

Knowledge Allocation Using Negotiated Agreements in Service Markets

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Abstract

Research in the area of knowledge management investigates how the right knowledge can be brought to the right people at the right time. In this position paper we present an approach to this problem that packages knowledge and experts possessing this knowledge as knowledge provisioning services. Optimal allocation of knowledge is then assured by introducing an electronic market for these services – a knowledge market. We present a scenario, general requirements, first steps, and open issues for the application of electronic markets to the problem of knowledge allocation. We envision that artificial intelligence techniques can be instrumental role in resolving some of the open issues. The resolution of these issues will provide us with a self-organizing and self-optimizing mechanism for knowledge management that is guided by the “invisible hand of the market”.

Introduction

Knowledge management usually comprises the task of bringing the right knowledge to the right people. Also, from a different perspective, knowledge management incorporates allocating the right people with the right knowledge to the right task.

Expert finder systems (Vivacqua 1999) partly address this issue. These applications help users identify experts in an area by evaluating, for example, a person’s contributions to discussion databases or tracking his or her deliverables such as Java source code. In many cases though, knowing who the expert is will not be sufficient. If a new project has to be set up, a manager first needs to know the best resources to staff this project. The next step is to assign tasks to these experts. For this the manager might compete with other project leaders intending to recruit the same experts. In this situation, supply and demand for the services performed by experts have to be matched in order to allocate the experts’ scarce resources to tasks – a process traditionally coordinated hierarchically.

The approach we propose here is to use knowledge markets for coordination. Knowledge markets are electronic service markets on which expert services are transacted. These markets present an interesting alternative to hierarchical coordination mechanisms because they promise a self-organizing and self-optimizing allocation of knowledge resources provided that transaction costs can be reduced to (almost) zero. In management science, much

research has been and is still being conducted to find ways to motivate people to contribute their knowledge. A knowledge market would solve this problem, as high prices of services would reward the possession and usage of critical knowledge. This process is also self-organizing because knowledge providers can use their “income” to outsource tasks in other areas to people who can perform these services better.

Below we will present a scenario that illustrates the use of knowledge markets. We then identify requirements for electronic markets to act as knowledge markets. Finally we describe experiments we have conducted and open issues we have identified in the process.

Scenario

A manager needs to staff a project. Evaluating the requirements and generating a first work plan, she estimates the length and type of the tasks to be performed. Some tasks are quite structured, others require specific qualifications, and yet other tasks are performed by specialized organization units. However there are some tasks, for which the manager either is not aware of anybody knowledgeable enough to perform them or for which dedicated resources are not available in the restricted time frame of the project.

The project manager now submits service requests for these tasks to domain-specific service markets. Upon receipt of this request, the market authority notifies potential providers for this service, based on either profile (pre-) registration or dynamic discovery mechanisms (see below). The candidate providers can then bid to perform this service. Bids can include the estimated time to complete the task, the price, or the quality of service attributes. On the basis of preferences defined by the project manager, the market authority then determines the winning bid. Finally, the corresponding provider, together with the manager, can then prepare the actual service provisioning.

Requirements for Knowledge Markets

Transactions in an electronic market consist of a finite number of interactions among providers and consumers.

Each of these interactions belongs to one of four phases (Schmid & Lindemann 1998):

- *Knowledge* (gathering information concerning services, providers etc.)
- *Intention* (specifying offers for supply and demand)
- *Agreement* (discussing the terms and conditions of the service provision)
- *Settlement* (executing the agreed-upon contract).

For electronic markets to act as knowledge markets, specific considerations are necessary for each of these phases.

During the “knowledge” phase, prospective consumers of knowledge services have to be supported to identify their knowledge needs and to derive from these needs a preference profile that helps them find and evaluate matching services offered by the service providers (i.e. experts). To enable such a mapping the market has to be built on an evolvable *ontology* of service descriptions. The market must also provide mechanisms that are able to operate on this ontology to enable service retrieval, browsing, and evaluation.

Knowledge markets also require specialized support for *negotiation* during the “intention” and “agreement” phases. In markets with highly standardized goods, agreement mechanisms and decision strategies are relatively easy to define because negotiations are limited to a discussion of price. But the services transacted in knowledge markets are complex “goods”. In such differentiated markets, coordination cannot be reduced to the negotiation of a single attribute (Ströbel 2000). Agreements in these complex commerce spaces have to be more flexible, and they must reflect consumer requirements and preferences as well as the abilities of the provider to customize the provisioning of the service. Therefore, a critical prerequisite for knowledge markets is support for *flexible agreements, incorporating several negotiable attributes*.

Finally, for the “settlement” phase we have to introduce money or a corresponding scarce *compensation means* to pay for performed services. A price expresses the shortage of supplies (expert work) in the market, which we use to reach efficient allocation. Internal costing mechanisms (profit centers, activity-based costing, etc.) could be used to reflect prices. The negotiated price for a service is then the amount that the consumer organization unit has to pay the provider organization unit. In another, less formal approach, artificial money could be used, which is convertible into real incentives such as holidays or options. This is particularly applicable to “soft” services such as co-authoring of a conference paper.

During all market phases transaction costs for service advertising, negotiation, and payment have to be kept minimal for knowledge markets to work properly. According to transaction cost theory (Williamson 1989), markets can only ensure optimal allocation of resources if *transaction costs are low* compared to the value of the transacted goods. The acceptable level of transaction costs varies for each transaction and is influenced by the

frequency of the transaction, its complexity, its uncertainty, and finally its strategic importance (Picot 1992).

Reducing transaction costs to close to zero is highly important for knowledge markets in which the transacted services are of relatively low value (e.g. the answer to a question). The use of electronic markets for coordination already promises lower costs of market coordination (Bakos 1991), but additional mechanisms will be needed to minimize the need for human intervention and control.

In summary, for electronic markets to act as knowledge markets, the following requirements must be met:

1. The market must provide an extendable ontology of services and associated support mechanisms for advertising, retrieving, and evaluating flexible services.
2. The market must provide flexible mechanisms for integrative negotiation of multiple service properties.
3. The market must define one or more compensation means as currencies for service payment.
4. The market must ensure minimal cost of market transactions.

First Steps and Open Issues

In our work at the IBM Research Lab in Zurich we have experimented with different mechanisms for describing complex services and matching consumer requirements to provider offers (Field & Hoffner 1998). We also worked on the issue of evaluating offers on the basis of multi-attribute utility theory (Stolze 1998). At the symposium we present our current design of a knowledge market for translation services. Our design combines these components with mechanisms for integrative negotiation and an artificial currency for payment.

The resulting electronic market meets the requirements 1-3 listed above. In our view the central remaining challenge is to devise means to reduce the market transaction costs. We believe that artificial intelligence techniques can be instrumental in achieving this goal. In particular we identified the following missing support components that would help reduce transaction costs to an acceptable level.

- Support for providers to create winning bids based on the consumer’s service evaluation function, the internal constraints for the service provision (work load, setup times, etc.) and the current market situation (level of competition).
- Support for market authorities to maintain and optimize a service domain ontology that would allow automatic categorization of unstructured service requests and notify potential service providers correspondingly.
- Support for market authorities or other intermediaries to create service evaluation templates that are adapted to the specific needs of individual consumers.

If most of the knowledge market coordination tasks are performed by automated mechanisms, transaction costs will reach a level where knowledge markets are a feasible mechanism for decentralized, self-optimizing knowledge management in organizations.

For the time being we have put aside the "soft" issues of knowledge markets. For example, we have not considered how to best support employee anonymity and privacy and still ensure responsibility and alignment with company values. We have also not studied how knowledge markets can best be used in organizations that are mainly managed in a hierarchical fashion. These "soft" issues will become pressing once we have created enough evidence that knowledge markets are a technically feasible mechanism for knowledge management.

Summary and Outlook

In this paper we introduced a decentralized approach to knowledge management that uses market-based coordination mechanisms to allocate knowledge in the form of services performed by experts. We outlined requirements that electronic markets must meet to support the transaction of expert work, and we described open issues we identified while designing a knowledge market for translation services.

Our next steps will be to create a simulation platform for knowledge markets in order to facilitate the study of their dynamic properties. Using this simulation platform, we want to investigate the impact of offering different types of negotiation support (multi-round, sealed-bid, etc.) for their suitability in this domain. Our other area of interest is to investigate ex-post analysis of the market coordination. We want to compare the overall time to complete a set of services and the achieved consumer satisfaction level to an alternative allocation based on hierarchical coordination. We are particularly interested to study how knowledge markets evolve over time driven by the opportunistic decisions of the market participants.

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