A network approach to project business analysis

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Abstract

Purpose – Based upon previous models and the extant literature, the purpose of this paper is to present a network approach to describing and analyzing inter-organizational relationships in project business. The framework provides a better understanding of the dynamic processes and critical interfaces in a network context, and advocates the use of the tools of agile supply-demand networks (ASDN) and design structure matrix (DSM).

Design/methodology/approach – This conceptual paper uses a network approach to understand inter-organizational business relationships in resource management. This approach is useful for understanding relationships in project business, which usually involves a wide array of actors or stakeholders who provide resources or have an interest in project outcomes.

Findings – The paper concludes that a network-based framework provides a solid basis for a rich description and analysis of a multi-actor project business, as well as assisting in understanding important interpersonal relationship factors that affect project success—such as trust, commitment, and adaptation.

Research limitations/implications – Models of the type discussed here have been implemented in larger multinational corporations, but they might not be applicable in smaller enterprises that do not have overall control of a network.

Practical implications – The paper presents useful practical tools for understanding the dynamic processes of networks in project-based business, and for identifying the actors, activities, and resource interdependencies involved.

Originality/value – This paper extends upon previous approaches to project business and presents practical tools that can be used to analyze project-business networks.

Keywords Networking, Supply and demand, Matrix organizations

1. Introduction

Project business has been one of the dominant modes of international business for the past 50 years, and its prevalence continues to increase. More than 60 percent of exports from Finland and Sweden are in the form of project business, and the proportion is similar in other developed countries (Artto et al., 1998; Hadjikhani, 1996), with surveys showing that more than half of the international trade between developed countries is project business (Cova et al., 2002). This trend is expected to continue (Lundin and Steinthórsdon, 2003). As Bryde (2000) has observed:

... the need to survive and prosper in ever-changing external environments is the most important driver behind the growth in project management.

The reason for such growth is customer demand for customized products, competitive prices, and prompt delivery.

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The major characteristics of project business are:
- uniqueness;
- complexity; and
- discontinuity.

A project is unique in the sense that every project differs from another in size, type, customers, suppliers, construction, price, and so on. It is complex in terms of the technical, financial, political, and social factors involved. Finally, it is discontinuous in terms of a high degree of discontinuity in economic relations between suppliers and customers. Hellgren and Stjernberg (1995) define the project network as a set of relations, where no single actor may act as a legitimate authority for the network as a whole.

A network is the involvement of two or more organizations in long-term relationships that position them as a “mechanism” in markets and hierarchies. The central characteristic of a network is that actors or organizations are embedded (Granovetter, 1992) in interconnected social and business relationships that determine behaviour. According to Dubini and Aldrich (1991), networks can be defined as “patterned relationships” among individuals, groups, and organizations that facilitate or constrain the activities of people and groups. These activities are interdependent and can be defined by both horizontal and vertical dimensions in the project business.

The present study extends previous theory in the area of project business by using a network approach to demonstrate that intra-organizational improvement needs to be complemented by corresponding improvements in inter-organizational arrangements. The study presents a framework of the reciprocal interactions of actors, activities, and resources within and outside a given organization – thus providing a coherent basis for continuous improvement using the network approach. In addition, the study presents new tools – design structure matrix (DSM) and agile supply-demand networks (ASDN) – which can be used to analyze project-business networks. The research demonstrates how project-business activities can be optimized using the right resources at the right time with the right actors to take the right actions in a network approach.

The rest of this paper is arranged as follows. The next section discusses the scope of project business. Section 3 describes networks and sub-networks, including their actors, activities, and resources. Section 4 discusses the importance of relationships in project business. An overview and generic architecture are presented in section 5, where ASDN and DSM are described in depth. Finally, the study draws its conclusions and offers suggestions for future work in section 6.

2. Scope of project business
Project business has become a feature of certain types of industries, including the construction of power plants, aerospace facilities, military installations, and other types of infrastructure. For the purchaser, the complex technical and economic issues involved and the relatively large amounts of resources required dictate a need to buy whole projects from project sellers (contractors), who offer project planning, implementation, and management. For sellers, project business is a profitable and strategic form of differentiation and international expansion (Hammarkvist et al., 1982; Ahmed, 1993; Gunter and Bonaccorsi, 1996). Some researchers have also noted that
some companies, in the later stages of internationalization, become involved in selling know-how, services, and integrated packages for projects (Luostarinen and Welch, 1990). Other researchers have noted that project business is an inevitable aspect of company development in small and open economies (Kosonen, 1991).

The term “project business” refers to the overall activities of a project company that creates and delivers projects to its customers. The supplier takes more responsibility for the success of a project than it would if supplying only some components or merely exporting some parts. Project business is thus an interaction of network activities (both within and between organizations) with respect to marketing, procuring, and executing project activities. Davies and Hobday (2005) have used the term “project business” to refer to:

...organizations – which may be entire firms or units within firms – that deploy projects to achieve major business objectives, including all firms which design and produce complex products and systems.

Artto and Wickström (2005) defined “project business” as:

...the part of business that relates directly or indirectly to projects, with a purpose to achieve objectives of a firm or several firms.

For the purposes of the present study, the term “project business” is used broadly to encompass all business functions in which network actors and other stakeholders are involved in the process of conducting a project. During the lifecycle of a project, these functions can include: management, customer interface, concept development, engineering, supply and procurement, transportation and logistics, construction, and operations. In all of these activities, intra-organizational actors interact with inter-organizational actors, and one department can be involved in many business areas and in various networks. Holstius (1989) took a similarly holistic view in defining “project business” as:

...a discrete package of investments, services and other actions designed to create – within a designated period of time – capital assets that produce benefits for the buyer over an extended period of time.

Project business involves the provision of an integrated package of resources to solve technical and economic problems. This often requires wide-ranging resources and activities, and thus involves cooperation with other parties apart from the immediate buyer and seller – including consultants, sub-contractors, financial institutions, government ministries, regulatory organizations, and quasi-autonomous government organizations. This cooperation among the purchaser, the seller, and other parties in marketing, planning, and implementing the project forms a business network. The project purchaser and project seller are the main actors in the network, but other important actors include consultants, the major sub-contractors, and political or regulatory authorities. Peripheral actors include minor sub-contractors, suppliers, and peripheral interest groups.

3. Interdependencies in networks
3.1 Overview of network theory
As described above, the formation of a network is an inevitable corollary of project business (Dubois and Gadde, 2002; Mattsson, 1973). The network encompasses the
formal and informal relationships among various actors in the project. These actors might include the marketer of the project, the purchaser, financiers, consultants, sub-contractors of various types (such as suppliers or construction sub-contractors), and governments (as purchasers or regulators). The relationships among these various actors evolve through the initial marketing and negotiation stages, and usually become contract-based relationships involving the buyer, the seller, suppliers, financiers, and sub-contractors (Hellgren and Stjernberg, 1995).

According to Amabile (1998), managers often destroy creativity in project business by failing to make appropriate connections between actors and activities. It is important to identify the interdependencies between particular actors and specific activities, and to identify the resources they require to perform their tasks. However, it is often difficult to determine the “appropriate” connections, and careful analysis is required to identify who should perform particular tasks in a network.

Industrial and social network ties increase the likelihood of the adoption of new business development (Becker, 1970; Björkman and Kock, 1995), and the development of project business in concert with external network organizations increases the possibility of developing and implementing new resources. A project-business network thus involves the cooperation of actors in a chain to construct a project of value for the end customer. To achieve this, the development of cooperative relationships in networks and sub-networks is essential. In such cooperative relationships, the interacting partners must share (or exchange) resources and perform activities in the common interest. This involves an agreed orientation, shared commitment, and interdependence. This was characterized by Håkansson and Snehota (1995) as a mutually oriented interaction between two reciprocally committed parties.

Figure 1 shows a typical project business network and its sub-networks. Table I sets out the interdependencies of actors, activities, and resources from an inter-organizational perspective and an intra-organizational perspective.

Networks tend to be characterized by “clusters” (Gulati, 1995; Uzzi, 1997). The extent to which clusters are formed is determined by the degree of relational “embeddedness” in a network. On occasions, network ties can be dormant or weakened, and a network can thus be active or quiescent at various stages in the life of a project. The intersection of relationships defines an individual’s centrality in a group, and a group’s role in the wider organization (White et al., 1976).

### 3.2 Interdependencies among actors

The actors in today’s business networks are defined more by the activities they perform than the positions they occupy, and their roles are typically mixed and interdependent. An individual actor can have a variety of roles – as a buyer, a seller, a competitor, a collaborative partner, and a complementary actor (Sandhu and Kock, 2006), and certain relationships between two actors can mean that they have all these roles simultaneously. Indeed, it has become increasingly common for business network actors to compete and cooperate simultaneously, in what has been described as “co-opetition” (Bengtsson and Kock, 2000).

A typical project involves a variety of actors (see Figure 2). A supplier can supply products to a buyer and, simultaneously, compete with the buyer against the end customer. The same supplier can also directly or indirectly cooperate with the buyer to create a new market. In addition, the supplier can sometimes buy products from its
buyer, thereby confusing the roles even more. Moreover, the embeddedness of the two actors means that the perceptions of others in the same business network will affect the roles of the actors.

The complexities of these relationships mean that, for analytical purposes, it is best to focus on the interdependencies of the various actors, rather than attempting to analyze whether a relationship between two given actors is vertical or horizontal.
As Figure 2 illustrates, the buyer and the seller of a project are embedded in relationships with different kinds of horizontal and vertical connections. The crucial criterion in assessing this situation is the strength of the relationships. Granovetter (1992) has stated that relationships based on weak ties are of greater importance when considering the distribution of new information in a network – because people moving in more distant circles have access to different information. However, close relationships reflect the degree of embeddedness, and Uzzi (1997) has noted that strong ties are important in establishing trust between potential partners.

Strongly embedded relationships have three main features that determine the expectations and behavior of the actors:

1. Trust.
2. Fine-grained information transfer.

Strong relationships that are based on trust facilitate access to privileged resources, and joint problem-solving arrangements facilitate learning and innovation. On the other hand, strong relationships can mean that the actors are slow to adapt if personal relations are overlaid on business links. In these circumstances, it can be difficult to take a dispassionate view of the members and activities of the network (Galaskiewicz and Zaheer, 1999).

Organizations that have more experience of involvement in project business networks are better placed to choose the right partners at the right time. In the project market, the development of a new international business network is actually an extension of the present business network for the focal organization, and it generally retains already established relationships. New relationships are added to existing ones, and the business network expands as the role of the focal organization is modified. The newly created relationships might be based on business or personal contacts (Håkansson, 1982).

### 3.3 Interdependencies among activities

The term “interdependencies of activities” refers to the way in which the technical, administrative, and commercial functions of a company are connected in various ways to network partners engaged in project business. An interdependent relationship implies mutual activity and exchange. The activities that are involved in such an

![Diagram of actors in a typical project network](source: Kock and Owusu (1998))
interdependent relationship can be sequential or in parallel, and they are usually linked by the need to involve various actors in achieving a successful outcome.

Various chains of activity can be identified in the network, and these involve various actors. The structure that links the chains of activity constitutes an “activity pattern” within the network. In establishing such an “activity pattern”, adaptations in the internal ways of doing things are required – whereby actors accommodate the needs of other network actors through cooperation and commitment.

3.4 Interdependencies among resources

Resources represent an important aspect of the interactions among actors, and the way in which they are used is pivotal to determining whether an activity is performed cooperatively or competitively between firms. In essence, project business involves the combining of resources, both tangible and intangible, to create new capabilities (Owusu, 2003). A form’s possession of certain resources, or the need to gain access to those possessed by other companies, determines how an activity is performed. The essential function of a network is to enable actors to access each other’s resources and thereby create synergy. Moreover, the network itself becomes a resource for the actors involved.

Alchian and Demsetz (1972) distinguished between homogeneous and heterogeneous resources. According to this distinction, the value of homogeneous resources is independent of the other resources with which they are combined, whereas the value of heterogeneous resources depends on other resources (Dubois, 1994). It follows that the need for access to resources possessed by other firms is greater if activities are built around heterogeneous resources than if they are built around homogeneous resources.

In a relationship perspective, resources can be conceived as being “double-faced” – that is, having a recipient and a provider. According to this notion of the relativity of resources, the relationship is one of provision and usage (Håkansson and Snehota, 1995). In contrast, the network perspective conceives of the production of new resources in the process, thus creating a “resource constellation” of resource ties among various groups. In the network perspective, the combination of resources is assumed to create synergies through adaptation, cooperation, and commitment.

In summary, as Figure 2 shows, a project business network involves the bonds and interdependencies that connect the various actors, activities, and resources involved in a project.

4. Network relationships in project business

The personal relationships embedded in a network are of crucial importance in project business – because the interdependencies of activities and resources vary in accordance with different interpersonal relationships (Emirbayer and Goodwin, 1994). Investigating such linkages within organizational groups or units not only advances the sharing of knowledge within the project business, but also contributes to understanding the process of organizational structuring. With such an understanding, project management can then become an open, equitable, structured process that is applicable to a wide range of business problems and that recognizes the multiple realities and perspectives within project business.
The Industrial Marketing and Purchasing (IMP) Group has adopted a “markets-as-networks” approach to business networks, which focuses on interdependencies in personal relationships and their effects on the companies involved (Håkansson and Snehota, 2000). According to this view, to comprehend the process of exchange in one relationship, it is necessary to understand the wider network of relationships within which the exchange takes place (McLoughlin and Horan, 2000). Through the relationships, firms can mobilize and use resources controlled by other parties (Håkansson and Snehota, 2000). Relationships can also be crucial in enhancing an actor’s ability to innovate and take part in technological development (Håkansson and Snehota, 2000).

Through such relationships, a firm can learn about its international partners’ capabilities, needs, strategies, business conditions, and market networks (Johanson and Johanson, 1999). A typical internationalization sequence has thus changed from gradual expansion to expansion “in leaps” by joining networks, and an experienced internationalized corporation can use its existing network position as a basis for further internationalization (Forsgren, 1990).

An extended “process model” for project business is presented in Figure 3 (as adapted from Håkansson and Johanson, 1992). This represents the main process structure in project-based organizations, but details can vary according to the actors, activities, and resources involved.

It can be noted from Figure 3 that the process model contains “intervening process factors”. These are the factors that move the relationship from one phase to the next. It

Figure 3. The process model in project business

Source: Adapted from Håkansson & Johanson (1992), and Sandhu (2005)
is necessary to understand the intervening process factors to obtain a full appreciation of the process of relationship development. The literature on relationship development or evolution (Ford, 1980; Håkansson and Snehota, 1995) has emphasized various process factors in the development of business relationships. Such factors are sometimes derived from critical incidents that have been solved in a satisfactory fashion, thus facilitating the evolution of the relationship to the next phase. This process model does not assume that change is inevitable with the passage of time; rather, it posits change as being an effect of the intervening process factors. The actors’ inputs of content and the intervening process factors develop the relationship, not the mere passage of time.

The “atmosphere” that surrounds the whole relationship creates the conditions for the long-term character of the interactions. The interacting actors stipulate their own individual goals within the project, but they can also have common goals with respect to the overall project. After the project is finished they will evaluate whether the outcome is congruent with the anticipated goals. It is important that the anticipated goals are realistic and feasible, especially with respect to quality and time schedule.

Various actors are committed to providing resources to the project, and the committed resources are tied up for some time and cannot be used for other purposes. Actors therefore have a mutual interest in establishing trust and norms of behavior with a view to reducing risk and enhancing the solution of potential conflicts. Nevertheless, certain actors possess greater power and can engender a state of dependence among other actors. In many cases the seller is the actor who can exercise such power on the basis of his superior knowledge of the project.

5. Modeling resource networks

5.1 Mapping of processes in project business

Companies in project business typically map their processes for quality-management purposes. This involves the mapping of the various interdependencies among entities that affect the management of resources – such as updated specifications and new information from the business environment. New tools for this type of modeling have been presented in the engineering and architecture literature (Smith and Eppinger, 1997; Steward, 1981).

The requirements for advanced network modeling include the following:

- incorporation of activities and resources;
- analysis of mapping dependencies between entities;
- analysis of system-level consequences from potential scenarios; and
- possibility of viewing different aspects of networks (for example: time; risk).

The interdependencies of actors, activities, and resources can best understood by classifying them into “strategic” and “operational” levels of processes. Two relatively new tools in project management are of special interest in this regard. First, a computerized network analysis tool known as agile supply-demand networks (ASDN) can be used to design strategic networks for project business. Secondly, design structure matrix (DSM) analyses project business processes in tactical and operational terms as a one-dimensional matrix showing dependencies among various tasks, actors, and environmental parameters.
5.2 ASDN

Agile Supply-Demand Networks (ASDN) software, which was developed at the University of Vaasa (Finland), is a network drawing tool for analyzing multi-site manufacturing and material flows (ASDN, 2005). The software was originally developed for the ABB Corporation to analyze large global supply-demand networks. In the ASDN model, each node (such as a supplier, a manufacturer, or a distribution warehouse) is identified as having certain attributes in terms of lead-time, inventory levels, and so on. The software enables users to analyze industrial networks in different scenarios from various perspectives – such as total inventory or order-fulfillment time. The calculation functionality of the system allows users to define the right levels of inventory to meet commitments to customers while minimizing cost. These calculations are based on predefined resource dependencies. The user can compare different chain strategies and analyze objectives – such as on-time delivery, lower inventory levels, fast delivery, and decreased cost of capital. The software is publicly available (ASDN, 2005). Figure 4 shows a screenshot of ASDN software.

ASDN concentrates on:

- the development of IT architectures to support global-network modelling and design;
- portraying the present status of network-level control;
- optimizing project-business processes for fast response time; and
- improving financial performance.

Methods, tools, interfaces, architectures, and applications are being developed to address all of these needs.

![A screenshot of ASDN software](image)
The objectives of ASDN in supporting the activities of project business can be summarized as follows:

- to provide an environment for fast and timely design of agile, integrated, and synchronized activities and resources;
- to develop a series of analytical models that are embedded into the network for optimized customer service level at affordable cost through the balancing of inventory and transportation cost;
- to provide an IT infrastructure and systems to support the management and operations of a project and facilitate the separation of information flows and physical distribution; and
- to generate a set of tools for performance analysis of various aspects of a project network.

5.3 DSM

Design structure matrix (DSM) is a tool for analyzing complex networks – such as those associated with projects, organizations, or technical architectures (Steward, 1981). In applying the tool to project business, DSM analyzes the interdependencies with a view to managing uncertainties and complexities. Practical examples of the use of DSM include its use in the design of a better project model for power-plant delivery (Sandhu and Helo, 2004) and for product development in the automotive industry (Danilovic and Sandkull, 2005).

Figure 5 presents an example of how task and resource dependencies are translated into a matrix form in the case of power plant delivery (Sandhu and Helo, 2004). The number of crosses shows the complexity of the procedure and demonstrates the dependencies between the tasks. The tasks in the upper half of the matrix (above the diagonal) show the uncertainty that might cause unwanted iterations.

Figure 5. DSM of power-plant delivery process
DSM allows the user to subdivide the activities into “n” number of “sub-activities” to manage the interdependencies and information transfer among activities. It thus not only demonstrates feedback loops, but also identifies and manages information exchange.

Project managers can use DSM at more detailed levels. For example, a client might wish to change the design or scope of a project. DSM analysis will demonstrate, in detail, how much rework will be caused for the total network if a particular activity is changed, which is difficult to demonstrate with conventional tools.

By analyzing the structure of the generated DSM, the total effect for the lifecycle of the project can be assessed as a function of parameter changes. The dependencies are mapped as crosses. Each row (and column) represents a task with given duration and identification. DSM thus provides in-depth study of operational activities and their interdependencies.

5.4 Linking the requirements
To develop a project business it is necessary to understand:
- the actors, the bonds among actors, and their interdependencies;
- the activities involved, the links among activities, and their interdependencies; and
- the resources required, the ties among resources, and their embedded dependencies.

A proper assessment of a project cannot be achieved without structuring all three aspects in the analysis. Typically activities are mapped in project plans, and this can best be achieved by using sophisticated methods – such as DSM. The actors and the bonds among actors need to be translated into key variables for the network models, thus providing a holistic view of decision-making parameters. The resource perspective is connected to management of capacity and the formulation of an organization. Organizational DSM can be used as a tool for defining which activities should be performed in the same phase and which resources are required in this phase. The teams and other actors can be defined in this stage by using clustering or other techniques. ASDN and DSM can thus be beneficial tools in identifying the structure and organizational functions of project business.

6. Conclusions
As Hellgren and Stjernberg (1995) have observed, project business involves situations that have a marked degree of uncertainty because of the interdependencies that exist among actors. Imbalances in the distribution of material resources, intangible resources, and authority all require analysis that goes beyond conventional project management. In addition to this, intangible resources (such as innovation and technology transfer between actors) can create learning imbalances (Meeus et al., 2004).

This paper has presented frameworks for analyzing the nature and development of inter-organizational relationships in international project business from a network perspective. One framework enables analysis of the actors, activities, and resources involved, as well as addressing the bonds, ties, and links that are created in the project network. Another attempts to capture the process of relationship development and the factors that impinge on it. New tools for planning business models and business
processes need to support the requirements of network-level analysis. This means in practice:

- changing the level of analysis from a supply-distribution level to a network level;
- incorporating more complex interactions among actors, activities, and resources (such as dynamic effects and feedbacks);
- incorporating scenario-building functionality in the analysis, thus deepening the understanding of the planned processes and the risk analysis associated with them; and
- combining the project plans to produce process maps, and making use of tools of logistics planning for engineering processes.

The frameworks presented here are broadly based and are thus suitable for analysis in a variety of project contexts. They contain a large number of variables, and are therefore able to offer a holistic view of project networks. In conducting focused studies, researchers will need to concentrate on certain variables, rather than using the whole model. For example, a researcher might choose to study the actors alone, or the activities alone.

Project business works mostly at the level of specific tasks and activities, thus making it difficult to achieve a holistic view of the environment. The concept of network modeling aids in understanding the frameworks of activities and in analyzing the relationships – thus providing a holistic understanding of the business. Network-based frameworks such as those presented here provide a solid basis for a rich description and analysis of a multi-actor project-business network, as well as assisting in understanding important interpersonal relationship factors that affect project success – such as trust, commitment, and adaptation.

References


**Further reading**


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