis, we draw a conclusion that business rules influence the decision-making involved in mediated business coordination, guide business activities, and direct the agreement made in between business partners.

Simulating Decision Processes using Agents

In order to study the decision processes involved in MBC, and verify our analysis of the roles of BRs and other influencing factors, it is necessary to gain insights of the decision processes.

As discussed in previous sections, the decision processes involved in MBC are distributed among multiple parties that have their own goals. The decision-making of each party requires the capability of autonomy, and the capability to coordinate with other parties.

Because of the characteristics of agents (i.e. autonomous, active, proactive, and social (Wooldridge & Jennings 1995)) and the characteristics of multi-agent systems (MAS) (i.e. MASs are ideally suited to representing problems that have multiple problem solving methods, multiple perspectives and/or multiple problem solving entities(Jennings, Sycara, & Wooldridge 1998)), we propose to use MAS to simulate the decision processes involved in MBC.

Business rules direct the decision-making of enterprises by acting as constraints on the deliberation process. They don't specify which solution to choose, but guide the decision-makers to possible solutions that may satisfy the constraints. Norms are commonly used in MAS to formally express the expected behaviour of agents in open environments (Vazquez-Salceda, Aldewereld, & Dignum 2004). They are usually formalized in deontic logic, in order to express accepted behaviour through obligations, permissions and prohibitions (Aldewereld *et al.* 2005).

The business rules of enterprises describe *obligations* (e.g. products must be delivered within three days after receiving the payment), *permissions* (e.g. purchase goods from the supplier that is located close to the company), and *prohibitions* (e.g. Never make all purchases from one single company). Therefore, business rules can be expressed as norms.

However, in order to be implemented, norms should be translated into operational representations such that they can be interpreted by agents. In (Vazquez-Salceda, Aldewereld, & Dignum 2004), some guidelines are given for implementing norms in Multi-agent systems. We use these implementation guidelines as the basis to implement the business rules that can be interpreted by our agents.

Here are two examples of expressing business rules as norms:

E.g. "Products must be delivered within three days after receiving the payment" is described as

$$[receive - pay(s, c)]O_{sc}(delivery - product \wedge day < 3)$$

E.g. "Never make all purchases from one single supplier" is described as

$$\forall c \forall p F_c(purchase(c, p, s))$$

The process is still ongoing. We are currently working on representing business rules as well as other identified influencing factors (such as economic values, number of business partners that are involved, etc.). In the meanwhile, the agent model that reason about these factors are being designed. These factors are represented as agents' beliefs and are used during the agent's deliberation process.

Conclusions and Future Work

Business rules play an important role in the decision processes involved in mediated business coordination. The decision-making of one enterprise depends highly on the decisions made by other business partners, which made the decision processes more complex.

The decision processes can be considered from two aspects: the decision process of each single party (the stakeholder aspect), and the influence of one party's decision on the decision-making of other parties (the mediator aspect).

The analysis of the roles of business rules from both aspects shows that business rules influence the decision-making of enterprises involved in mediated business coordination. They direct the agreement made among business partners, and help to understand the outcome of the decisions made by enterprises.

MAS can be used to simulate the decision processes, while business rules can be represented as norms. In order to simulate the decision processes, business rules as well as other influencing factors should be represented operationally for agent to reason about. The simulation results will give us an insight into the decision processes involved in MBC, help us to analyze the decision processes, and assist us to verify our theory.

A number of factors that influence the decision-making of enterprises have already been identified. However, more factors should be investigated, and these factors should be logically combined. We will continue working on the identification of the influencing factors of decision-making, the reasoning of the agent model, the design of the decision processes, and the development of the MAS.

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