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Travail, transparency and trust: A case study of computer-supported collaborative supply chain planning in high-tech electronics

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Abstract

Describes a case study of supply chain collaboration facilitated by a decision support environment in a high-tech electronics supply chain with multiple independent companies. In a business process called collaborative planning, representatives from these companies jointly take decisions regarding production and shipments for a large part of their collective supply chain. Particular attention is given to the interactions between levels of partner trust and information transparency on the one hand, and resulting improvements in supply chain performance on the other. The importance of hard work in developing the work flows necessary to support this joint planning process in starting a virtuous cycle of steadily increasing levels of all these aspects of supply chain collaboration is stressed. A theoretical model of the interactions between these aspects is presented, based upon a review in the literature. This model is then explored in an analysis of the collaborative planning case. Contains suggestions for further research and managerial recommendations.

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1. Introduction

These days, competition no longer takes place between individual companies but between supply chains consisting of multiple, collaborating or-

ganisations (Christopher, 1992; Fine, 1998). The complexity of managing such decentralised supply chains is obvious, both to practitioners (e.g., Siegle, 2002) as to academics (e.g., Handfield, 2002). In academia, the subject of how to best manage such a decentralised supply chain has received considerable interest from OR/MS researchers (Chen, 1999; Lee and Whang, 1999; Weng, 1999; Cachon and Fisher, 2000) as well as from the field of Information Systems and Decision Sciences (Holland, 1995; Raghunathan, 1999).

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All of these publications stress the importance of supply chain *transparency*, of sharing data regarding current order and production statuses as well as plans and forecasts with the various supply chain partners involved (e.g., Gavirneni et al., 1999; Lee and Whang, 1999; Callioni and Billington, 2001). If these data are not only shared between independent companies but some form of joint decision-making takes place one talks of collaborative forecasting or planning (Sherman, 1998; Raghunathan, 1999; Aviv, 2001).

What has remained under-researched so far is *how this supply chain transparency is to be achieved in organisational terms, how it evolves over time*. Most research simply compares a situation of information sharing with one of none or limited sharing, without addressing the question of how one moves from limited information sharing to full transparency. This topic is especially relevant for an OR audience because, more and more, OR algorithms and decision support systems are used to aid decision-making in these contexts (e.g., De Kok and Visschers, 1999; Callioni and Billington, 2001).

This is the topic of the current paper. We look specifically at how supply chain transparency is created in a collaborative planning setting in the high-tech electronics sector. This planning setting is supported by a DSS based upon algorithms derived from hierarchical planning concepts for multi-echelon inventory systems (e.g., Rosling, 1989; De Kok and Visschers, 1999). We argue that here, transparency is not just the result of the algorithms and DSS employed, but, organisationally speaking, also the result of reinforcing dynamic interactions between *trust* levels between partners and the level of transparency that is in line with that trust level.

Moreover, we show that both are created over time by working together and surmounting difficulties jointly, i.e. by what we call *travail*. In the French sense of the word, this simply means “work”, in English it is specifically associated with hardships, such as a woman undergoes during childbirth. The more supply chain partners work closely together, the more they will trust each other, and the more data they will dare to share. This will improve their performance level while

working together, which further raises trust, etc. These dynamics are generated by a set of reinforcing feedback loops.

This paper is structured as follows. We develop our theoretical perspective on the basis of a literature review in Section 2. We synthesise these findings from the literature in our research model in Section 3. Section 4 describes our research method, which can be labelled as theory-building case study research. Section 5 describes our empirical base, which is a real-world case in a supply chain with four independent companies in high-tech electronics that we have observed and worked with over a period of two years. A collaborative planning *process* was designed and linked into the existing planning and execution processes, and *tooling* consisting of a decision support system and a data management environment was developed and linked into the existing IT infrastructure. We describe the phases in the implementation history and the decision support system. In Section 6 we compare our research model with the case findings. We discuss the limitations to and opportunities for this research in Section 7 and close off with some overall conclusions.

2. Literature review

2.1. The importance of transparency for decision-making quality in SCM

The importance of information sharing for better decisions was first asserted by Forrester (1961), who showed that delays in passing on information lead to demand amplification in supply chains. Since then, this “Forrester effect” has been repeatedly described and analysed, e.g. by Meadows (1970); Van Aken (1979); Sterman (1989) and Evans et al. (1993). This phenomenon was re-introduced as the “bullwhip effect” by Lee et al. (1997). Their research was followed up by several authors such as Chen, 1999; Gavirneni et al. (1999); Lee and Whang, 1999 and Callioni and Billington (2001).

However, this recent research in the field of Operations Research/ Management Science is not always very outspoken about the advantages of

information sharing between supply chain partners. For instance, Cachon and Fisher (2000) found hardly any benefits for the supply chain as a whole. In other cases, there is no benefit for all parties involved, only for the suppliers. One possible explanation is that most of the analytical models employed in this research assume stationary demand, whereas it is obvious that it is timely information about auto correlated changes in demand, such as cyclical market movements, that is beneficial for supply chain performance (Sterman, 2000). At any rate, Aviv (2001) is probably right when he writes in his recent *Management Science* article on collaborative forecasting that “this study comes at a time when various types of collaborative forecasting partnerships are being experimented within industry, and when the drivers for success or failure of such initiatives are not yet fully understood” (p. 1326).

2.2. The importance of trust for openness of communication and hence transparency

The field of organisation studies has written extensively on the topic of trust. Nevertheless, trust remains an elusive concept. One recent definition is that trust is to be seen as “the belief that the other party will act in the firms best interest in circumstances where that other party could take advantage or act opportunistically to gain at the firm’s expense” (McCutcheon and Stuart, 2000, p. 291). Originally, the concept attracted attention in the area of buyer–supplier relationships from research into successful Japanese companies (Sako, 1992). Back then, this ran against established market theories concerning trust (Williamson, 1993) These days, the importance of trust for effective interorganisational relations is well established both in economics and strategy (e.g. Das and Teng, 1998; De Jong and Nooteboom, 2000).

2.3. The importance of trust for absence of gaming and hence decision quality

Next to the general importance of information transparency there is a phenomenon specifically related to supply chain control. This is the phe-

nomenon of game playing between buyer and seller in volatile markets. As Lee et al. (1997) have noted, the infamous bullwhip effect is, if not generated, then at least exacerbated by “shortage gaming”. With this term Lee et al. (1993) mean the following. During a period of shortage, which frequently occurs in an industry upturn, buyers tend to order more than they really need from a supplier, because they anticipate that they will be getting less anyway. Since all buyers do so, this strongly inflates the incoming order level, which then generates further amplifications upstream. Since the suppliers know this is happening, they tend to downscale all incoming demand levels. The only way to prevent this amplification from happening is if the buyer can *trust* the supplier to interpret this order information correctly and if the supplier can *trust* the buyer to provide him with correct demand figures (Akkermans et al., 1999; Lee et al., 1997; Sterman, 2000).

2.4. Interrelations between transparency and trust

As the preceding discussion of game-playing illustrates, there is an other side to the relation between trust and transparency: the impact that transparency can have on trust. Again, this topic has been well studied in the organisational literature. Anderson and Narus (1990) found past communication between companies to be positively related to trust. Parkhe (1993) found that a history of co-operative behaviour in alliances was negatively related to perceptions of opportunistic behaviour. Young-Ybarra and Wiersema (1999) found that, in strategic IT alliances, more open communication leads to more trust. Finally, in the context of organisational decision-making, Korsgaard et al. (1995) found that the more transparency there was on the rules, on procedural justice, the more trust and commitment resulted.

2.5. The importance of social exchange for transparency and trust

This still leaves us with the original question for this research: how are transparency and trust generated? Anderson and Weitz (1989) were

among the first to point out that past experiences with a partner breed trust (Anderson and Weitz, 1989). Partners get used to each other, understand each other better, as they continue their social exchanges over time. De Jong and Nootboom (2000) label this phenomenon as *habituation*: “it is repeated interaction which leads to the forming of habits and the institutionalisation of behaviour. Any human activity that is frequently repeated is subject to habituation, which frees the individual from having to make decisions and thus provides psychological relief” (De Jong and Nootboom, 2000, p. 222). This corresponds with the well-established notion of “familiarity breeds trust” (Gulati, 1995).

3. Research model

In this section we synthesise the findings from the literature review in the preceding section into our research model of how trust and transparency are generated. Partly, this model is based upon earlier research by the first two authors (Akkermans et al., 1999). It is visualised in Fig. 1 by way

of causal loops (Sterman, 2000), which can be seen as a special form of cognitive mapping (Rosenhead, 1989; Eden and Radford, 1990).

The model reads as follows: Supply chain transparency is the result of self-enforcing dynamic interactions between ‘shared hard working or toiling’ (*travail*), ‘believe in the honesty, integrity, reliability, justice of the partners’ (trust), and ‘open sharing of all relevant information’ (transparency). As such, it is the struggling on the long and winding path towards transparency that determines the level of success of the collaboration between supply chain partners, rather than its definition by management.

It is important to note the *feedback loop* nature (Senge, 1990; Sterman, 2000) of this causal model: increases in trust lead to increases in transparency, which improves decision-making quality, which leads to better supply chain performance. This then leads to habituation, which, in turn, increases trust further. The result of this is that partners in a supply chain often get caught in either a vicious or a virtuous cycle. If performance is low, trust and transparency remain low. If somehow this vicious cycle is broken and trust and transparency start

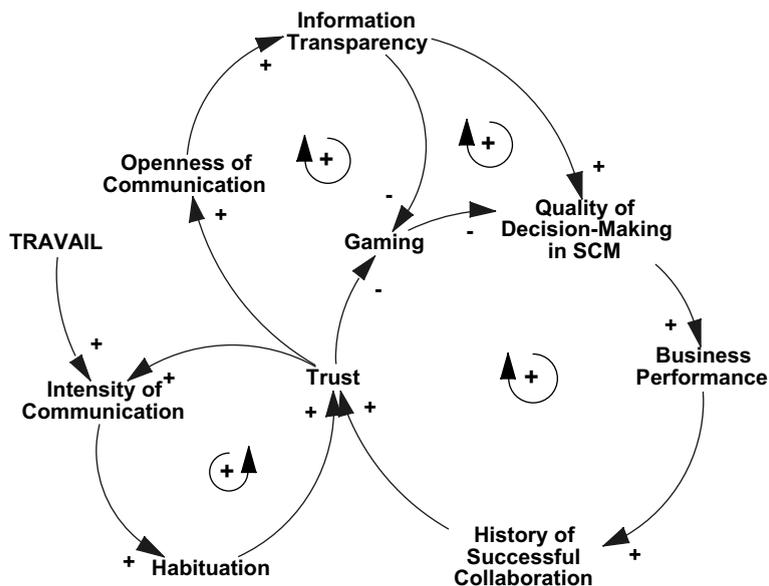


Fig. 1. The theoretical model for this research.

going up, an upward spiral over steadily improving supply chain performance can be achieved.

In the current research model, our interest is in how a virtuous cycle of supply chain collaboration can be started. Here we have found our notion of *travail* very enlightening. Triggered by the literature on social exchange and habituation as well as our experiences as action researchers in this case, we have noticed how trust and transparency grew gradually as the result of, simply, a lot of hard work by the people involved. It is the quiet accumulation of joint and positive experiences that has formed the foundation for the subsequent successes.

4. Research method

4.1. Case studies for theory-building

The research reported here has attempted to generate new theory on the basis of existing theoretical constructs. As we noted in the literature review, our specific research aim has been a relatively novel one. Therefore, we have chosen a case study approach, which is generally recommended as a suitable research design for theory-building (Yin, 1989; Eisenhardt, 1989).

4.2. Action research for validity and relevance

Being intimately connected with empirical reality is often problematic for outside researchers, certainly in the case of evolving supply chain collaboration. The issues involved are often sensitive, the content matter tends to be complicated, the stakeholders are many in number and often time-pressed and not easily accessible and the collaboration process progresses with unpredictable timing. Therefore, employing an action research design (Reason and Bradbury, 2000) has definite advantages over a more “hands-off” approach. In this research project, the authors have been actively involved as consultants for the entire period of about 1.5 years that we describe further on (with the second author coming on board about half a year later).

This choice for an action research perspective has well-noted methodological advantages. Firstly, it provides the possibility to closely observe an organisation in mostly no outsiders would be allowed. Secondly, it ensures the direction of the research to be of guaranteed managerial relevance, as company management is closely involved in the research effort in progress (Gill, 1983). And thirdly, it indirectly generates the close relations and common understanding that enable researchers to revisit the company after they are no longer involved directly.

4.3. Overcoming reliability limitations of action research

The very same characteristics that make case study research in general, and action research in particular, so well suited to study buyer–supplier relationships over time, generate considerable problems in ensuring sufficient rigor and reliability as well. By reliability we mean the degree to which statements are based on a careful observation of reality, rather than on accidental circumstances regarding measurement instruments or the researchers’ own biases as people being personally involved (Yin, 1989). For our research, we have taken several measures to ensure adequate levels of reliability. In general, these boil down to limiting personal biases by employing as many independent perspectives and sources of data as possible in an iterative process of data collection, analysis, reflection and synthesis.

In our case analysis, we have started off with a set of *ex ante constructs* (Eisenhardt, 1989) based upon the existing literature and earlier research already published in a refereed journal (Akkermans et al., 1999). We then used an *independent evaluator* to collect data on assessments from the various stakeholders in the organisation regarding progress in the supply chain collaboration (see Table 1 in Section 5). Also, we employed extensive *peer review* amongst the three of us and our fellow consultants for our preliminary findings (Miles and Huberman, 1984). Finally, we checked earlier strands of our analysis with key stakeholders in the organisation, thereby conducting a so-called *member check* (Flick, 1998).

Table 1
Selected survey results from blueprinting phase

Question	Partner 1 ($n = 4$)	Partner 2 ($n = 4$)	Total ($n = 8$)
I think that collaborative planning will generate mutual benefits	4.5	2.8	3.6
I think that collaborative planning will improve supply chain performance	3.8	3.8	3.8
Do you feel that the theoretical concept of Collaborative Planning matches the practical day to day business environment?	5.0	3.8	4.4
In your perception, does Collaborative Planning address the relevant business issues?	4.8	4.4	4.4

5. Case description

5.1. Collaboration in a high-tech electronics supply chain

Our case concerns the implementation of a collaborative planning (CP) process, including DSS tooling, in the high-tech electronics industry. The partners involved were a manufacturer of integrated circuits (ICs), a number of contract manufacturers (CMs) assembling subassemblies and a producer of innovative personal computer parts. This supply chain was characterised by (a) a high dependency on a limited number of key ICs (10); (b) long stacked lead times (20 weeks); and (c) short product life cycles of end products and key components (6–12 months).

The primary objectives of implementing a CP process were an increase of market share through reduction of time-to-volume, improving material availability and cost reduction through lowering overall stock levels and less obsolescence. Moreover, it was envisioned that collaboration at the operational goods flow level would contribute positively to collaboration in other areas (such as product design, supply chain design and capacity creation).

Our involvement spanned roughly 18 months and covered the design, development, implementation and execution of a CP process as a joint effort by the IC manufacturer and the PC part manufacturer. Apart from external and internal consultants, the project organisation consisted of

logistic planners, account managers, purchase managers and supply chain managers.

5.2. Phases in the implementation history

In the project six phases can be distinguished:

1. *History.* Prior to our involvement, the partners had made a first step towards a collaborative relationship. In weekly telephone conference calls, the state of affairs was discussed, and decisions with regard to next week's actions were made. However, the information used in the conference calls was packed in various hard to read and often inconsistent spreadsheets, and the discussion focused on 'fire fighting' rather than on 'proactive decision-making'. As a consequence, supply chain performance was rather poor and the trust between the partners was low. The feeling grew with participants and their management that formalisation of a truly collaborative process—with a supporting DSS environment—was badly needed.
2. *Initiating workshops.* As a first step, a number of joint workshops were organised. These workshops focused on the clarification of supply chain and product structures and the planning processes to control these structures. Moreover, a mutual understanding of issues and goals was developed. Both operational planners and their managers were closely involved. An important observation was that, while the project team was struggling with describing and defining

their joint business and supply chain, the level of trust increased. The phase concluded with the decision to start a pilot phase for a simple part of the supply chain, i.e. involving a single product through a part of the physical supply chain. In a pilot phase the envisioned collaboration process would have to be introduced and tested, and the first prototype of a supporting decision support system (a DSS based on supply chain analysis concepts, models and algorithms already available) was to be introduced.

3. *Pilot*. In the pilot phase the team concentrated on developing and introducing the DSS, defining processes for collecting all relevant data from the operational systems, and on defining and introducing the ‘weekly cycle’. This was a structured process aiming at synchronising the material flows—in a weekly heartbeat—through the whole supply chain. Another aspect of trust was that during this phase, the first signs of the world-wide downturn in PC business appeared. It took the planners four weeks to really trust the figures presented by the DSS and to react according to the decision proposals. This resulted in high stock levels (which was bad) and the recognition that the tooling proposals were correct (which was good). The pilot was concluded with the decisions that yes, the tooling and the process were promising, and yes, the companies needed to proceed with a further roll-out of both process and tooling.
4. *Blueprinting*. Before going ahead it was decided to insert a *blueprinting phase*. A high level view on the *total* supply chain and its planning processes were developed, a business case—summarising expected costs and benefits—was drafted, and the project approach was defined. To assess organisational support for the CP process a survey was conducted with the key stakeholders. Amongst others, the following questions were asked, to be answered on a five point scale, ranging from 1 = strongly disagree to 5 = strongly agree. The conclusion was that there was a high confidence that CP would indeed be beneficial to both parties. This contrasted strongly with the relatively low levels of trust and transparency observed with many of the stakeholders prior to the CP project.

5. The *Proof of Concept* phase aimed at proving that collaborative planning would also work on a larger scale. Proving implied getting positive answers to the following questions: Is the DSS robust and powerful enough? Can we get all the data? Are people (planners, supply chain managers) willing to co-operate? Is it feasible to squeeze the weekly decision-making process into a 2-hour virtual meeting? Can we link the CP process to all other processes? Does it bring the value we expect it to bring? Can we find a reasonable rule for sharing supply chain related costs and benefits?

During this phase, the concept of ‘collaborative planning’ was introduced at a much wider scale than before. The consequence was that quite some ‘new’ people needed to be brought on board. Workshops were instrumental for getting the necessary buy-in. When it comes to ‘travail’: as in any project where software is developed using prototyping, there were the occasional ups and downs in appreciation of the tooling being developed: ‘peaks’ when new functionality became available in rapid successions; ‘downs’ when some things proved more difficult to develop or transfer than expected.

6. After a successful conclusion of the Proof of Concept phase, the project entered the ‘*maturity*’ phase: objective of this phase was a further maturation of the tooling (scalability, sustainability, maintainability), a further roll out of the CP process (more business lines, more components) and a fine-tuning of the process. Where the previous phases had a *business* rather than an *IT* focus, now the further development of the IT environment consumed most resources. From our Travail/Trust/Transparency viewpoint, this phase was rather uneventful, and it gradually passed into the—current—*operational* phase.

At the time of writing, the beginning of 2002, we have a running collaborative planning process executed by the supply chain partners, there is an almost full transparency of the integral supply chain has been created, and the important weekly decisions are truly joint ones. In the design of the weekly process an ‘escalation’ step had been

included. This step—involving senior management—aimed at solving problems that could not be solved by the operational planners. The fact that during the entire project this road was never taken, demonstrates that the partners have reached a situation where they have moved from fire-fighting, discussions on correctness of figures and under-performance, have come to a effective ‘working together’ relationship.

5.3. The decision support system

Though people, and managers in particular, generally feel that decision making is a form of art and requires experience, intuition and creativity, it is also generally acknowledged that decision-making processes are greatly enhanced by the application of appropriate scientific methods. However, decision-makers will only use such scientific methods, if the supplier is able to provide an environment allowing for an effective stipulation of the ideas (easy generation of options at the required aggregation level) and a rapid analysis of those ideas (fast on-line generation of highly visible quantitative insights). This then has been the challenge that has been met in this case with the DSS environment that was developed.

The collaborative planning DSS environment aims at the co-ordination of material flows through a complex supply network with multiple independent players. This co-ordination makes sense only if it generates an improvement of the overall performance and decreases the total supply chain costs. To accomplish this, a tailored software environment has been put in place providing a means to define supply chain structures, supporting the gathering and preparation of relevant data from the multiple network entities, creating a transparent view of the shared supply network and offering fast and effective support for the crucial decisions to be taken.

The basic elements of the environment are: (a) the decision problem, (b) the quantitative model, (c) the decision support environment (including a user interface) and (d) the data management environment. This last aspect will not be discussed in the context of this paper.

(a) The *decision problem* may be (very briefly) stated as follows: co-ordinate the material flows through the supply network in such a way that demand and supply plans are matched in the most profitable way and taking into account decisions on (safety) stock levels and capacity constraints.

(b) We have based our *quantitative model* and algorithms on hierarchical planning concepts for multi-echelon inventory systems (see e.g. Rosling, 1989; and De Kok and Visschers, 1999). This leads to a so-called modified base-stock policy approach which enables the rapid calculation of appropriate order releases throughout the network and provides, through a forward and backward pegging mechanism (for the allocation of supply quantities to demand and vice versa), the detailed information to identify and solve bottlenecks.

(c) This modelling and solving approach provides the basis for fast and effective calculations. Effective in the sense that within the constraints posed by the network, materials are provided in a synchronised (on time) and balanced manner (in the right quantities). A powerful graphical user interface developed in close co-operation with the actual users complements the *decision support environment*.

6. Case analysis: Interactions of travail, transparency and trust

As could be grasped the previous section, this case largely confirmed the ex ante research model that we had developed on the basis of the existing literature. In this section, we look at *new* aspects of the dynamics of transparency and trust that we had not anticipated beforehand. In particular, we found four aspects of this case especially informative.

6.1. Data transparency alone is not enough

In the very early stages of the project, significant amounts of data (forecasts, inventories, pipeline stocks) *were* exchanged between the customer and supplier; far more than what one would expect in an average customer/supplier relation. At

the same time, the level of trust that existed between these parties was relatively low.

One of the root causes for this lack of trust was a lack of understanding for each other's planning processes and, even more, for each other businesses. For instance: a high volatility in forecasts was initially suspected to be the result of 'playing games'. In fact, that volatility was the consequence of market dynamics, and the flexible MPS (master production schedule) processes that were set up to accommodate those dynamics.

6.2. Workshops are an effective means for "travail", for getting virtuous cycles started

Only after spending a number of workshops, focused on explaining businesses, processes, and systems, a mutual understanding for each other's perceived volatility (or rigidity) did materialise. The essence of these workshops lay in creating an additional level of transparency: not on the down-to-earth data level (what do you expect to be able produce in the near future) but at a higher level: *How* do you plan? *Why* do you do it that way? *Who* are involved? Creating this level of transparency significantly contributed to creating trust. And also: creating this level of transparency involved a great deal of *travail*; it was certainly not self-evident to create the open atmosphere that encouraged the organisations to open up to each other.

6.3. Developing and feeding the DSS also is a form of travail, generating trust

A major activity during the project was the development of tooling (a DSS and a supporting data management infrastructure) supporting the CP process. The tooling not only provided the required transparency, but also provided the analytical and number-crunching capabilities needed to get an efficient and effective decision-making process; a process that to a large extent centred around a weekly (virtual) meeting in which decisions for the imminent weeks were taken. Again, creating the transparency needed involved lots of *travail*: getting data of approximately 10 organisational entities turned out to be a laborious

undertaking; not only in terms of systems development, but also in terms of getting people and organisations 'on board'.

6.4. Collaboration needs to take place at multiple organisational levels

When it comes to the Trust > Communication > Habituation cycle: during the project communication took place at many managerial levels: at the start,—during the telephone conference—only the operational planners were involved; based on *their* experiences the feeling grew that things needed to be done differently: too many data, while at the same time insufficient true transparency, too many discussions on the *quality* of those data, but also excess stocks and lost sales. The supply chain managers and general managers who initiated the project played an important role here. At this managerial level, prior to the project, there was already a certain degree of habituation and trust. This helped to get the operational people involved in the workshops that, over time, built trust at this level as well.

7. Discussion

7.1. Reflection: Trust and transparency are generated by hard work

To a large extent, this study has confirmed empirically the validity of existing strands of theory regarding trust and transparency. In particular, it has supported the notion of the self-reinforcing feedback loops between these key aspects of supply chain collaboration as identified by Akkermans et al. (1999) and De Jong and Nootboom (2000). This in itself may be seen a valid contribution to the literature, as both these earlier research efforts called for empirical validation of their theoretical propositions.

What this research has revealed or at least emphasised is the importance of what we have called *travail*, of plain honest hard work by all parties involved, in generating the habituation between parties that drives trust and transparency. It is this hard work that, in this case at least, changed a

situation of relatively low levels of trust and transparency into one where a virtuous cycle of increasing levels of trust, transparency and supply chain performance could be entered into.

But, one can ask, what is needed to get this travail started? Here there can be many answers. Akkermans et al. suggested as potential reversals into a virtuous cycle: learning from the success of effective newcomers, demanding customers and visionary managers. To some extent, all these favourable conditions and more were, in retrospect, present in this particular case.

7.2. Limitations and follow-up opportunities

Obviously, this was a single case study and so the generalisability of our findings remains limited. Therefore, an obvious follow-up research effort would be to evaluate multiple collaborative planning settings in a similar manner and generalise on the basis of a cross-case analysis of these.

Also, it might be beneficial to translate the research model presented here into a quantified simulation model to explore with more rigour the various dynamic patterns of behaviour that are possible in such a causal structure, which is also recommended by De Jong and Nootboom (2000). As with collaborative planning, quite some research travail will be needed before sufficient transparency is established in this complex but fascinating matter.

7.3. Managerial implications

Theoretically, many questions remain. But, managerially speaking, the implications from this study are straightforward: Supply chain collaboration is essential to prosper in many of today's volatile markets. Collaborative planning is an advanced form of such collaboration, which requires seamless joint work flows, "open kimono" attitude (show all the info and knowledge you have attitude) at all parties, tailored IT support and knowledgeable and trusting supply chain professionals. But, first of all, before such a situation can be reached, it requires a lot of hard work from the people involved. They will only engage in such an arduous task if they are convinced that they have

the full backing of their senior management. It is here that, even in today's highly decentralised organisational settings, managers still can and have to play a leading part.

8. Conclusions

Supply chain collaboration is more important than ever. It requires high levels of trust and information transparency on all sides. Here OR algorithms and decision support systems can provide essential support. However, what this study has stressed is that, to achieve the levels of transparency needed to make these algorithms and systems work, high levels of trust are required. And, that such levels of trust and transparency can be attained only by a great deal of hard work, or *travail* as we have called it, by all people involved. Once this is accomplished, supply chain partners will find themselves in a virtuous cycle of steadily improving supply chain performance leading to even higher levels of trust and transparency, which in turn will improve performance even further.

Meanwhile, collaborative planning remains an especially advanced form of supply chain collaboration, in which multiple independent companies take joint decisions on production and shipments for large parts of their collective supply chain. At the time of writing, no one is really sure of how such *collaborative planning* settings should really be designed but that, at the same time, the improvement potential of such collaboration seems very great. This case study of collaborative planning in a high-tech electronics supply chain has shown that, probably regardless of the specific design chosen, crucial roles are played by the concepts of *travail*, transparency and trust.

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