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Incentive Issues in Outsourced Maintenance Supply Networks: A Delphi study in the Process Industry

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Introduction

In the field of maintenance, outsourcing of activities has become a major trend in the past few years, as companies continue to focus more and more on their core competencies and keep look for opportunities for greater flexibility with regard to their non-core operations. Relatively speaking, maintenance outsourcing arrangements have joined this business-world wide trend fairly late in the game. In production supply chains for most of the manufacturing industries, especially for high-clockspeed industries such as electronics, outsourcing of the bulk of the production activities of the OEM to an entire network of suppliers has been going on for more than twenty years. Similarly, in the field of services, outsourcing of IT services has been a major development in many industries for over a decade.

In North-Western Europe at least, most asset owners in capital-intensive industries have followed similar trajectories in the past fifteen years. Somewhere in the mid 1990s, top management in many of these companies decided that the focus in maintenance management was too much a technocratic one. The general mood was that a more financial orientation was required. Central technical departments were abolished and highly specialized technical expertise in-house was made redundant. This resulted in the development of outsourced maintenance supply networks as the dominant life form in various industries.

This drive towards outsourcing initially led to major savings on maintenance costs and significant headcount reductions. However, after some years, unintended side effects of this short-term and financial orientation became apparent. Incidents started to increase, largely outsourced maintenance activities became more and more expensive and relations with suppliers became more and more frictional, as the supply base turned out to be less inclined and/or able to innovate and increase productivity than had been expected. In the last five years or so, many asset owners are seeing attempts to bring maintenance, repair and overhaul expertise back into the own company. However, the relations of the asset owners with their maintenance service providers often remain tense and it is at present largely unclear how to organize optimally here.

In summary, the present situation is that, in maintenance supply networks, many outsourcing arrangements leave much to be desired in terms of (1) their financial performance in terms of costs incurred and revenue secured, (2) their operational excellence in terms of e.g. Mean-time-between-Failure (MtbF) and Hands-on-Tool-Time, and (3) their quality of the buyer-supplier relationship in terms of mutual trust, transparency and satisfaction. It seems quite plausible indeed that performance in these different areas is interrelated, but how?

This paper looks at this question from the question to what extent it are inadequate incentive issues that lie at the root of these performance issues in maintenance outsourcing. We investigate this question by dividing it into three interrelated research questions:

- Q1. These days, what are the main performance issues that asset owners are facing with regard to their outsourced maintenance operations?*
- Q2. What are the main root causes for these performance issues, in particular insofar as these are related to incentives between and within companies?*
- Q3. What kind of incentive structures for maintenance outsourcing arrangements may lead to superior financial and operational performance in outsourced maintenance arrangements?*

Although outsourcing has been a major trend in the industrialized world for at least two decades, the role of information and incentive issues is still under-researched (Arya et al. 2011). Moreover, given the relative novelty of outsourcing in services in general, and in outsourcing in particular, we know even less about incentive alignment in maintenance outsourcing. Therefore, an exploratory research design is most adequate. We zoom in on the chemical process industry and combine insights from the exiting literature on incentive issues in SCM outsourcing and IT outsourcing with a so-called policy Delphi-study to arrive at a number of propositions that summarize the main issues to be investigated in the coming years in this matter.

Problem: incentive issues in maintenance outsourcing

The world of supply chain management has been leading the way in outsourcing, or offshoring as it is often called there, for over a quarter of a century now. Especially large industries such as automotive and electronics have a wide and deep experience with outsourcing of production activities. In fact, almost everything that is produced in our present-day economy is done by a network of collaborating suppliers, by a supplier network.

Despite this long experience, it is well-known in manufacturing that building deep relationships with suppliers is not an easy task. For more than 20 years, U.S. automobile manufacturers have unsuccessfully tried to build supplier partnerships (so called supplier keiretsu) similar to the once established by their Japanese counterparts (Liker and Choi 2004). Also, a close relationship demands maintenance to avoid opportunistic behavior and feeling of distrust to build up between partners (Anderson and Jap, 2005). Indeed, in aligned and supply chain members have to take action as soon as supply chain problems arise (Narayanan and Raman, 2004).

IT outsourcing is relatively speaking a newer activity, but nevertheless one that is extremely wide-spread and likely to continue for a considerable time to come. However, again all is not well there either. AMR, a research outfit closely related to Gartner, the leading IT research institute, published in 2010 a report containing amongst others the pie-chart in Figure 1,

showing what companies say who indicate that their IT outsourcing efforts have failed to deliver what they had hoped for.

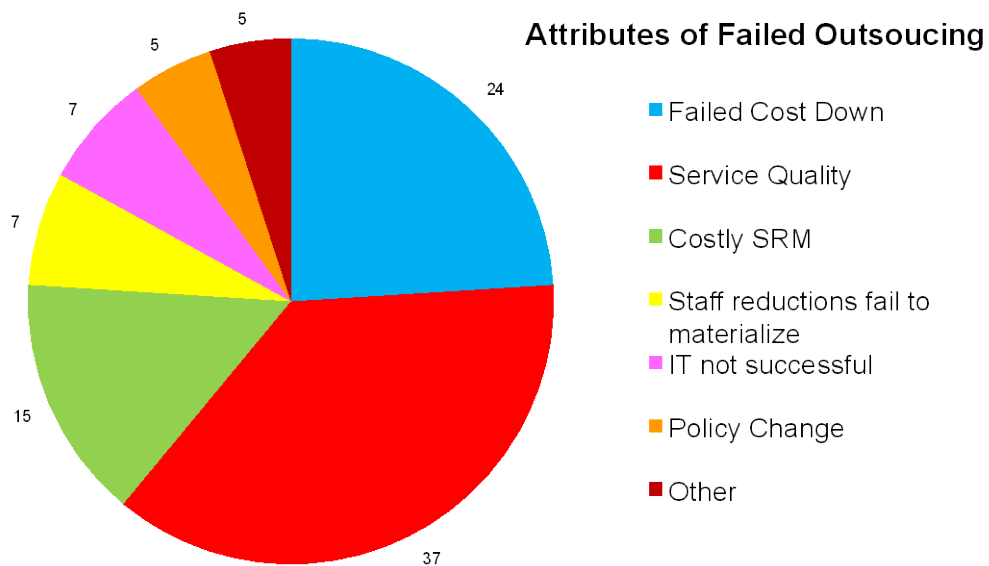


Figure 1: Aspects of failed outsourcing arrangements in IT outsourcing (AMR, 2010)

After IT outsourcing, costs have not gone down, service quality has not gone up. The costs of managing the supply base (Supplier Relationship Management, or SRM) has been higher than anticipated, the staff reductions that were expected have not materialized. Many of these observations resonate when one talks to maintenance executives about outsourcing of maintenance activities. However, what are precisely the real problems in maintenance outsourcing? What is driving them? And what can be done about them? These are questions to which at present the academic literature provides little guidance. Hence, an exploratory research design is required and the one chosen in the current paper is that of the Delphi-study.

Method: a policy-dephi study in the process industry

A Delphi method research design

In general terms, the Delphi study is a method for structuring a group communication process so that the process is effective in allowing individuals to deal with complex problems (Linstone and Turoff, 1975; Delbecq et al., 1975). The Delphi technique lends itself especially well to exploratory theory building on complex, interdisciplinary issues, often involving a number of new or future trends (e.g., Klassen and Whybark, 1994; Akkermans et al., 1999). One essential characteristic of the Delphi study is the need to have sufficient variety and quantity to overcome risks of individual biases contaminating the aggregate responses. A group size of 14 experts from a variety of backgrounds with on average well over 15 years of experience with maintenance issues was brought together to satisfy these quality criteria.

Our group of participants consisted of maintenance managers and supply managers of two very major petrochemical companies, one steel producing company, three chemical companies and two electrical energy producing companies. Present were also three managers of major Dutch contractors to the process industry and two university professors in the field of maintenance, next to a team of outside facilitators, amongst whom the first author.

Another defining characteristic of Delphi studies is the opportunity of receiving feedback on earlier comments as well as the opportunity of further elaboration on the basis of that feedback. In this particular research design, this feedback was almost instantaneous and continuous, thanks to the use of a so-called group model-building exercise (Vennix et al. 1996), in which a trained facilitator elicits the collective “mental map” of the group using causal diagramming (Sterman 2000).

The Delphi session script

The Delphi study was structured as followed. On October 12, 2011, our group of 14 experts convened in the Faculty Club of Tilburg University for an afternoon session. Shortly prior to this meeting, a mini-survey had been sent out to be filled in via the Internet, which served to establish some common ground quickly and to jump-start the discussion. The main results from this survey, which are discussed further on, are not meant to suggest statistical generalizability, due to vastly insufficient group size, as the Delphi study is not a substitute for a survey research design. It is the quality of responses from which Delphi studies derive their strength, not the quantity of the responses.

The session itself started with a round of introduction and a short explanation of the purpose of the session and the order of the day. Then some two hours were spent on constructing the diagram of which a “raw” version is presented in Figure 2 below.

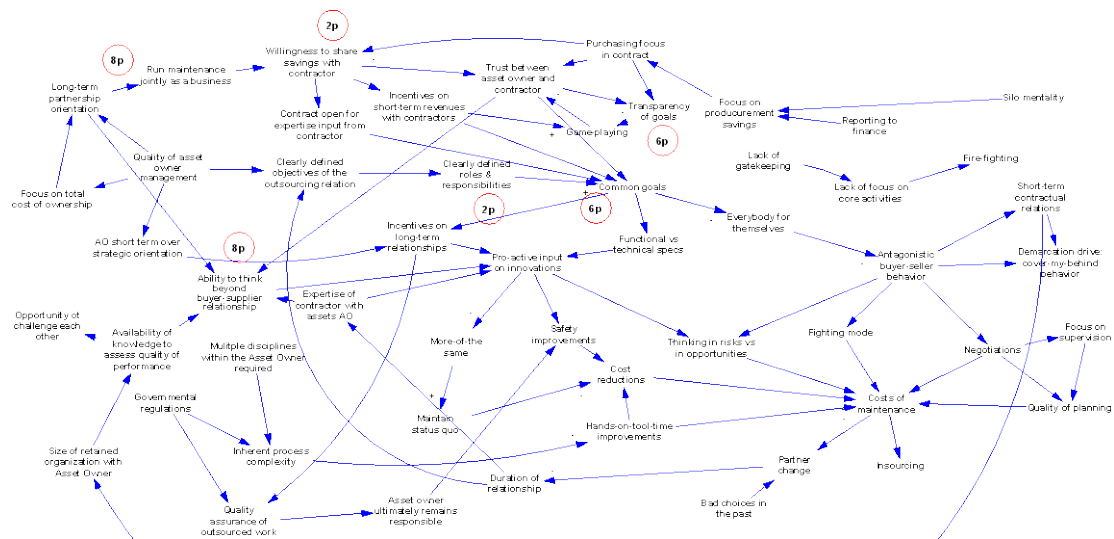


Figure 2: "Raw" diagrammatic representation of output of Group causal diagramming exercise

The way in which this diagram was constructed is not at all so unlike to other forms of mindmapping, or Ishikawa diagram analysis: for every variable that is listed on the board, the facilitator can, and often will, ask what is causing it or where it is leading to. Over time, as the board is filling up with new factors to be taken into account and links between them, causal feedback loops start to emerge. So also in this session and we will discuss these in the next session.

After this causal diagramming exercise, a discussion followed on what could be done to improve the situation the industry appeared to be in. Here, the participants could vote: three votes could be placed on specific locations on the diagram. These reappear in Figure 2 as the circles with numbers within them, indicating the number of votes received.

The session ended with a concluding round where each participant could indicate main benefits from this session and concerns at the end of the session. These are not reproduced in this paper for reasons of conciseness and focus.

Post-session analysis

After the session the authors have restructured the material from the diagramming session. Mostly, not by adding or deleting causal relations and/or factors, on the contrary. Only on a few (3) occasions have new causal links been added, that clearly were implied by the group but were simply missed by the facilitator because of time pressures.

What was added for every relation is its nature: pluses (+) and minuses (-) for positive and negative correlations, and symbols indicating feedback loops. Then, the model is disassembled in digestible “chunks”, centered around key feedback loops, and these chunks are then explained in words. The results from this analysis is then fed back to our panel of experts for their feedback, a so-called member check (Miles and Huberman 1984).

Findings: caught in vicious cycles

Pre-Delphi mini-survey findings

To jump-start the discussion, prior to the Delphi meeting a mini-survey was sent out to the participants. No statistical generalizability was attempted, rather a sense of the overall feel for the status quo and the historical development towards the present situation. The general feeling that emerged from this survey is that, in terms of outsourcing, one pendulum movement has already been completed, and we are swinging back towards pre-1995 arrangements in several respects. In other respects, the status quo is a continuation of a trend that has been going on for some 20 years.

The overall feeling: the pendulum is swinging back

As indicated in the introduction, the general feeling of our expert panel was that the process industry, at least in North-West Europe, is on its way back from recovery, as can be seen from Figure 3, which shows a recovery from a performance level of 92 (with performance in 1990 as the norm of 100) in 2000 to a performance level ten years later over 115. From 100 to 92 and back to 115, a pendulum swing indeed.

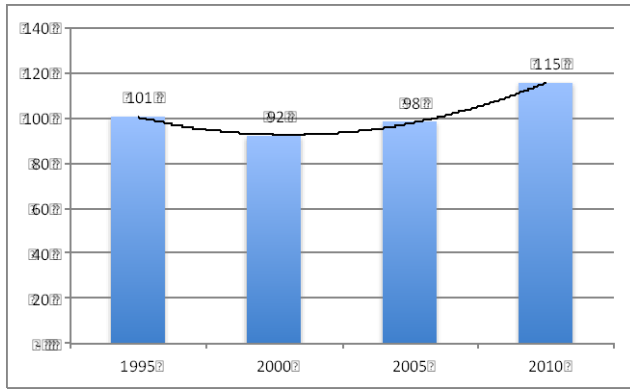


Figure 3: Technical performance of assets (1990=100)

Figure 4 and Figure 5 show that this dip in performance is mirrored in a dip in technical competence, especially of internal staff. Given that the bulk of the outsourcing of maintenance activities has taken place from the late 1990s until the mid of 2000, it is perhaps not surprising that this has coincided with a drop in maintenance expertise of internal staff, as Figure 4 testifies.

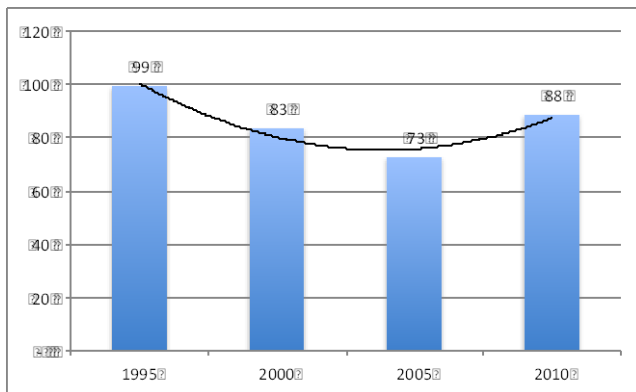


Figure 4: Technical competence internal maintenance staff (1990=100)

However, drop of internal competence levels has not been met by a strong increase of skills with contractor staff, as Figure 5 shows.

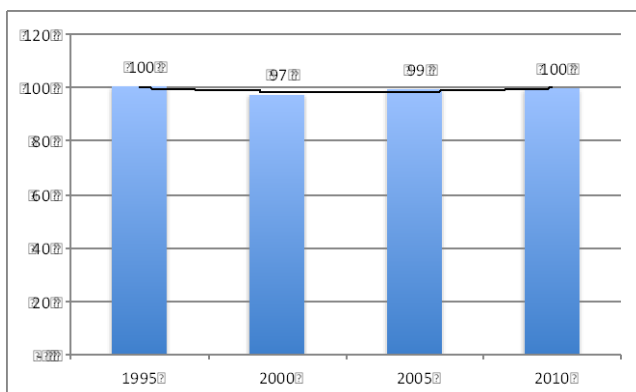


Figure 5: Technical competence contractor staff (1990=100)

In both cases, the last few years witness a return of competences, to varying degrees.

In other aspects, our expert panel seemed to be observing a continued trend over the past two decades. For instance, our panel saw a clear convergence in the degree in which

contractors are evaluated against their short term performance, as opposed to their long-term performance. This is shown in Table 1. In 1995, some companies still looked for mostly the long-term, some still maintained a balance of short and long term. However, in 2010, we see a convergence that almost all go for short-term goals first, with some long-term goals added. For an activity as maintenance of capital goods, which is inherently an activity where one aims for the long-term performance of the assets, this is a curious development indeed.

Table 1: Short-term or long-term evaluation of contractor performance

	Purely long-term goals	Mostly long-term, some short-term	Equal balance of long and short-term	Mostly short-terms, some long-term	Purely short-term goals
1995	0%	33%	17%	0%	50%
2000	0%	33%	33%	0%	33%
2005	0%	0%	17%	50%	33%
2010	0%	0%	0%	83%	17%

How would you evaluate the degree in which maintenance contractors are evaluated against their SHORT TERM performance in the current period versus LONG TERM performance over the years?

An equally confusing observation is that of the divergence in the governance arrangements for maintenance. As Table 2 shows, back in 1995 maintenance was mostly a decentralized affair, taking place in the business units. Recently, in 2010, governance solutions vary the entire range from fully centralized to fully decentralized. One possible answer to this puzzle is that companies choose what works best for them. However, another answer may be that companies just no longer are sure what is the optimal organizational arrangement for maintenance....

Table 2: Degree of centralization of maintenance activities for asset owners

	Fully centralized, central Technical Dept	Mostly centralized, with BU technical mgrs	Halfway in between (3)	Mostly decentralized, with BU business mgt	Fully decentralized, with local site mgt
1995	0%	0%	0%	50%	50%
2000	17%	0%	17%	17%	50%
2005	17%	33%	33%	17%	0%
2010	17%	33%	17%	33%	0%

How much centralized/decentralized has the decision-making authority for maintenance activities been with your company for the past 15 years?

Despite the variety in organizational solutions, in one aspect there was strong agreement among our expert panel: management of maintenance contracts has become much more problematic over the years. This becomes quite evident from Figure 6, which shows the

effort required to manage contractors, rising to 35 percentage points between 2000 and 2010.

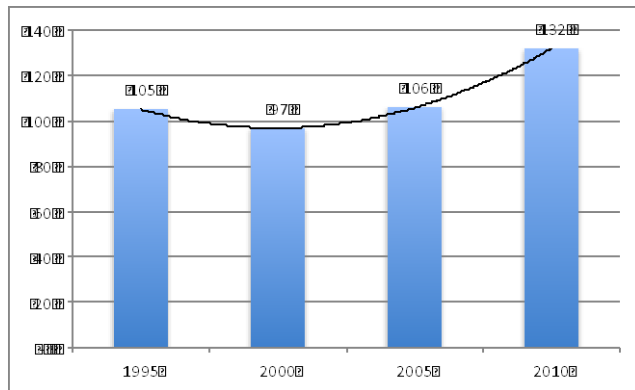


Figure 6: Effort required to manage contractors (1990=100)

The reader is reminded that these graphs do not suggest statistical generalizability, but rather give a useful snapshot of the collective “mental maps” of the experts in the Delphi panel. The implication of Figure 6 also served to trigger the causal diagramming exercise that followed next. In the coming paragraphs, we will summarize our synthesis of the insights contained in the “raw” causal diagram shown in Figure 2.

Reinforcing feedback between commonality of goals and maintenance performance

Figure 7 suggests some very hopeful causal interrelations between the quality of the buyer-supplier relationship and maintenance performance, that unfortunately at present appear to be working the wrong way round. Such is the nature of reinforcing feedback loops, that the same mechanism can generate both a virtuous, so ever-improving, cycle, and a vicious, so ever-worsening, cycle. At present, two vicious cycle appear to be active.

Loop R1: Common Goals Loop: There is a lack of common goals, so it is everybody for themselves. This results in antagonistic buyer-supplier behavior, with a number of negative effects: thinking in risks, rather than opportunities, and a lot of negotiating and fighting between asset owners and contractors. All these have detrimental effects on maintenance performance. This then leads to disappointment and hence a choice for new, fresh contractors.

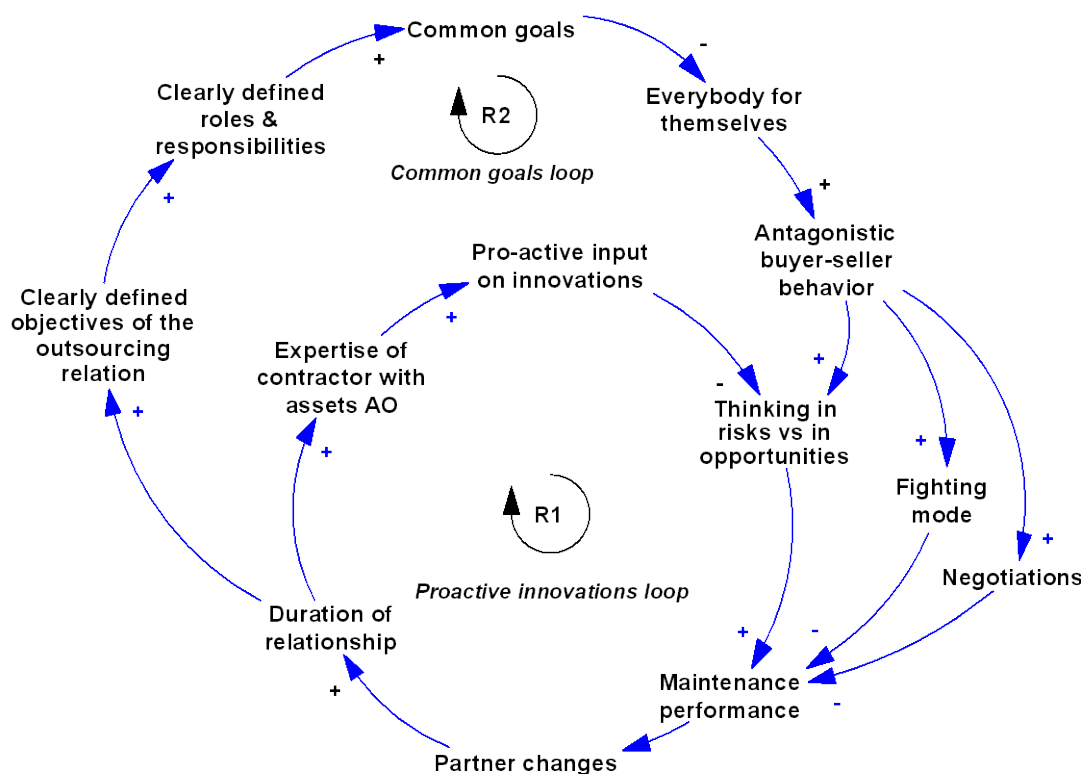


Figure 7: Reinforcing feedback loops between performance and buyer-supplier relationship

Unfortunately, these new contractors lack the expertise that is required to provide pro-active input for innovations. Hence, maintenance performance worsens further.

R2: Common goals loop. A side-effect of changes in the contractor base is that insufficient time is taken at the outset of the outsourcing relation to specify objectives on both sides. As a result, goals of the two parties continue to differ and the vicious cycle continues.

The hopeful message from this part of the diagram remains that if these vicious cycles can be reversed, precisely the same mechanisms can lead to better and better performance. Common goals will lead to innovations, which will improve performance, which will increase the duration of the relation and the expertise on both sides, and thereby can lead to further innovations and performance improvements. However, before we can move towards solutions, we first need to add some further confounding vicious cycles.

The self-fulfilling prophecy of a Purchasing bias

There were a European supply manager and an ex-CPO in our expert panel, but these too confirmed the undesirable effect of a purchasing savings buying in present-day outsourcing arrangements. This works as follows, as is shown in Figure 8.

R3: Procurement bias loop: Mediocre maintenance performance leads to higher maintenance costs. As these costs go up, the role of Purchasing in contract negotiations becomes greater and greater. With cost-saving minds behind the wheel, the willingness to share potential savings with the contractor decreases, and hence contracts are not designed in a way that will encourage expert input from the contractor. On the contrary, incentives will be mainly of short-term revenue optimization for the contractor. This results in game-playing and a misalignment of goals, and hence feeds back into the vicious cycle of antagonistic buyer-seller behavior that we say just before.

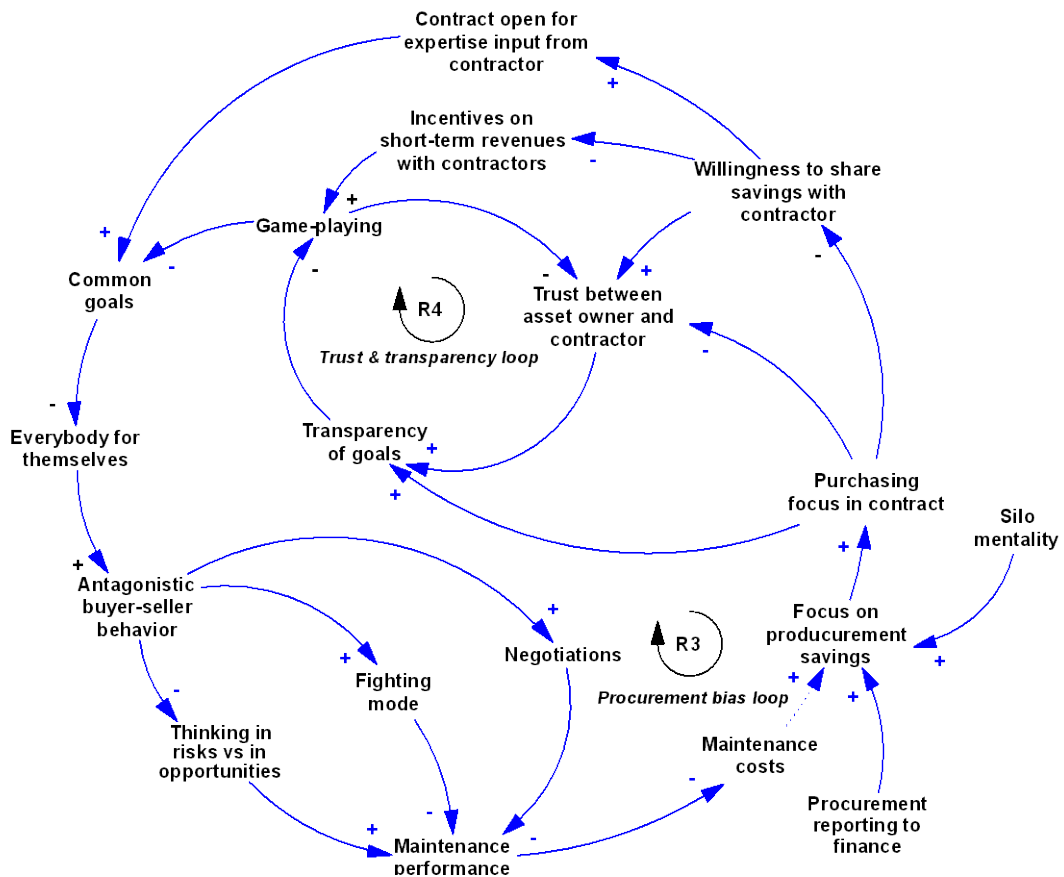


Figure 8: Reinforcing loops related to Purchasing bias in maintenance contracting

R4: Trust & transparency loop. In between all this, trust withers. There is a self-reinforcing feedback loop between trust and transparency: The more parties trust each other, the more they dare to share information, to be transparent. This transparency at the same time makes it more difficult to “play games”, as is so common in contract negotiations. Hence, parties become more trustworthy in their behavior and can share even more information leading to better performance.

The crucial role of strategically thinking asset owner management

What is needed is asset owner management that can break through this purchasing bias and short-term cost saving orientation. Asset owner management that can think strategically and long-term, will be looking at maintenance from a total cost of ownership perspective. This calls for a long-term partnership orientation, in which maintenance is jointly run by asset owner and contractor, almost as a separate business. In such an arrangement, there is sufficient willingness to share savings with the contractor, which can lead to the trust levels required to reverse a vicious cycle of low trust, transparency and performance into a virtuous one.

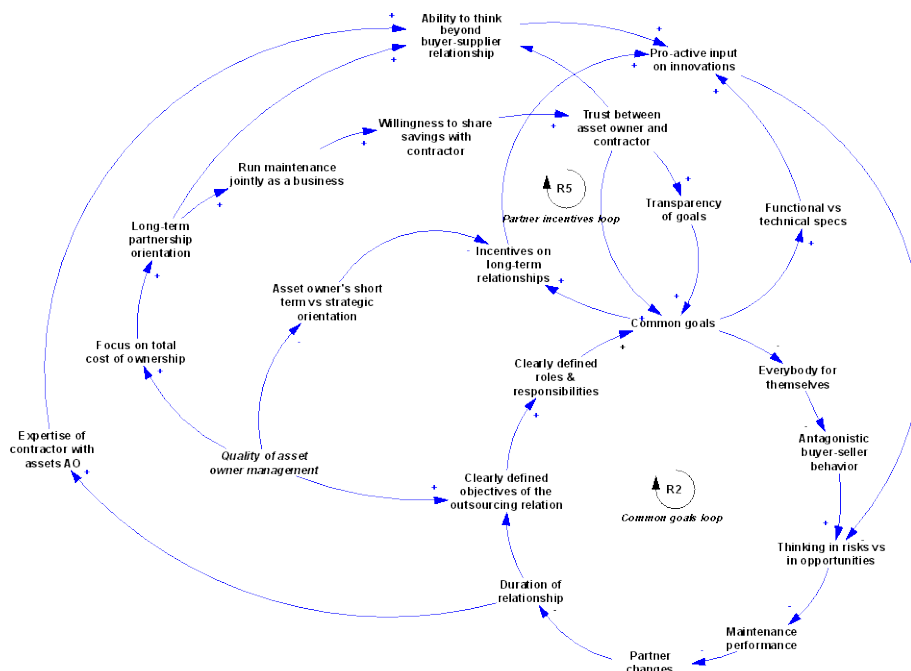


Figure 9: Impact of quality of Asset Owner management on performance

It takes two to tango, obviously. It is almost just as important that the contractor can look at the work to be done beyond the classical buyer-supplier antagonistic relationship. Incentives on long-term partnerships will help here, but so will an in-depth expertise of the contractor with the assets, so that its added value is beyond question.

Additional complicating factors

Our expert panel suggested several further complicating factors, that do not lead to additional feedback loops, but that do build upon the ones already described. These factors are visualized in Figure 10.

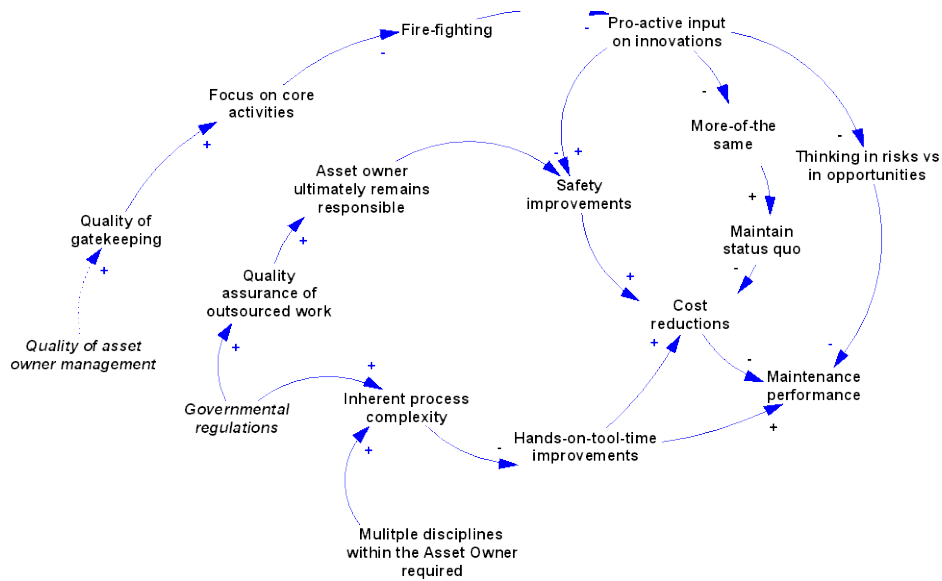


Figure 10: Additional complicating factors

There is the notion that in this industry, process complexity is very great indeed, and will only increase further. Issues are inherently multidisciplinary. Governmental regulations will only increase, and the need to make further safety improvements will persist. At the same time, asset owner management quality so far has not been such that a clear focus on what is really core and what isn't has been maintained. This has led to fire-fighting and a more-of-the-same mentality, which has stood in the way of innovation. Again, no loops in themselves, but none the less complications that have to be surmounted if world-class maintenance is to be achieved.

Discussion: implications for research and practice

There is a wide array of normative studies on how buyer-supplier relationship should be, often from an explicit or implicit theoretic perspective of principal-agent theory. That is not where the research priority must be. Priority must lie with first better understanding how maintenance outsourcing arrangements evolve over time, how the reinforcing feedback loops described in the previous section generate their behavior, for better or for worse. From such descriptive research may emerge insights on how to reverse the vicious cycles into virtuous ones. As indicated by the numbers in the overview diagram Figure 2, our expert panel was especially hopeful towards the following five themes:

- (8 votes) Thinking beyond classical buyer-supplier relationships; the “nation-wide perspective”;
- (8 votes) Long-term partnership models;
- (7 votes): Trust, transparency, and clearly defined roles & responsibilities
- (6 votes) Goal commonality between asset owners and contractors;
- (6 votes) Incentives on short-term vs long-term performance.

Conclusion

World-class maintenance management is of crucial importance for the aging European economies. Technical and demographic challenges are huge. Nevertheless, at present it seems that outdated viewpoints on how to best structure contractual relations between asset owners and contractors stand in the way of world-class performance in maintenance. Such mistakes have been made in manufacturing outsourcing and in IT outsourcing. There is no law or necessity why these mistakes must be repeated in maintenance. An expert panel consisting of executives from leading Dutch petrochemical, chemical and energy producing companies and contractors working for these asset owners, complemented with academic researchers, identified why outsourcing issues persist in maintenance. This panel also identified promising directions for research and practice to reverse the vicious cycles the industry seems to be caught in. These require that managers on both side of the buyer-supplier relationship think beyond their classical role division and move towards a partnership model, with common goals, long-term performance incentives, and trust, transparency and clearly defined roles & responsibilities on both sides. Most of all, it will require a lot of hard work.

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