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THE IMPACT OF TRUST AND POWER ON KNOWLEDGE SHARING IN DESIGN PROJECTS: SOME EMPIRICAL EVIDENCE FROM THE AEROSPACE INDUSTRY

J. Cloonan, T.Matheus and F.Sellini

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1. Introduction

The purpose of this research paper is to present findings from interviews with engineers in the aerospace industry on how relationships in supply chain teams impact knowledge exchange. We investigated the challenges faced by aerospace wing engineers in sharing design information, knowing that the trend in aircraft design and manufacture is to make more use of external suppliers. This evolution within the global aircraft industry increases the need for collaboration between aerospace companies.

This work is a subset of the Knowledge Enabled Wing Engineer (KEWE) research carried out for the European VIVACE project (2004-2007). The VIVACE research project delivered an improved aeronautical collaborative design environment with associated processes, models and methods to design an aircraft and its engines as a whole. Advanced capabilities developed included Knowledge Enabled Engineering which identified knowledge management related challenges in the extended enterprise.

Design engineers find that engaging with integrated project teams has become a common way of working. Due to the dispersed nature of knowledge in aerospace supply chains (Rosenberg, 1982) knowledge sharing is important in order to be able to develop existing and new products. From the literature we can see that support of knowledge exchange is a multi-faceted and complex subject.

In this paper we focus on the two research issues of trust and power and how they influence knowledge sharing in the supply chain. Different dimensions of power (Hardy, 1996) are important in this context because they enable and/or constrain the integration of the disperesed knowledge during the product design process in an inter-firm network (Swan and Scarbrough, 2005). Rolland and Chauvel (2000) comment that "trust is, after all, the single most important precondition for knowledge exchange".

2. Trust and knowledge sharing

Trust is a multi-faceted subject illustrated by the fact that you can find different definitions in the literature. There are many definitions of trust offered in the existing literature. For the purpose of this paper we consider trust to be a willingness to rely on another party in the confidence that this reliance will provide a positive outcome. Mayer et al. (1995) define trust as "one party's willingness to be vulnerable to another based on the expectation that the other will perform an action important to the trustor". The trustors who share knowledge make themselves vulnerable in that they do not expect that

their interests will be threatened. This vulnerability can be more acute if the information recipient is unknown.

Trust can be considered to depend on the lifecycle of a relationship between two partners in that relationship. At the start trust is given conditionally, as both parties in the relationship are willing to work with each other (JONES and George, 1998). As the relationship develops and matures, values are shared and the level of trust becomes unconditional. Conditional trust becomes unconditional as individuals become more comfortable with other team members and as they understand better each others roles and abilities. If partners in a relationship do not meet each others expectations then a state of distrust will exist. This leads to an unwillingness to interact due to a lack of trust. Another concept is that of swift trust (MEYERSON et al., 1996). In contrast to this, swift trust is required where teams are temporary in nature or are put together at the last moment. The preconditions for developing swift trust include factors which force the development of trust. They include a dependency on each other to achieve or people who are linked by rewards or penalties.

Personal and impersonal trust are also relevant concepts to understand in our context. Morris and Moberg (1994) describe personal trust as based on the interactions between individuals and impersonal trust as based on the roles or position within a company. Organisational trust is described as a confidence that the actions of the organisation and it's leaders will provide a benefit to the individual.

Cross et al. (2002) advocate the use of social network analysis to support amongst other things the development of communities of practice. Social network analysis can highlight the effectiveness of information flow and enable the use of appropriate interventions to maximise this flow. This includes personal networks where 'know-who' knowledge can either enable or constrain operational effectiveness. Cross and Parker (2004) conducted sixty interviews across three organisations to understand the needs that networks fulfil. They found a number of reasons why people turn to their network. People look for colleagues who can provide information to get things done ('task purposes'), for someone who can make sense of events ('sense making') and for people who can help cope with issues ('personal support'). The literature supports the idea that knowledge is shared through networks.

Connections between trust and knowledge sharing have been researched by Abrams et al. (2003). These authors investigated how trust enables effective knowledge creation and sharing within organizations and propose "trustworthy behaviours" that can help managers to promote trust in their organizations. Examples include acting with discretion, ensuring a shared vision, enabling personal connections and ensuring that decisions are fair and transparent. The trust builders promote either 'benevolent trust' or 'competence trust'. Benevolent trust is about being happy enough to ask a colleague for information. Competence trust is about being confident in the competence of the person you are exchanging information with.

Kanter (1994) describes how partners in a business relationship need to share the required amount of information to achieve their common goals. A failure to do so can lead to conflict and a reduction in trust. As well as accessibility, information accuracy and visiblility can reduce risk in the supply chain by increasing the confidence and trust in supply chain partners. Liker and Choi (2004) identified steps employed by Toyota and Honda in supporting knowledge sharing within supplier relationships. These steps require the sharing of information 'intensively' but 'selectively' and call for partners to conduct improvement activities jointly.

Von Krogh et al. (2000) recommend a number of steps to create trust. One particular recommendation is about sharing personal information within the context of smaller groups. The argument is that sharing personal information increases interpersonal trust which in turn encourages information sharing. It then becomes a virtuous circle of sharing information through unconditional trust.

In summary, trust is core to developing and maintaining a successful relationship. Information recommended by a trusted colleague is more likely to capture your interest than receiving information from someone that you do not know (DIXON, 2003). More research on trust in different organizational settings is required (Sahay, 2003). This is also true of the aerospace industry. It will be seen in later sections of this paper how these dimensions of trust combine with those of power in order to support and / or inhibit knowledge sharing in supply chain relationships.

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3. Power

The literature on power is too extensive to be completely reviewed for the purpose of this paper. Power is an elusive, complex and multifaceted notion that lacks an unanimously acknowledged definition (Haugaard, 2002). For the purpose of this work undertaken power is seen as 'a force that effects outcomes, while politics is power in action' (Hardy, 1996, p. 3). One rationale for incorporating power into the notion of interorganizational knowledge integration is based on Hardy and Phillips (1998) as well as Lawrence et al. (2005), who mention that very little conceptual and empirical work has been done regarding the nature and effects of power at an interorganizational level. Hardy (1996), based on Lukes (1974) earlier work makes an analytical distinction between four dimensions of power. They are power of resources (e.g. rewards, sanctions, coercion, authority, credibility, charisma, expertise, information and political affiliations (Benfari et al., 1986)), power of processes (e.g. non-decision-making; manipulating of agendas (Bachrach and Baratz, 1962)), power of meaning (e.g. symbols, structure, values and language (Pfeffer, 1992)) and power of the system (e.g. the influence of the institutional context on the product development process).

In reality these dimensions are recursively intertwined. However, the rationale for choosing this framework of power is that it provides a useful analytical framework for exploring power effects (Swan and Scarbrough, 2005). Moreover, previous research combining power and inter-firm networks has focused merely on the resource-based view of power (e.g.Cox et al., 2004; Maloni and Bentton, 2000).

Subsequently, expanding the power framework may shed light on different aspects of the nature of power in the inter-firm context besides counterproductive effects in relation to collaboration and trust, which have been revealed using the resource-based view of power (Handfield and Bechtel, 2004).

4. Research questions

The analysis of the literature indicates that there are gaps in investigating the support of individual engineers in building or maintaining supply chain relationships from an aerospace perspective. This leads to our research questions. How can we enable people to share information across the extended enterprise in confidence, i.e. with trust and the second one how power influences knowledge sharing in supply chains?

5. Research methodology

There are three aspects to the methodology, how to establish and define the business context, what sampling method to use and what data collection approach is appropriate.

5.1 Business context

To capture real life experiences the researchers engaged with people who had previous or current experiences in supply chain relationships through membership of integrated project teams. These engineers would bring both the aircraft manufacturer and the supplier perspectives to the research. The unit of analysis is the intergrated project team within the design process. The rationale supporting this choice in connection to the case study is that the design process can include interactions at both intra- and inter-organizational levels and that boundaries across these levels are often unclear.

The rationale for the utilization of a case study is related to the exploratory nature of the study, in which a case might help to identify meaningful patterns in the data. Another rationale for the single case study design is that the original equipment manufacturer (OEM) (the name of the focal organization was changed due to confidentiality reasons) is a unique case (Yin, 2003), which has not been researched from the perspective of this study.

5.2 Snowball sampling, data collection and analysis

In order to get in touch with the relevant target population the researchers used snowball sampling. The rationale for this approach is that it helped the researchers to overcome the problems related to

concealed populations, such as the inter-firm network and the invisible social relationships within such a network. Furthermore, snowballing is an informal method for getting in touch with the target population (Faugier and Sargeant, 1997).

For the purpose of this paper 25 semi-structured interviews with engineers in the supply chain and design related positions were carried out. The researchers used a list of 15 questions to guide the interview process.

6. Discussion based on interviews

Trust and power were the notions that stood out from the interviews in terms of facilitating or inhibiting knowledge sharing. These will now be discussed.

6.1 Trust

This section presents the main reasons, as established from the interviews, that influence the level of trust in supply chain teams. There is no distinction made between the comments from the aircraft manufacturer and the supplier as interestingly the issues tended to be the same ones. It should be noted that as the researchers interviewed individual engineers, comments relatingto trust tend to be of an interpersonal nature.

The constraint of page count prevents the discussion of all the factors affecting trust so the researchers focused on the four main topics identified by interviewees as the most important in affecting levels of trust. They were:

- Timely communication
- Consistent information sharing
- Personal networks
- Exploring trust levels

Information is not always presented on time and according to plan, often caused by changes to plan. The changes themselves although unwelcome do not necessarily cause the frustration. It is the fear of giving bad news that causes the 'surprise' and bad feeling within teams. If advised on time it may be possible to mitigate the effect. Failure to communicate on time leads to a questioning of competence (competence based trust) or the ability to meet target delivery of work. In this context a comment like "*I can't remember getting one thing that I wanted on the day that I wanted it on*" was typical of many of the interviewees. This was a shared 'root' problem which tends to retard the development of conditional based trust to unconditional trust. Relationship entities are willing to work with each other but there is a suspicion regarding being able to provide information on time.

On occasions sharing information is complicated by an awareness of what really can be shared. A number of interviewees referred to the inhibiting fear factor of what information could be shared between partners. The request was for increased transparency in the relationship by declaring what knowledge should and also should not be shared to help achieve objectives. Intensive but selective information (LIKER and CHOI, 2004) sharing is required. Issues of communication clarity and quantity of communication was mitigated by frequently organised drumbeat meetings. This means that partners do not distrust each other, rather a low level of conditional trust exists i.e. both entities in the relationship remain willing to interact with each other.

Personal networking is considered important to knowledge exchange. Engineers refer to internal and external colleagues that they worked with on previous projects for information. Personal trust was reported as the most common form of trust. It was felt that although an important facet of relationships, personal networking is not formally recognised as important. It is recognised that networks can be cemented through the concept of relational capital i.e. the goodwill and trust in the

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relationship can be successfully developed by organising social events for project teams. "*What is underrated is face-to-face discussions. Now we have the use of e-mails, travel budget restrictions and video conferencing availability, face to face is (considered)old fashioned and non-pc but it's worth more than 1000 novel team building exercises, having a drink with people. It works".* Sharing of personal information within personal networks helps to maintain unconditional trust, a trust based on past shared experiences.

The reasons as to why trust is low is not usually jointly discussed amongst partners. Partners in a supply chain relationship may both rate the trust maturity of the relationship as low, but the reasons for the low level of trust may differ. Its not necessarily the same issue. From the interviews it was clear that there was no framework for capturing the reasons behind the low trust and consequently no plans developed to resolve any related issues. If recorded rationale could be re-used to think critically about relationship performance. This promotes the concept of benevolent based trust (Abrams et al., 2003), which is about caring about somones issues and them feeling comfortable (do not feel vulnerable) about sharing information with you.

What was common in the discussions was the lack of formal awareness of trust issues and consequently that no framework or support for dealing with them exists in either the aircraft manufacturer or supplier.

6.2 Different dimensions of power and knowledge sharing

The researchers found that the different dimensions of power mentioned earlier have positive as well as negative impacts on knowledge sharing in supply chains. This is addressed in the following sections.

Situation 1: Power of processes, systemic power and knowledge sharing

In some situations, the non-raising of issues by suppliers (power of processes) inhibited the sharing of knowledge. In situations in which a new supplier had been sourced, in some cases they were overwhelmed by the tough performance objectives introduced by the OEM. Subsequently, issues that caused problems within the supplier in relation to, for example a lack of understanding of manufacturing processes or customers requirements regarding a particular component, which might have caused a delay of the entire project, were not being raised at meetings with the OEM. These issues were simply taken off the meeting agenda and the OEM only became aware of them shortly before the project delay was apparent. Hence, systemic power, in terms of tough performance measurements, triggered the hiding of problematic issues, which subsequently inhibited the sharing of knowledge by the OEM in order to resolve the problem the supplier had been dealing with. Furthermore, systemic power and the non-raising of issues also inhibited the exploitation of knowledge. This is in contrast to how Lawrence et al. (2005, p. 189) argue, i.e. "(…) whereas organizations characterized by relatively weak systemic power will perform poorly in terms of exploitation". This means that despite strong systemic power the exploitation of knowledge might not always be achieved.

In situations like these, this non-raising of issues might have inferred a lack of trust of suppliers, i.e. how would the OEM have handled the situation if they had been aware of the problem the supplier had and how would this have affected the allocation of future business? A comment made by one of the OEM's suppliers highlights the relationship between meeting performance criteria and the non-raising of potential issues:

"They [the OEM] do that by a quarterly evaluation against a set of key criteria. I mean from day to day they'll tell us okay and we'll look at each delivery, we look at the performance as we go through the project but then every quarter what happens is that there's a formal review of our activities against a set of pre-criteria, which then gets wrapped together with all the other work that we [the supplier] do and then that'll get sent to the headquarters [of the OEM] to say this is how the supplier are doing...[and if we don't meet the performance criteria], there is a mechanism there to say right well if you're not... if you get to a certain level of performance and you decrease at that level, the OEM will not give you work and you'll be taken off the preferred supplier list."

Situation 2: Power of resources, power of meaning, systemic power and knowledge sharing in civil and defence aerospace supplier relationships

This situation draws on interviews conducted with various purchasing and customer-business-facing managers.

It is quite common for an original equipment manufacturer (OEM) to select new suppliers based on the outcomes of a supplier selection process. Throughout this process the new supplier is assessed based on various hard and soft performance indicators (i.e. systemic power) (Hardy, 1996). In some cases, when the OEM has intentions of selling aircraft to the Ministry of Defence of a different country and / or to a government owned airline (in both cases non-UK), the results of the previous supplier selection process are discarded. This is due to an authoritative decision made by the respective government that the OEM must work with a particular supplier that would not have been considered because of non-conformance to the performance indicators of the supplier selection exercise (power of resources (Benfari et al., 1986)). In the cases reported in this research, the effects of such a decision by the non-UK government had negative effects on the sharing of knowledge between the OEM and the respective suppliers. However, the sharing of knowledge in the instances discussed in the interviews was vital because the new supplier had to learn new engineering and design standards so that the OEM was able to meet the requirements for particular components and the final product laid upon it by other external institutes (e.g. Airworthiness Authority). The non-UK suppliers however, took advantage of the decision made by their national government because the suppliers knew that no matter how well they would perform, they would not lose the contract with the OEM. These aspects were openly discussed with the OEM when specific issues regarding the suppliers non-conformance to requirements were raised by the OEM. Subsequently, the power of meaning was negatively impacted by the power of resources. The rationale for this is the authoritative decision by the non-UK government to use a particular supplier as well as the decision by the OEM to comply to the these demands to be able to complete the business deal with the non-UK Ministry of Defence (Hardy, 1996). In the cases reported throughout the interviews both, knowledge exploitation (e.g. the utilization of the OEM's existing knowledge to improve the supplier's performance) as well as exploration (e.g. the utilization of new ideas provided by the OEM to the suppliers) was hindered due to the influence of the dimensions of power used for the purpose of this paper (Lawrence et al., 2005).

Situation 3: Power of meaning, power of the system and knowledge sharing

A positive example that was reported during the interviews is related to the outsoucing of various design activities from the OEM to a new supplier. This time though, there was no non-UK government involvement at the supplier selection stage. The new supplier was merely recruited due to the fact that it was able to meet selected performance objectives. Subsequently, systemic power (e.g. the introduction of tough performance measures by the OEM in terms of meeting various milestones along the stage-gate-product-development-process as well as the ability of the new supplier to deliver accordingly) and the power of meaning (Hardy, 1996) (e.g. the symbolic value of becoming a preferred supplier of the OEM as well as the ease with which the OEM was able to achieve conformance to institutional design requirements) had a positive impact on knowledge sharing between the OEM and the supplier.

The knowledge sharing activities included the exploitation of existing knowledge within the supplier's own design knowledge repertoire as well as drawing on the OEM's existing knowledge base. Furthermore, the power dimensions used in this paper influenced knowledge exploration between the supplier and the OEM positively because the supplier had to acquire new knowledge from the OEM in order to be able to meet the customer requirements imposed on it by the OEM. This corroborates what Lawrence et al. (2005) discovered in terms of the positive association between strong systemic power and knowledge exploitation.

Based on the previous discussion it is important for managers working at the interstices of organizations to create an awareness of the positive and negative effects different dimensions of power and trust have on knowledge sharing in this context. One of the questions to investigate is whether it is worthwhile pursuing supplier integration activities. One example in this connection would be a case

where the supplier did not meet any of the requirements of the supplier selection exercise and if in the long-run it may have been more profitable for the OEM to use a national supplier with the requisite knowledge instead of a foreign supplier. The reason for this research question is justified through potential project delays and subsequent lost revenue-generating opportunities from the perspective of the OEM.

7. Conclusions

The limitations of the paper are that the claims made are based on a relatively small sample within four organizations. Additionally, the researchers discovered further intricacies in their data regarding some of the concepts discussed in this paper, which might enhance the existing knowledge in this area of research. However, due to time constraints and word limit, these could not be discussed at this point.

A more rigid investigation of how trust between supply chain partners is affected due to the interplay of different dimensions of power (not just the power dimensions discussed here) and their impact on knowledge sharing might shed light on unexpected improvement potentials in complex products and systems supply chains.

Another suggestion for further research is to research the concepts delineated in this paper in a number of organizations in order to verify whether the claims the researchers made are applicable to different organizational and supply chain settings within the aerospace industry and beyond.

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Joe Cloonan, KM research co-ordinator
Airbus CIMPA Knowlegde Management
Airbus UK, New Filton House
Golf Course Lane, Filton BS99 7AR Bristol, United Kingdom
Email: joseph.cloonan@airbus.com

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