Coordinating customers and proactive suppliers
A case study of supplier collaboration in product development

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Abstract
This case study aims at increasing our understanding of what factors are critical for successful supplier collaboration, and shed light on the complexity of collaboration. The research was performed as in-depth case studies of the product development collaboration between a Swedish auto manufacturer and five of its most important system suppliers. The empirical evidence is based on 36 personal interviews and four group interviews with representatives both from the auto manufacturer and from the five suppliers. The results indicate that reality is often more complex and multifaceted than has been illustrated in previous research. The suppliers’ internal organization of product development and production and their co-operation with other manufacturers and suppliers were found to be of crucial importance. Further, both auto manufacturers and suppliers will need to adapt to new roles when suppliers are involved in the product development process.

1. Introduction
Ultimately, the long-term competitiveness of any manufacturing company depends on the success of its product development capabilities (Wheelwright and Clark, 1995). Product development is, however, in many respects a difficult task characterized by a highly non-linear and iterative process (Lundqvist, 1996) aiming at a moving market target (Wheelwright and Clark, 1992). In addition, as identified by Bonaccorsi and Lipparini (1994), there is a need to mobilize not only internal but also external actors since the development process cuts
across knowledge domains both within and outside the firm. The interorganizational network of suppliers, (see Imai et al., 1985), plays an important role for increasing speed and flexibility in product development. Consequently, in order to better utilize competence and resources held by suppliers, auto manufacturers involve suppliers to an increasing extent in the development of new products (Clark and Fujimoto, 1991; Lamming, 1993). Earlier ‘arms–length’ relationships with suppliers are replaced with closer collaboration (Smith and Reinertsen, 1995).

Properly managed supplier involvement in product development may result in, for example, reduced development time and cost, access to new technologies and increased quality (see e.g. Monczka and Morgan, 1995). The understanding of what factors affect the performance of collaboration is, however, still underdeveloped. The aim of this case study is therefore to demonstrate factors that are critical for successful supplier involvement in product development, at least within the auto industry. The aim is not, however, to give a complete list of factors but rather to provide an understanding of factor characteristics, what underlying causes there may be and how these should be taken into consideration.

2. Degree of supplier involvement

Suppliers may be classified in different ways depending on the extent to which they are involved in product development. Clark (1989) and later Clark and Fujimoto (1991) distinguish between three main categories of product parts:

- Detail-controlled parts: development entirely carried out by the auto manufacturer.
- Black-box parts: auto manufacturer specifies the functional requirements, while detailed engineering is carried out by the supplier.
- Supplier proprietary parts: standard parts where development is entirely carried out by the supplier.

Regarding detail-controlled parts and supplier proprietary parts, the supplier is not truly involved in product development. In the latter case the supplier is carrying out the development, but since this only concerns standard or ‘off-the-shelf’ parts, it cannot be considered involvement. In the black-box case, the auto manufacturer specifies performance requirements and interface details and the supplier develops the technology. According to Clark and Fujimoto (1991), this enables the auto manufacturer to utilize supplier engineering expertise while maintaining control of basic design and total vehicle integrity. Thus, black-box can be considered supplier involvement in product development. Supplier involvement is, however, an iterative process and, according to Lamming (1993) and Clark and Fujimoto (1991) the term black-box is not fully adequate. They argue that it is also necessary to distinguish ‘gray-box’ parts, i.e. black-box parts where the auto manufacturer has more influence on the parts’ internal functioning.

The extent of supplier involvement in product development primarily depends on the supplier’s ability to take responsibility and perform the development work. Kamath and Liker (1994) use a conceptual model for distinguishing supplier roles in a buyer–supplier relationship, as shown in Table 1.
Table 1
Supplier roles according to Kamath and Liker (1994)

<table>
<thead>
<tr>
<th>Design responsibility</th>
<th>Partner</th>
<th>Mature</th>
<th>Child</th>
<th>Contractual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire</td>
<td>Supplier</td>
<td>Supplier</td>
<td>Joint</td>
<td>Customer</td>
</tr>
<tr>
<td>subsystem</td>
<td>Complex</td>
<td>Simple</td>
<td>Simple</td>
<td>Simple parts</td>
</tr>
<tr>
<td>Specifications provided</td>
<td>Concept</td>
<td>Critical specifications</td>
<td>Detailed specifications</td>
<td>Complete design</td>
</tr>
<tr>
<td>Supplier’s influence on specifications</td>
<td>Collaborate</td>
<td>Negotiate</td>
<td>Present capabilities</td>
<td>None</td>
</tr>
<tr>
<td>Stage of supplier’s involvement</td>
<td>Pre-concept</td>
<td>Concept</td>
<td>Post-concept</td>
<td>Prototyping</td>
</tr>
<tr>
<td>Component-testing responsibility</td>
<td>Complete</td>
<td>Major</td>
<td>Moderate</td>
<td>Minor</td>
</tr>
<tr>
<td>Supplier’s technological capabilities</td>
<td>Autonomous</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
</tbody>
</table>

As can be seen in the table, the supplier takes the design responsibility in the partner and mature stages. In the child stage there is a joint responsibility, but the supplier is provided with detailed specifications, implying that the supplier is playing a minor role in product development. In the mature and particularly in the partner stages, however, the supplier takes full responsibility for the design and is involved at an early stage. In a study comparing automobile and electric machinery industry, Asanuma (1989) presented a comparable model distinguishing parts and suppliers based on how specifications and drawings are provided. As noticed by Twigg (1997), a distinguishing feature between suppliers in Asanuma’s model is their product development capabilities.

3. Supplier involvement—potential benefits and critical factors

In the literature, several benefits of closer relationships and supplier involvement in product development can be found. Powell (1987) states that a partnership relation can afford the involved parties access to complementary skills, economies of scale in joint research, access to new technologies or markets, risk sharing and access to knowledge located outside the boundaries of the firm. According to Clark (1989), engineering capabilities in the supplier network allow the firm to benefit from the suppliers’ know-how, thereby, reducing the development time. Ragatz et al. (1997) found evidence of important benefits regarding cost, quality and reduced development time. Gomory (1995) states that making manufacturing expertise contribute directly to product development at an early stage is one of the most important challenges for high-technology managers. As concluded by Wasti and Liker (1997), supplier involvement is positively associated with design for manufacturability considerations and product design improvements.

However, drawbacks and potential risks associated with closer collaboration are seldom taken into consideration. There is evidence showing that the implicit assumption of greater competitive strength for the parties involved in a relationship is not always fulfilled (Mohr and Spekman, 1994). Hartley et al. (1997) conclude that simply adopting the techniques suggested in the literature will not necessarily reduce development time or lead to technical success in the project. Eizenhardt and Tabrizi (1995) even found that supplier involvement
could affect product development time negatively, especially when markets and technologies are rapidly and unpredictably evolving. The research by Littler et al. (1995) showed that over 40% of the respondents expressed the view that collaboration makes product development more costly, more complicated, less efficient, more time consuming and more difficult to control and manage. They conclude that there must be a point where the value of product development collaboration should be questioned. This paradox between assumed benefits and potential failure indicates a need for a more thorough understanding of what factors are critical for the outcome of a relationship.

Several researchers have identified factors affecting the outcome of relationships where suppliers are involved. Ragatz et al. (1997) found, based on a survey, twelve factors (e.g. supplier participation on buying company’s project team, direct cross-functional intercompany communication and shared education and training) to be significant. They also recognized top management commitment to be a critical enabler of these management practices. Bruce et al. (1995) emphasized top-level commitment, cultural compatibility between the parties and awareness of the dynamics of the external environment. Based on a questionnaire, Littler et al. (1995) found that factors of considerable importance were establishment of ground rules, objectives and responsibilities, frequent communication, the relationship being perceived as important and having a product or collaboration champion.

Clark (1989) and Hartley et al. (1997), among many others, have emphasized the importance of involving suppliers at an early stage. Studying cross-industry R&D, Kodama (1995) identified substantiality, meaning management making a commitment to the joint R&D, and reciprocity to be important. Reciprocity here concerns mutual respect, responsibility and benefit. According to Clark (1995), alliances are to be seen as a basis for ongoing transfers of knowledge, not as one-shot collaborations, thus pointing out the importance of a long-term view of the relationship.

Based on a questionnaire examining characteristics of partnership success, Mohr and Spekman (1994) found communication quality and participation, co-ordination, commitment, trust, and conflict resolution techniques of joint problem solving to be significant. Also Granovetter (1985) emphasized the significance of trust (in relation to social relationships), and Ring and Van de Ven (1992) regard trust to be present in relational contracting when the level of risk is high, as in the case of product development. Dyer and Chu (see Landry, 1998) found that relationships with high levels of trust were associated with substantially lower costs and, since trust encourages the sharing of resources, it actually adds value to the relationship.

Hence, involvement of suppliers in product development may result in a range of potential benefits for the participating parties, although several factors that are critical for the outcome of the relationship have to be taken into consideration.

4. Research method

The empirical research was performed as a single case study at a Swedish auto manufacturer with five embedded cases (see Yin, 1994). An exploratory case study approach was chosen since it enables in-depth data collection and a thorough understanding of contextual factors. The study started in October 1997 and was finished in July 1998. The researchers
in co-operation with representatives from the auto manufacturer selected the five cases. In each case the relationship between the auto manufacturer and a system supplier formed the unit of analysis. All five suppliers were working within the same overarching project (the development of a new car platform) but within different development areas (engine, interior, exterior, electrical system and chassis). This research layout made it possible to compare case findings on a detailed level.

Before the collection of empirical data commenced, an exploratory literature study was performed resulting in a crude list of more or less relevant factors affecting the outcome of supplier relationships. This crude list was trimmed in co-operation with practitioners from the auto manufacturer’s Department for Product and Process Development. The practitioners added relevant factors, based on experience from earlier supplier relationships. These discussions were valuable, since aspects not generally dealt with in current literature were considered.

The aim of the data collection and the following analysis was to narrow down and structure the crude list of critical factors into a net list of factors. Several methods for data collection were used, involving 24 partly unstructured and partly highly structured interviews, four team discussions and one dialog seminar.

The interviewees were initially asked to freely give their opinions about the project as well as what factors they considered to be critical regarding the supplier collaboration. They were then presented with the list of ‘critical factors’, and asked to rate them along several dimensions (their occurrence in the project, importance for the outcome of the project, etc.).

When all team members had been interviewed, they were gathered for a team discussion (using affinity diagrams, see e.g. Bergman and Klefsjö, 1994), where they worked together to appreciate what factors are generally critical for successful supplier involvement in product development. Each team discussion ended up with a chart of factors, where each factor was ranked according to its importance.

The results from the interviews and team discussions were compiled and presented in a dialog seminar where interviewees and department managers at the auto manufacturer participated. The relevance of each factor was discussed thoroughly. One outcome of the dialog seminar was that the factors were primarily operative and did not reflect some of the more strategic aspects expected to be found. Therefore, 12 additional interviews with department managers from the auto manufacturer (product development and purchasing) and supplier representatives were conducted. These interviews were semi-structured, giving the interviewees the possibility to add factors previously not considered.

5. Empirical findings

The predominant view among the respondents was that the achieved product development performance would not have been realized without involving the suppliers. There was, however, also consensus that the supplier involvement had taken more time and had been more difficult to manage than was first expected. Before presenting the critical factors, the main characteristics of the suppliers will be discussed (see Table 2).

According to Kamath and Liker’s model (see Table 1), four of the five suppliers (A–D) are classified as ‘mature’ and in some respects as ‘partner’. Supplier E is generally classified
Table 2
Main characteristics of the five suppliers

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Classification according to Kamath and Liker (1994)</th>
<th>Earlier relationship with the auto manufacturer</th>
<th>Market presence</th>
<th>Collaboration experience (on corporate level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier A</td>
<td>Mature/(partner)</td>
<td>No</td>
<td>Global</td>
<td>Extensive</td>
</tr>
<tr>
<td>Supplier B</td>
<td>Mature/(partner)</td>
<td>Yes</td>
<td>Global</td>
<td>Extensive</td>
</tr>
<tr>
<td>Supplier C</td>
<td>Mature/(partner)</td>
<td>Yes</td>
<td>Global</td>
<td>Extensive</td>
</tr>
<tr>
<td>Supplier D</td>
<td>Mature/(partner)</td>
<td>Yes</td>
<td>Europe</td>
<td>Limited</td>
</tr>
<tr>
<td>Supplier E</td>
<td>Mature/(child)</td>
<td>Yes</td>
<td>Europe/(global)</td>
<td>Limited</td>
</tr>
</tbody>
</table>

as ‘mature’ but in some respects, such as design responsibility and product complexity, as ‘child’. Here, it should be mentioned that supplier E’s system is closely related to parts of the vehicle that the auto manufacturer traditionally has kept in-house. This may have affected the supplier’s possibilities to take a full design responsibility. Further, regarding the complexity of supplier E’s product, the assembly is fairly simple (explaining the classification as ‘child’) while the development of the system is more complicated.

Three of the five suppliers (A–C) have a global presence as well as extensive experience from product development collaboration, while the two other suppliers (D and E) mainly compete on the European market and have more limited development experience. Though, a larger global supplier had recently acquired supplier E. Supplier A is the only supplier among the five that was totally new to the auto manufacturer. However, among these five cases no differences in development performance could be traced to either global presence or the suppliers’ earlier experience from collaboration with this auto manufacturer.

With regard to the classification by Clark (1989) and Clark and Fujimoto (1991), the studied supplier relations would be classified as ‘black-box’. This classification is, however, not fully accurate since part of the development work was performed jointly between the auto manufacturer and the suppliers, implying that the term ‘gray-box’ would be more accurate. The suppliers had their own project managers and engineers participating on the auto manufacturer’s cross-functional development teams. In addition, meetings were continually held with the suppliers for discussing also non-technical issues.

The study focused on what factors are critical when involving suppliers in product development. In total, nine factors were identified as critical for a successful outcome and have been listed below.

- Technological competence.
- Suppliers’ co-operation with other auto manufacturers and own suppliers*.
- Openness and matching of expectations.
- Timing of involvement of suppliers.
- Long-term strategy for involvement.
- Coupling between production and product development*.
- Project management.
- Pro-active supplier*.
- Co-ordinating auto manufacturer*.
Several of these factors have, however, already been discovered and thoroughly described by other researchers (as exemplified above). Therefore, we have focused on the four factors marked with ‘∗’. These factors have received less attention in previous research, and here our case study can contribute to a deeper understanding of the underlying factor characteristics complicating supplier involvement. It should, however, be emphasized that this does not mean that these four factors are considered more important than the other five.

5.1. Suppliers’ co-operation with other auto manufacturers and own suppliers

All respondents were of the opinion that, to make relationships successful, it is necessary that the supplier co-operate also with other auto manufacturers. This will help the supplier stay updated, learn new technologies and view own development results more critically. Thus, the supplier has a better chance to remain a competitive partner over time. There is, however, a risk that critical knowledge spillover to other manufacturers via the supplier. All respondents were, notwithstanding the fact that the auto manufacturer in some cases (e.g. case A and C) is a leader in terms of innovation and technology, of the opinion that the benefits of suppliers co-operating with other manufacturers overshadow the potential risks. A limited amount of knowledge transfer between manufacturers (via suppliers) was therefore regarded positive.

Although all five suppliers co-operate with other auto manufacturers, in some cases the expected benefits did not come about. There were mainly two reasons for this. Firstly, the possibilities of knowledge transfer were offset due to the supplier’s internal organization. Either the supplier had a hierarchical organization (e.g. supplier C; a global actor with a large, geographically dispersed organization) limiting the communication between the units working with different manufacturers. Or, in some cases, the supplier had designated special development teams for different manufacturers. This was especially evident in case B where the limited communication between these teams also limited the amount of knowledge transfer between different development projects.

Secondly, in some cases learning and knowledge transfer from other manufacturers was limited since the supplier co-operated with auto manufacturers in areas that were of little or no interest to the auto manufacturer studied. This was especially emphasized in case A and to some extent in case C where front-line technology was developed and comparable systems were more difficult to find. Therefore, several respondents emphasized that a supplier’s co-operation with other auto manufacturers should be thoroughly analyzed prior to involvement regarding the possibilities of learning and knowledge transfer.

Further, to a greater extent than before, first tier suppliers use second tier suppliers for the development of sub-systems. The study showed that some problems regarding product development and a great part of the quality problems in the assembly could be traced back to second tier suppliers. The problems mainly concerned communication. The engineers at the auto manufacturer felt that information from second tier suppliers was ‘filtered’ due to the extra step via the first tier supplier. On the other hand, the first tier suppliers sometimes felt bypassed when the engineers at the auto manufacturer communicated directly with second tier suppliers. As a consequence, it was emphasized that when also second tier suppliers are involved in the development process, there is a need to formalize communication.
5.2. Coupling between production and product development

A majority of the respondents emphasized the importance of a close relationship between the supplier’s production facilities and the Product Development Department. Especially in case A this relationship was considered to have been of vital importance for the successful outcome of the supplier’s development work. The close relationship with the supplier’s production facility had helped the development team design products suitable for production in the supplier’s facility, with improved quality and reduced cost as a result.

However, the study also presented evidence that supplier collaboration in the development process does not guarantee access to the supplier’s production competence and resources. Again organizational issues played an important role for the possibilities of knowledge transfer. No evidence indicated that geographical closeness was necessary, but in cases where the suppliers’ Development and Production Departments belonged to different but recently merged companies (as in case E), or when a hierarchical organizational structure separated these departments (e.g. case B and C), communication and transfer of knowledge was limited. Another important factor was the suppliers’ use of technical consultants in the development work. Since the consultants were often not familiar with the supplier’s production facility, the transfer of production knowledge to the development team was limited.

Traditionally, suppliers have manufactured simpler components or sub-systems according to specifications from the auto manufacturer. However, as outsourced modules are becoming increasingly complex and functionally interrelated, the importance of close communication between production and design increase. To prevent the pitfalls described above, several respondents emphasized the importance of having a representative from the supplier’s production facility as a member of the development team.

5.3. Pro-active supplier

Involving suppliers in product development means new challenges to both auto manufacturers and suppliers. An increasing number of interdependencies regarding organization, technologies and competence need to be managed properly. The study clearly shows that new role characteristics can be distinguished for the collaborating parties.

Taking an extensive responsibility for the design of a new system puts high demands on the supplier. Respondents from both suppliers and the auto manufacturer emphasized the necessity of suppliers being pro-active. Four explicit implications were identified and are presented here.

First, the suppliers need to take over part of the responsibility for benchmarking competitors and other key actors in their area of activity. Traditionally, the auto manufacturer had mostly done this. However, as suppliers increase their share of the responsibility for design, and are supposed to develop certain key technologies themselves, they need to know what is in the technological front-line. Well-developed benchmarking activities are also important to convince the auto manufacturer that they will get front-line design solutions from the supplier.

Second, both auto manufacturer and supplier representatives agreed that supplier involvement implies that the supplier is active and comes up with new, own design solutions, although it has not been explicitly demanded by the auto manufacturer. The supplier is
supposed to possess the key competence needed and should therefore take own initiatives. In former projects, supplier E had done this at several occasions and many respondents were of the opinion that this had been crucial for this supplier’s future as a system supplier. In general, a majority of the respondents were of the opinion that such initiatives are important for a close relationship between the supplier and the auto manufacturer.

Third, in all five cases it was stressed that suppliers must scrutinize their design solutions more critically, especially regarding their systems interplay with other systems. As an example, supplier B had developed a system that worked technically, but when tested in the car by the auto manufacturer it did not fulfill all requirements. The developed system did not function satisfactorily with other systems although the supplier had several test-vehicles at their disposal. The need for a thorough understanding of the supplier’s own system’s interplay with other, interrelated systems was therefore frequently emphasized.

Fourth, a pro-active supplier should foresee needed resources and have the management capacity to take an extensive development project responsibility. Especially project management skills at the supplier were emphasized by respondents from the auto manufacturer. It was also stressed that suppliers must give early warnings when managerial and technical problems arise.

Although the suppliers in many respects had tried to act pro-actively, the general opinion was that they had not managed to take responsibility for product development as expected from the beginning. The suppliers had come up with few own solutions, and although the suppliers were supposed to develop a whole module/system the engineers at the auto manufacturer felt they had to intervene and help suppliers solve problems on a detailed level. Performance is, however, also largely dependent on the auto manufacturer’s role in the relationship.

5.4. Co-ordinating auto manufacturer

The respondents, especially representatives from the suppliers, emphasized the importance of the auto manufacturer taking the role as co-ordinator, leaving the development responsibility to the suppliers. The suppliers felt the engineers at the auto manufacturer often, due to traditional habits, interfered with the suppliers development work. This indicates new demands on the auto manufacturer’s management skills that affect the internal organization. People who have been working with engineering tasks will, for example, need more project management skills. Further, the purchasing function faces a different situation, since long-term reciprocal relationships demand more competence regarding, for example, law (due to more complex contracts, etc.) and cross-functional work.

Although the auto manufacturer takes the role of co-ordinator, their product development competence will remain important for the total vehicle planning and layout, and for formulating functional requirements to be communicated to suppliers. The capability to evaluate and select suitable suppliers for collaboration was also considered to be of increasing importance for the auto manufacturer. Supplier collaboration is a long-term engagement involving vast resources, implying that the selected supplier must be a good choice also in the long-term perspective. However, during the relationship, competitive powers cannot be used as before to evaluate and compare supplier performance and, hence, other ways of supplier evaluation will need to be developed.
6. Discussion

Previous research and the respondents’ experiences from supplier involvement in the five cases studied formed the base for the nine factors that were identified as most critical. Our overall impression is that involving suppliers in product development is a far more complex and multifaceted task than generally described in theory. In this section we discuss our findings further.

As presented in the previous section (see Table 2), the five suppliers were different in many respects. The fact that supplier A was ‘new’ and had no former relation with the auto manufacturer was compensated for by a strong commitment to the relationship and quickly building up design competence. Further, three of the suppliers had, on the corporate level, a global presence and extensive experience of collaboration, while the two other suppliers were smaller and less experienced. In practice, however, these differences proved to be of less importance, since the global suppliers had established branch offices for the collaboration and, hence, in many respects were acting as local firms. It would be reasonable to believe that large and globally represented suppliers would have better possibilities to provide the technological competence needed. However, as a consequence of the branch offices, there was no evidence in the study giving support for this assumption.

As referred above (e.g. Powell, 1987; Clark, 1989; Gomory, 1995), collaboration is associated with potential benefits, such as the possibility of different kinds of technology and knowledge transfer. Our results show, however, that these expected benefits were not always realized. There might be only limited knowledge transfer between the supplier’s Design and Production Departments and, even if the supplier has other collaboration partners, their respective technologies may be of no interest to the auto manufacturer. Further, according to respondents from both suppliers and the auto manufacturer, the suppliers’ development competence was often insufficient, or as in case A, it was too similar to the auto manufacturer’s own competence.

Since it may take several years to develop a fruitful supplier relation, these issues need to be considered already when suppliers are selected. Therefore, the supplier selection process is an important managerial issue, though often neglected in available literature. It goes without saying that selecting the best supplier is a crucial task, but several respondents in the study considered it to be a complicated issue. Underlying factors preventing expected benefits from materializing might be difficult to foresee. In addition, collaboration with only a few suppliers will reduce the possibilities of comparisons between different suppliers, making the selection process even more difficult. Therefore, new methods and tools for supplier evaluation and selection are needed.

Many respondents were concerned about how to avoid a weakening of the auto manufacturer’s own technological competence when suppliers perform a great share of the development work. Even if suppliers take care of the development, technological competence is crucial for the auto manufacturer’s possibilities of selecting and evaluating suppliers, formulating appropriate design requirements and performing the total vehicle planning. The auto manufacturer’s possibilities to retain competence are, however, largely dependent on how the development work is performed in practice. Above we compared the studied supplier relations with theory and found the ‘black-box’ classification not to be fully accurate. That is because ‘black-box’ does not reflect the continuous communication and joint
development we observed to be of crucial importance in the development work. We argue that this interactive way of working is important, in the long-term, for the auto manufacturer to maintain necessary competence.

Further, the case study showed that there is a need for a better understanding of how to organize for supplier involvement. In the stated theory, some examples of organizational measures can be found. One important issue here is suppliers participating on cross-functional teams (e.g. Ragatz et al., 1997), though this mainly concerns the project organization. However, based on the results from this study and some earlier experience, we argue that it is necessary to adapt the company organization and its internal processes for supplier collaboration. Much research has been focusing on the relationship between different organizations, but it is also necessary to consider what internal organizational measures need to be taken. As shown in the study, supplier collaboration implies new roles for the involved parties and, as a consequence, organizational matters need to be considered at all levels in the company.

A critical issue, often neglected in theory but emphasized by many respondents, is the potential risks associated with supplier collaboration. For example, what will happen when it 1 day becomes apparent that the collaborating supplier is stuck with the ‘wrong’ technology or materials? Further, as indicated by Littler et al. (1995), it should be questioned whether supplier collaboration is suitable in all situations. According to some respondents in our study, suppliers should not be involved in relatively small development projects since the co-ordination activities consume too many resources.

7. Conclusions and further research

The aim of this study has been to demonstrate factors that are critical for the outcome of relationships where suppliers are involved in product development. Case studies of five supplier relationships enabled an in-depth insight into the characteristics of supplier collaboration. Nine critical factors were identified:

- Technological competence.
- Suppliers’ co-operation with other auto manufacturers and own suppliers*.
- Openness and matching of expectations.
- Timing of involvement of suppliers.
- Long-term strategy for involvement.
- Coupling between production and product development*.
- Project management.
- Pro-active supplier*.
- Co-ordinating auto manufacturer*.

The case study has focused on the four factors marked with ‘*’ since they have received less attention in previous research and here we may contribute to a deeper understanding of the underlying factor characteristics complicating supplier involvement. From the results of the study it can be seen that supplier collaboration in product development is a far more complex issue than generally described in the literature. The study showed, for example, that expected transfer of knowledge from the supplier’s production facility might not be realized due to the supplier’s organizational structure.
Another example is that there were no major differences between globally represented suppliers and relatively smaller suppliers regarding their respective development capabilities. This was explained by the fact that the global suppliers had established new branch offices for the collaboration and were therefore acting more like local firms. Further, new roles were identified for the collaborating parties. The suppliers need to be more pro-active than before and the auto manufacturer needs to focus on co-ordinating the development activities.

The exploratory approach of the study also gave rise to new questions and it is clear that further research is needed in a number of areas regarding supplier collaboration. First, as described above, the selection of suppliers is a crucial process that needs to be further developed, especially since the conditions for selection of suppliers are changing in the long-term perspective. Second, as argued earlier, a crucial issue is how to organize for supplier collaboration. For example, how does collaboration affect the internal organization and what organizational characteristics are important for proper organizational matching? Third, there is a need for further research on what risks collaborating parties are exposed to, particularly in the long-term. We believe that the results from this case study can be used as a starting point for further research, which may deepen the understanding of what makes involvement of suppliers in product development a success or a failure.

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