CIRP Annals - Manufacturing Technology 57 (2008) 485–488

Contents lists available at ScienceDirect

CIRP Annals - Manufacturing Technology

journal homepage: http://ees.elsevier.com/cirp/default.asp

Shaping inter-firm collaboration in new product development in the automobile industry: A trade-off between a transaction and relational-based approach

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ARTICLE INFO

Keywords:
Product Development
Co-operative Production
Co-operative Concurrent Engineering

ABSTRACT

Shaping collaboration in the new product development (NPD) has always been a very difficult task, especially in complex industries like the automobile one. This complexity is particularly true during the engineering phase of the NPD process, where different complex systems are to be designed in a collaborative way. Basically, two-kind of approaches have been observed in the literature and industry: one is more related to market transactions, specifically the west car-company style, the other is more relational based, as in the Japanese car-company style. Now, the increasing globalisation of the industry asks for a merge of the two approaches; indeed, the increasing use of standard components push towards a market outsourcing, while the need of product customisation and the increasing technology complexity push towards long-term alliances and partnerships; then, several companies face the problem of how designing good collaboration solutions in several phases of the NPD process. This paper offers a methodological solution to this problem by searching a trade-off between market and relational approaches and by offering to the original equipment manufacturer (OEM) a decision support for shaping well fitting inter-firm relationship.

1. Introduction

The increasing competitive pressure, know-how diffusion and market globalization are modifying the competitive patterns of manufacturing enterprises.

Companies success depends on the ability of merging: (1) cost reduction needs, which represent the major response to the increasing competition pressure, (2) rising know-how which is the major response to the increasing demand of innovation, and (3) market localization which represents the major response to market globalization.

As response to these competitive drivers seems to be product and organization modularity, i.e. adopting business networking models. Industrial experiences like the "contract manufacturers" of the American semiconductor sector [1], the common platforms now largely adopted in the automotive sector [2], the modular design of machining centres more frequently adopted in the machine tool industry, confirm the manufacturing companies trend towards the adoption of product and organization modularity models. An empirical study conducted by Hoetker [3] reveals the positive correlation among product and organization modularity although no causal explanation is given to this phenomenon.

To remain competitive in the actual scenario, thus, manufacturing companies must implement business network models. In this case two issues appear to be strategic: (a) the design of proper coordination mechanisms [4], (b) the definition of inter-firm relationship. As far as the second issue is concerned, Ahmadjian et al. [5] analyzed the case of inter-firm relationships in the Japanese automotive sector. The analysis reveals an important perspective: it shows a governance structure, "keiretsu", which is characterized by a strong leadership role of Toyota. This kind of structure brought Sturgeon classifying Japanese networks as "captive production networks", that represents the basis for lean production systems. A captive production network is characterized by a strong hierarchical leadership of the OEM, but also by a high trust level among the network members which reduces risks of free-riding behaviours. The reciprocal trust is less present in the American manufacturing networks of the automotive sector, which are more transaction-oriented.

Inter-firm relationships are of course essential also during the product design phase [6]. As again confirmed by the automotive market [7], and more recently from the electronic industry [8], early supply involvement (ESI) allows to reduce costs and times related to product development, allowing, in the same time, to achieve competitive advantages in term of product performances, quality and reliability.

So, in an increasing inter-firm scenario, many manufacturing companies face the problem of how structuring the relationship with their network partners. This problem is even more complex during the engineering phase of the new product development (NPD). The engineering phase is that stage of the ESI, where a main contractor (MC), usually the original equipment manufacturer (OEM) or its strategic partner, needs engineering services, often design ones, to develop the product. This task is particularly complex in term of inter-firm

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0007-8506/$ – see front matter © 2008 CIRP.
doi:10.1016/j.cirp.2008.03.021

relationship, because the object of the transaction is a specialised service.

This paper addresses such a problem. In particular, Section 2 reviews the principal theoretical approaches that support inter-firm relationship design; Section 3 describes the proposed methodological approach to shape collaboration in the engineering phase of product development.

Finally, Section 4 reports a case study, taken from the automotive industry, of the methodological approach described in Section 3, which shows how it would be possible to build a decision support system (DSS) supporting the MC in shaping the collaboration in the engineering phase of the product development.

2. Theoretical approaches to inter-firm relationship design

Scientific literature in inter-firm relationship is very rich and multidisciplinary. The subject was raised by Coase in 1937 in a pillar contribute titled "The nature of the firm". The Coase contribution started the so called "organisational economics theory" (OET) field whose main contributions are due to Williamson with the transaction cost economy (TCE), by Alchian and Demsetz with the Team Production Approach, and by Grossman, Hart and Moore with the property right theory (PRT) of the firm. The OET contribution focuses on the theory of the firm by trying to establish whether a transaction should be organised hierarchically within the firm, or through a market approach. Recently, results from OET have been used to design hybrids, that are different forms of inter-firm relationships such as partnership, joint venture or outsourcing solutions [9].

Besides the OET, a more managerial science approach was developed starting from the work of E. Penrose, by Wernerfelt in 1984 and, mainly, by Barney in 1991, that is the so called "Resource-based view of the firm", i.e. the RBV theory. RBV is primarily focused on what makes unique a firm and not on the boundary of the firm. Therefore, according to the RBV approach, inter-firm relationships are primarily based on the pooling of relevant resources belonging to different firms. Indeed, relevant resources characterise the firm, while resource pooling characterises firms-networking. Since then, a sort of dichotomy OET vs. RBV is characterising the scientific literature on inter-firm relationship.

In this paper, we will develop an original contribution aimed at designing successful inter-firm relationships in product development process. In order to proper understand our approach a brief review of the TCE, Team Production, PRT and RVB theories is provided.

2.1. Transaction Cost Theory (TCE) Approach

TCE focuses on transaction costs, that is those costs characterising a transaction (research, negotiation and control). The higher transactions cost are, the more a transaction should be managed internally, that is through a hierarchy. According to Williamson, transaction cost are higher when: (a) investments in the relationship are highly specific or idiosyncratic; in this case, indeed, the risk of opportunism is high and so are transactions costs; (b) transaction uncertainty is high; (c) transaction frequency is high; indeed, an increase in frequency increases the number of transactions needed.

2.2. Alchian & Demsetz (A&D) Approach

Team production is related with an increase of the resources productivity when they are pooled together. When team production is an issue, the focus should be posed on the organisation of the resources and on the residual right control. Then, according to Alchian and Demsetz, when team production is an issue, transaction should be managed by a firm.

2.3. Property Right Theory (PRT)

Property right theory focuses on strategic assets "expropiability", that is on the possibility for a partner in a network to expropriate assets rent through opportunistic behaviour. In this case, according to the Grossman, Hart and Moore (GHM) approach, critical assets, which can be expropriate, should be protected by vertical integrating or by reliable inter-firm relationship.

2.4. Resource-Based View (RBV)

What it makes a firm unique are its resources and capabilities. What makes a resource or a capability critical for a firm are: value, rareness and difficult to be imitated by other. As already highlighted, RBV do not evaluate the transaction, but the firm itself on the base of its resource. A valuable firm should be considered for a reliable and long-term inter-firm relationship.

3. Shaping collaboration in NPD: a novel methodological approach

In this paper we refer a very specific industrial problem, i.e. the engineering stage during the NPD phase. During such a phase, the MC manages a design project in which tasks are typically engineering services. For example, by referring to the development, or the restyling, of a new car, the engineering phase consists on designing all the car systems such as: the electric system, the transmission, the air conditioning, the brake system and so forth. The outputs of this phase are usually computer aided outputs (CAx). In an ESI environment such a stage is conducted in collaboration with engineering suppliers. Resources and capabilities of suppliers are of course intangible such as knowledge and experience and tangible such as investment in CAx systems. The MC usually defines a project characterised by tasks to be accomplished. Each task consists on the design of a system. Of course, the MC handles a set of suppliers too. The kind of inter-firm collaboration to be settled with a specific supplier depends on both the task and the supplier attributes. Our method is based on taking into account for:

- *the task to be accomplished through a typical OET approach*; indeed, it defines the kind of transaction in which MC and suppliers will be involved;
- *the suppliers to be involved through a quality assessment and RBV evaluation*; indeed, the quality assessment considers for the reliability of the supplier, while the RBV approach accounts for the "strategicity" of the supplier for the MC.

In order to do that, let us indicate with $i = 1, \ldots, N$ the generic engineering task. Table 1 shows how each task in the project can be evaluated. As the reader can notice, for each approach (TCE, A&D, GHM), a criterion is located and a set of parameters, able to measure it are defined. In Table 1, C is the criticality, F the frequency, U uncertainty, TP the team production, AE the assets expropiability. Such criteria will be used to map each project task into a *inter-firm collaboration solutions*. Such collaboration forms are ranked according to their market orientation level (MOL) as reported in Table 2.

The MOL expresses the affinity degree of the collaboration solution for a typical market transaction. The outcome depicted in Table 2 is the result of a literature analysis on different forms of inter-firm collaboration when measured in term of market transaction distance. Table 2 also shows how to associate a fuzzy linguistic value to each MOL level. Thus, basing on the described task evaluation, it is possible to associate a collaboration form to each task i.

The decision making model, in this case, is based on a set of linguistic rules formalising the main result of the OET and reported in Table 3. Having defined the linguistic variables low (L) and high (H) for the above-mentioned rules, the inference proceeds by applying the Mamdani's inference fuzzy approach by using the