Failures in collaborative design with suppliers: Literature review and future research avenues

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Abstract

The focus of the firms on their core competencies associated with the increasing complexity of products due to an integration of various technologies has led to an extension of their New Product Development (NPD) activity across organisational boundaries. In this respect, it is now acknowledged that Early Supplier Involvement (ESI) in product development confers a competitive advantage. Nevertheless appraising the benefits of such collaboration on the product development performance is not easy. Our method is based on the "*glitch*" concept that enables to appraise ESI benefits from the opposite direction i.e. by identifying what happens when the collaboration with suppliers is absent. Our previous work presented at IPSERA 2011 dealt with an in-depth case study analysis of an unsuccessful collaborative development with a supplier. In this previous paper, we identified ten "*glitches*" that prevented from reaping the benefits of supplier involvement. The aim of this paper is to carry out a literature review about failures in collaborative development of new product between a customer and a supplier. By comparing those literature review results with case study results, we aim at proposing a classification of the failures currently encountered in collaborative development with suppliers in order to tackle them.

Key words: New Product Development (NPD), Early Supplier Involvement (ESI), Failure, Glitch, Literature review

Paper Submission as a working paper

1. Introduction

Today's aggressive and expanding global marketplace and competitive pressures compel firms to consider new strategies in order to compress time between each stage of the value chain (Batchelor, 1997) and to stay competitive. It is acknowledged that innovation helps enterprises to increase their competitive position (Rehm et al., 2011). The suppliers represent an important source of potential innovation. Furthermore, (Stephan and Schindler, 2011) stated that in the year 2015, about 90% of all manufacturing activities will be carried out by suppliers. Therefore, customer companies have to successfully collaborate with suppliers in new product development in order to gain competitive advantage. A means that many companies are adopting to gain competitive advantage is to involve suppliers earlier in the design phases. Early Supplier Involvement (ESI) is generally defined as a form of vertical cooperation in which manufacturers involve suppliers at an early stage in the NPD process (Bidault et al., 1998). A large range of papers has identified the benefits of Early Supplier Involvement (ESI) on product development performance measured by shorter time to market, improved product quality and reduced development costs (Bidault et al., 1998; Ragatz et al., 1997; Van Echtelt et al., 2008). Moreover, literature contains contradictory results (Hoegl and Wagner, 2005) concerning ESI benefits on NPD performance and some studies present a negative impact (Eisenhardt et al., 1995; Wynstra, 1998). For a lot of industrial actors, it is thus difficult to invest resources in collaborative design with suppliers when real expected benefits are unknown.
The aim of our research work is to appraise ESI benefits in order to legitimate this practice. But as it is complicated to obtain a quantification of those benefits, we have adopted an approach from the

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opposite direction through the help of the "*glitch*" concept i.e. "*a costly mistake that could have been avoided if some of the parties involved had understood things that were known by other participants* (Hoopes and Postrel, 1999, p838)". A *glitch* is due to to a lack of knowledge sharing which can cause unnecessary iterative loops in New Product Development Processes for instance in decision making process. As all dysfunctions in collaborative new product development with suppliers are not due to a lack of knowledge sharing but can also be due to strategic aspects for instance, the word "*failure"* will be used to enlarge to other classes of dysfunctions. Following the ISO 9000 standard (2005), a failure corresponds to the non-fulfilment of one or more product requirements and can have fatal consequences for the product's success. This way, considering *glitches* and other potential failures, identifying their impact on product development performance and hence defining preventive actions to avoid these unproductive phenomena seems to be a good path to appraise ESI influence on collaborative New Product Development with suppliers.

This paper embodies a part of a research program and is complementary with our previous IPSERA paper (Personnier, Le Dain, Calvi, 2011). The aim of this research program is threefold: (1) to obtain a list, as exhaustive as possible, of typical failures that can occur during co-development with suppliers, (2) to classify those failures and (3) to identify means to tackle them in order to have successful collaborative development and generate gains. We adopt an iterative approach: case study results have raised questions, then literature results enabled us to answer some questions and other case studies are carrying out in order to enrich results obtained. The first step of this research work was an inductive approach including an in-depth case study of an unsuccessful collaborative development of a new product with a supplier. This work allowed us to gather data and to obtain a first list of ten observed failures with associated costs. The second step of this research work is presented in this paper. Stemming from a literature review about failures in collaborative New Product Development with suppliers, the aim is to draw up a list of typical failures and to categorise them. Then we integrate empirical insights coming from field case study by comparing them to literature review results. Finally conclusions are drawn from this work by discussing future research avenues.

2. Review methodology

The study is based on a literature review using a four-stage process (Figure 1). It aims at collecting and analysing potential dysfunctions during a collaborative new product development with a supplier.

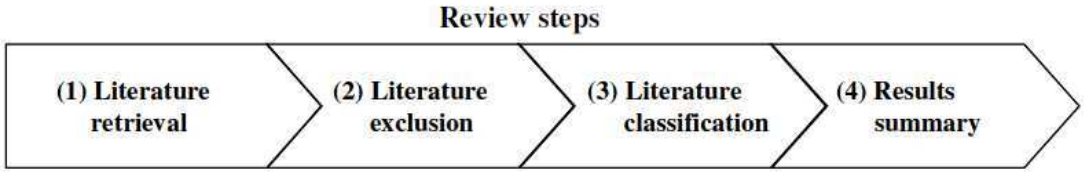

Fig 1 Review approach inspired from Westner(2007)

The first step *literature retrieval* involves a research of articles in databases and journals thanks to key words such as glitch, barrier, failure, dysfunction, and impediment in New Product Development. Only articles published in peer reviewed journals were considered. The time frame starts in the 1980s because following (Johnsen, 2009) study, the first research focusing on supplier involvement in NPD was the study by (Imai et al., 1985). The second step *literature exclusion* is a step for selection in order to exclude articles non relevant concerning our focus. We have focused our work on about fifteen articles. Those articles deal with failure/dysfunctions/impediments/glitches in collaborative development of new product between customer and supplier companies. For each article, the main failures reported were extracted. The third step *literature classification* involves classification of data collected. A table was employed for mapping the literature in order to compare previous papers across various fields such as: the failure description; the article's author and the methodology. More than 100 failures were encountered in the body of literature and were then organized in classes. A feature map was built to locate any similarities and differences between failures identified in literature (Hart, 1998). From those similarities and differences, 22 sub-classes have been proposed. The fourth and last step *results summary* is an analysis and discussion about the results. The data obtained, which is a list

of failures, were then compared to the data of our previous case study carried out in a French company considered as a global market leader for roller shutter motorisation.

3. Proposition of a classification of failures in collaborative design with suppliers

A literature review has been carried out in order to collect and analyse potential failures during a collaborative new product development with a supplier. Table 1 presents an overview of failures noticed in this literature review and mentions the author, the methodology adopted, the failure characteristics and the sub-class the failure is related to.

Table 1: Failures in NPD with suppliers identified in literature

Author	Method	Failure	Failure related to an issue in (sub-class)
Dowlatshahi, 2000	9 propositions tested with a case study in a medical manufacturing company	The depth and breadth of information sharing between the company ant its suppliers, especially at the early stages of the product design cycle, were largely shallow, insignificant, and superficial	Information sharing
Hillebrand, Biemans, 2003	Literature review	Problem with external cooperation in PD	Internal collaboration
		Non adapted boundary persons (people that transfer information between organizational groups or between organizations)	Internal & external communication
		Too many boundary persons	Internal & external communication
Karlsson et al., 1998	Survey with more than 300 suppliers of an OEM in the Europe automotive industry and case study with the OEM and 2 suppliers	Extremely short lead times. No coordination on lead times	Detailed planning
		Not enough standardization, which increases cost.	Optimisation of product cost
		Specifications are too general. They do not cover the requirements of the part in question.	Specifications definition
		There are a lot of opportunities to add more costs	Optimisation of product cost
		There is a lot of overspecification, which increases the cost. For example: the tolerances are too narrow; Some of the criteria are well beyond the life usage of the product	Optimisation of product cost
		In the worst case, suppliers do not even read the specifications properly	Supplier participation in the specification proces
		Even when it is very urgent, some specifications are missing. For instance tolerances and dimensions are missing.	Specifications definition
		Some specifications are non adapted to the supplier capacities	Specifications definition
		Internal functional conflicts. Ambiguous specifications.	Specifications definition
		Suppliers' role was often far from clear within the OEM	Roles and responsibilities
		All functions are not agree on the specific action outline. Contradictory messages are given to the different suppliers.	Internal and external communication
		The original equipment manufacturer does not give reasons for changes in specifications to the supplier	Specifications modification
		Specifications keep changing all the time	Specifications modification
		Specifications are even changed after tooling and method of manufacture have been decided	Specifications modification
		Original equipment manufacturers do not listen enough to the expertise of suppliers. For example, too much cost-saving in the design might lead to poor satisfaction of functionality in several cases.	Information sharing
		Different actors did not perceive a question in the same way.	Interpretation and understanding
Kleinsmann & Valkenburg, 2008	A case study in the automotive industry. The learning history method (Roth & Kleiner, 2000). The company develops a midrange truck, in The Netherlands	Differences in frame of reference between the company people and the suppliers. Difference of mindset between truck customer and automotive supplier. Misunderstandings about what the supplier could contribute to the project (cars Vs trucks producers).	Relational alignment
		Overestimation of what extend the suppliers could contribute to their design process	Competene needed
		Difficulty to achieve a full internal commitment	Joint decision for the supplier choice
		Bad collaboration. Both languages and distance complicated collaboration.	Interpretation and understanding
Kleinsmann et al., 2010	literature review	Difficulty for the project team to explain their problems with the supplier to the management. The management knew the successful stories from the Japanese automotive industry.	Internal communication
		Changes in the documents or incomplete documents. No common management of documents set up.	Information sharing
		Lack of information sharing before award and commitment.Need of supplier information before commitment but difficult to obtain.	Information sharing

Table 1(continued): Failures in NPD with suppliers identified in literature

Author	Method	Failure	Failure related to an issue in (sub-class)
Koufteros et al. 2010	Hypothesis testing (sample of 191 PDP in the automotive industry)	Lack of understanding, confusion in specifications	Specifications definition
		Late release of information	Information sharing
		Lack of communication	Internal and external communication
		Equivocality = ambiguity (existence of multiple & conflicting interpretations about organization's situation)	Interpretation and understanding
		The product design did not meet customer requirement(s)	Requirements
		The product design did not meet supplier requirement(s)	Requirements
		The product design did not meet manufacturing requirement(s)	Requirements
		The product did not meet assembly requirement(s)	Requirements
Mc Ivor et al. 2006	Case study & literature review	Lack of information sharing concerning the cost	Information sharing
Schiele, 2011	Literature review, case studies and social exchanges theory	Lack of willingness from one of the partners	Strategic alignment: motivation
Stephan & Schindler ICED 2011	Literature review and survey in the automotive industry	Incomplete requirements	Specifications definition
		Unrealistic requirements	Technical content
		Changing requirements	Specifications modification
Tan & Tracey, 2007	Literature review	Problem with external cooperation in PD	Internal collaboration
Vaaland, Hakansson, 2003	Case study & literature review	Different firm's strategies	Strategic alignment: goal convergence
		Bad prior history with the supplier and its influence	Relational alignment: trust
		Lack of understanding about the domain of the parties. Interdependencies of activities and resources.	Technological alignment
		Lack of commitment & involvement. Goal incompatibility.	Relational alignment: goal convergence
		Lack of precision of exchanged data	Information sharing
Van Echtelt et al., 2008	8 case studies in the copier and printer industry	Prototype cycles not synchronized with product and component life cycles	Project management
		Lack of future project or continuation at risk	Strategic alignment: goal convergence
		Doubts on correct supplier choice	Criteria for the choice
		Limited supplier assessment for 2nd tier supplier	Criteria for the choice
		Lengthy in-project discussions on contract price elements	Deliverables
		No specification about part availability, supply risks, & safety stock policy	Deliverables
		Hidden specifications (specifications do not match functional behavior)	Specifications definition
		Unclear restrictive specifications format	Specifications definition
		Lack of continued focus on simplification & standardization . Increase of coordination costs	Optimisation of product cost
		Problems in roles & responsibilities definition	Roles and responsibilities
		Complex communication interface with supplier organization	External communication
		Language translation problems	Interpretation and understanding
		Customer's organization and procedures not very transparent	Information sharing
		Availability of information. Incompatible CAD or data management systems.	Information sharing
		Changing first-tier supplier during project. Supplier non adapted to the customer need.	Competene needed
		Doubts/discussions regarding supplier's assembly, test, and production capabilities after collaboration started. Trust in capacities (Sako, 1992).	Competene needed
		Doubts/discussions regarding design capabilities of suppliers after collaboration started. Trust in capacities (Sako, 1992).	Competene needed
		Unexpected or undesirable divestment, acquisition, merger activities. Not mentionned in the initial contract.	Deliverables
		Unexpected technical problems prototypes during development. Prototype unsuitable.	Technical content
		Transfert of design &/or engineering tasks back to the customer	Roles and responsibilities
		Transfert of assembly & testing tasks back to the customer	Roles and responsibilities
		The customer not able to limit changes in team composition	Project management
Wagner & Hoegl, 2006	Literature review	A lack of partnership between the 2 organizations: trust & commitment	Relational alignment: trust
		Difficulties in the configuration of the project team (Communication, fit of the team members, competence of the team members, culture, motivation, trust, project leader, ability to work in a team, language, ability to work interdisciplinary)	Project management
		Specification definition non adapted to supplier's skills. Adaptation following the supplier's skills.	Specifications definition
		Problems of coordination between the NPDP. Different project stages between the two companies.	Project management

Two comments can be made from this literature review.

- Firstly, all failures reported are not *glitches* following (Hoopes and Postrel, 1999) definition. In fact, when the unit of analysis is the project, three requirements have to be verified to

recognize a failure as a *glitch* (Hoopes and Postrel 1999). Firstly, the product development must be conducted by a cross-functional team. This condition is not always explicitly mentioned in literature studies except from research works based on case studies. Secondly, the failures lead to unsatisfactory project results. In most articles, the authors reported the observed failures but without always specifying their sources and their impact on the project results. Thirdly, the failure observed could have been avoided using knowledge of one actor involved in the project. This condition is difficult to verify because details about the failures are not always available. Nevertheless, some authors reported a lack of shared understanding inside the project team (Karlsson et al. 1998 and Kleinsmann et al. 2008 & 2010). (Mc Ivor et al., 2006) observed a lack of information exchange in particular concerning strategy. When the unit of analysis is the organization, (Van Echtelt et al., 2008) report failures due to inappropriate management of the supplier involvement; (Koufteros et al., 2010) mention a lack of organizational response from the customer organization; (Vaaland and Hakansson, 2003) speak about conflict between organizations.

- Secondly, from the list of 22 sub-classes, a categorisation of six global failures classes was proposed (Table 2). This categorisation was inspired by main themes mentioned in literature concerning collaborative development of new products with suppliers.

Table 2: Proposition of sub-classes and classes of failures in NPD with suppliers

Sub-classes	Classes
• Strategic alignment: motivation; goal convergence • Technological alignment • Relational alignment: mindset (industrial or culture); trust	① Alignment between both companies
• Criteria for the choice • Competences needed • Joint decision for the supplier choice	② Supplier choice and status
• Decision power distribution • Confidentiality agreement • Deliverables • Intellectual property • Detailed planning	③ Contractual coordination
• Technical content • Optimisation of product cost • Specifications • Requirements • Supplier participation in the specification process	④ Specification process
• Roles and responsibilities • Project management • Internal collaboration	⑤ Procedural coordination
• Interpretation and understanding • Information sharing and lessons learned • Internal and external communication	⑥ Communication

The definition of each class of failures is given below.

① *Alignment between both companies*

The alignment can take the form of the strategic alignment (motivation and goal congruence), technological alignment or relational alignment (Emden et al. 2006; Evans and Jukes 2000). The relational alignment refers to alignment of mindsets (industrial or cultural) and to the trust (Sako 1992).

Alignment of mindsets is not synonymous to 'similarity of mindset' as highlighted by (Lam and Chin, 2005): "With the mindset that certain conflict could be beneficial, clients and suppliers are apt to

express their judgmental differences for improving decision making, which also fosters cognitive conflicts and thereby leads to better NPD performance as well" (p.764).

② Supplier Choice and Status

This class refers to the question of how the supplier has been chosen and for what competences (supplier status). The supplier status is one of the outputs of the "*Design-or Buy-Design"* decision-making process. It refers to the situation of supplier involvement decided by the project team; black box, or grey box or white box engineering (Handfield et al 1999). Once the supplier status defined, what are the relevant criteria for choosing the appropriate supplier? The choice of the supplier and its status in the collaboration might be characterised by a joint decision (le Dain et al. 2010).

③ Contractual Coordination

This class has been inspired by (Sobrero and Schrader, 1998). It refers to the negotiation between customer and supplier about the issues to be included in the contract (confidentiality agreement, deliverables expected from supplier and customer, intellectual property and patent policies, detailed planning).

④ Specification Process

This class refers to the specific problems mentioned by (Karlsson et al., 1998) in their study of automotive suppliers related to the technical content, the requirements, the product cost, and the participation of the supplier in the specification process.

⑤ Procedural Coordination

This class is also inspired from (Sobrero and Schrader 1998). It refers to the coordination of the activities of the partners in the collaboration to achieve the objectives of the project. The authors argue that "*the higher the level of task uncertainty, the greater the need for procedural coordination*" (p.592).

⑥ Communication

Communication problems might be the outcome rather than the cause (Maier et al. 2009). In this class, we consider the communication failures as symptoms of, for example, lack of information sharing and lessons learned, differing interpretation and misunderstanding between actors. Previous research has stressed the central role played by inter-firm communication (Dyer 2000; Kamath and Liker 1994; Petersen et al. 2005; Takeishi 2001).

4. Discussion with results stemmed from a case study

In a second time, the literature results, presented in the previous section, were compared to results obtained during a case study carried out in a French company. At first the case study is presented. Then the failures encountered during this case study are reported and discussed with the background of literature.

4.1 Case description

A first recent experience of collaborative design (Project P) was judged as unsuccessful by partners ROLMO and its key supplier CAB. Thus, the customer expressed the need of understanding the reasons of this failure. This analysis acted as "learning history" and was used to stimulate thinking and encourage learning in the project teams of ROLMO and the supplier (Kleiner and Roth, 1997). ROLMO is a French company that manufactures roller shutter motorisation and supplier CAB is the world leader for cable manufacturer industry (for high voltage, energy cables) and it is an historical supplier of ROLMO. The analysis of project P with supplier CAB was conducted between February 2010 and June 2010 by the participant researcher who has joined the project team on a full-time basis. The collaboration with supplier CAB has started at the open of Project P in May 2009 and stopped in June 2010. This case study was reported in our previous IPSERA paper.

The goal of Project P is to create a new roller shutter motorization. The level of exigencies is very high because ROLMO wants to distance itself from Asia competitors by launching the development of a high-of-the-range product. Project P included the co-development of the external connector to be used in the new roller shutter motorization. The external connector is a sub-system including the development of a cable and a plug. ROLMO chose to outsource the design and the development of this sub-system. The main reason of this choice is that ROLMO did not beneficiate of internal resources and skills for this specific design and the development of this connector is not a core-activity for the customer. Thus, it was relevant to benefit from the experience of a specialist that can do the development work more efficiently than the customer. This connector is a specific sub-system that must handle the power supply of the motor. It was considered a key sub-system owing to its substantial impact on the performance of the motorisation. The function to be developed is also a critical function as regards part of cost structure, safety, resistance to humidity, resistance to handling, robustness, earth connection, resistance to transport, multi-sourcing and compatibility with voltages and currents.
Supplier CAB has been selected to perform this design. The previous roller shutter motor external connector was co-developed 15 years ago with the selected CAB. Since this previous project, CAB manufactured most of cables purchased by the customer but the latter has not been re-mobilised for its design expertise concerning the cables development. For this reason, CAB was more known as a key commodity supplier than as a designer supplier. In addition, CAB has known some difficulties in the past and then had to reduce its R&D resources. CAB has been recently integrated in a group who has a centre of R&D. At the beginning of the considered project, ROLMO needed design expertise and intuitively the project team has consulted this historical supplier for this technology. ROLMO conducted an audit to evaluate the capability of the product development process of CAB. The audit team, composed of supplier quality assessment actors and the commodity manager, highlighted some doubts related to the ability of the supplier to bring in the necessary R&D resources within a new product development project. Despite this negative signal observed, the project team minimized it because of the past experience and the trust toward CAB. In addition, the commodity manager advocated the selection of CAB. Supplier CAB has invested resources to develop a plant in a low cost country to support the business of ROLMO. The implication of CAB in project P1 would lead to the production in this new plant. Nonetheless, as collaboration progressed, the negative signal became more and more harmful. Despite of efforts to continue the collaboration with CAB, ROLMO took the decision to stop the collaboration with CAB and to change of supplier.

4.2 Failures encountered during the case study analysis

Table 3 and Table 4 show the failures observed following the six different classes presented in section3.
As the collaboration of this case study was observed in a chronological way, failures are reported following the relationship lifecycle. This chronological view of the co-development relationship is inspired from the lifecycle of partnership model of (Fraser et al., 2003). This model allows the mapping of issues that are likely to arise at the different stages of the collaborative relationship. We have distinguished two stages in this relationship lifecycle as in our previous IPSERA paper (Personnier, le Dain, Calvi, 2010):

- The relationship design. This stage takes into account the supplier selection and the construction of the relationship framework (contracting, determination of roles and resources, need specification).
- The day to day interaction. This stage embodies the interface between the supplier and the customer during the collaborative work. This is the daily work.

The last columns of Table 3 and Table 4 indicate the novelty of the failure observed compared to failures observed in our literature review.

Table 3: Failures observed during the relationship design stage for Project P

Classes of failures		Failures	Additional compared to literature: Yes or No
①Alignment between both companies	*Strategic alignment*	No alignment in project expectations	No
		The companies did not manage to coordinate their objectives	No
② Supplier choice and status	*Joint decision for the supplier choice*	Project team issues and commodity managers'issues not common	Yes
	Criteria for the choice	Difficulties to determine supplier's capacities searched by the customer project team	Yes
	Competences needed	A lack of questioning about the necessity of co-developping for this subpart	Yes
		No use of a recent audit tool dedicated to assess the ability of supplier to co-develop	No
③ Contractual coordination	*Decision power distribution*	Contractual arrangment hard to build up	No
		Contract redaction not very clear. New type of relationship with the supplier	No
		Who is responsible of what?	No
④ Specification process	*Technical content*	Difficulties to specify the technical requirement because the customer project team did not have the required skills	Yes
	Specifications	The supplier encountered difficulties to understand specifications	No
		Unstable specifications	No
	Supplier participation in the specification process	The supplier did not challenge the specifications	No
⑤ Procedural coordination	*Project management*	Problems for sharing quality requirements	No
		There were no project manager in the supplier team at the beginning of the collaboration	Yes
		Purchasing, technical, quality actors do not necessarily progress with the same energy and rapidity	No
		Sometimes all the project team members of the customer company are not present at the preparation meetings	No
⑥ Communication	*Information sharing*	Priviledged interlocutor hard to identify	No
	Internal communication	No information sharing between audit team and project team to check the ability of supplier in situ	Yes
		Weak information sharing about the project KPIs	Yes

Table 4: Failures observed during the day to day interaction stage for Project P

Classes of failures		Failures	Additional compared to literature: Yes or No
② Supplier choice and status	*Competences needed*	The customer did not have the capacity to develop	No
④ Specification process	*Technical content*	The supplier did not have the appropriate capacities to develop the product needed	Yes
	Specifications	Unstable specifications	No
	Requirements	Verification plan hard to obtain	No
⑤ Procedural coordination	*Roles and responsibilities*	Purchasing, technical, quality actors do not necessarily progress with the same energy and rapidity	No
		Sometimes all the project team members of the customer company are not present at the preparation meetings	No
⑥ Communication	*Internal communication*	Weak information sharing about the project KPIs	Yes

4.3 Additional failures observed

Among the failures observed during this case study, some of them were not noticed during our literature review. We explain below the additional failures compared to literature results. Those

failures were not observed *per se* in the articles we have considered. However, some authors have mentioned the corresponding issues or have tried to explain the causes of those failures. The results of those authors will bring complements in the following discussion.

- *Technical content failures*

Failures related to technical content were consequently reported in literature but the raisons observed during project P were not found in the literature review. Indeed, the ROLMO project team encountered difficulties to specify the technical requirements as the technology sought was not in its core competencies. In this respect, (Stephan and Schindler, 2011) say that more than 30% of the reasons for project failures are associated with the requirements definition.

Time would have been necessary to wonder what the competencies to ask to the supplier were but it was not the case. This led to misunderstandings from the Supplier CAB and an inappropriate answer. Furthermore, supplier CAB did not have the necessary R&D capacities to ensure the required development. But as the ROLMO project team was not very accurate about the real expectations, they were incapable of detecting the absence of necessary R&D capacities during the supplier CAB audit. Thus, supplier CAB's development capacity was over-estimated. For (Lee and Veloso, 2008) who have examined the development of automotive emission control technologies over a 28-year period, the problem might be explained by differences of knowledge framework that lead to misunderstandings between the customer and the supplier. Suppliers dominate component innovation whereas assemblers focus more on architectural innovation.

- *Supplier choice and status failures*

This failure was not reported in our literature review. For the choice of the supplier, several suppliers were short listed. Difficulties were encountered internally at the Company ROLMO to choose the appropriate supplier. The project team and the purchasing project manager visions were not in accordance with the commodity manager vision for the supplier selection. As the cable is the most important part in the overall cost, a choice of a cable supplier was privileged. Nevertheless, the expertise is on the connector part. Supplier CAB was already in the supplier base for cable supply and it was an historical and trustworthy supplier. The commodity manager has influenced this choice because of the current development project concerning a manufacturing plant in a low cost country with this supplier. The project team had carried out an audit to evaluate the ability of the supplier to co-design. The results of this audit pointed out an uncertainty related to the ability of Supplier CAB to bring in the necessary R&D resources within a new product development project. On the whole everybody agreed with this supplier choice but specified that it was more a compromise than an appropriate answer to the project needs. Finally, the historical relationship with this supplier and its manufacturing abilities prevailed upon its co-design abilities. During the pre-study stage, the supplier was not able to bring in its R&D resources. After several demands of improvement on this point without results, the customer team decided to change the supplier. One year of work was lost.

Literature has largely explored the supplier selection topic in NPD (Schiele, 2006; Humphreys et al., 2007; Emden et al., 2006) but the actors' point of view divergence in a new product development project was not considered.

- *Procedural coordination failures*

Problems were encountered in the communication of the customer's quality expectations. ROLMO was going to set up a very demanding new quality tool to assess the quality of the propositions made by its suppliers during the relationship lifecycle. CAB was not in accordance with this new tool that was judged too demanding.

Furthermore, there was no project manager in the CAB project team at the beginning of the project. Product innovation and quality were affected by all those circumstances. The proposed solution did not present real innovation or optimisation. The level of propositions made by the supplier concerning the solution was judged below what was expected.

Another point is that all the actors are not always present at the meetings to internal advancement or to prepare a supplier meeting. It can lead to coordination problems and sometimes the mechanical engineer for instance does not know that some points were already treated or validated with the supplier with the supplier quality assessment actor for instance. Therefore, time is lost and customer team may become incredible by the supplier.

In addition, all actors involved in a project (engineers, purchasing actors, quality actors…) do not progress with the same speed which can lead to bottleneck in the validation of project toll gates.
For (Dowlatshahi, 2000) who studied ESI and used a case study method in a medical manufacturing company for an in-depth analysis and propositions testing about the designer-buyer-supplier interface, supplier meetings are the core of buyer-supplier relationships. The level, frequency, and personal involvement of the designer and buyer largely determines the success of supplier meetings and training programs and the success of supplier meetings is largely dependent upon the success of information sharing. Furthermore, the relationships between buyers and suppliers must be based on confidence and trust. There must be a free flow and information sharing between actors in product design.

- *Communication failures*

Some failures were observed during our case study about communication aspects and not noticed in the literature. At first, the ROLMO project team complained of a lack of checkout that the supplier ability during the project is in accordance with the supplier ability detected by the audit team. Sometimes, the audit team is not involved in the project team and it should be checked that the daily project experience confirm the supplier skills. Secondly, some key performance indicators (KPIs) exist in each project but some team members do not know their existence or do not know where to find them. Therefore, they are not used except from the person who creates them.
(Dowlatshahi, 2000) stated that communication is usually a symptom and not the cause of many problems. Thus, it is generally futile to try to improve communication and dialogue if other aspects of the relationships are not fully mastered. In this respect, (Maier et al., 2011), who performed a literature review in order to improve communication in design, recommend to share information to improve communication. This information sharing practice must be set up at the early stages of a project both for internal and external communication.

5. Conclusion and future research

This paper proposes a list of failures issued from a literature review on new product development in collaboration with supplier. This list was consolidated and enriched with the results of an in-depth case study. From this list of failures, six classes of failures encountered during collaborative development with suppliers were introduced. Those classes are inspired from topics considered as key topics in ESI literature. This categorisation is going to be presented and discussed with industrial actors to benefit from their point of view.
Those results have to be generalized with other case studies. In this respect, six case studies have already been carried out and two others are in course. Another future research avenue would be to test the ability of the failures model to explain the success of a co-development project.

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