

WHO TAKES CARE OF MAINTENANCE? – MAKE OR BUY CONSIDERATIONS AND SUPPLIER RELATIONSHIPS IN THE SWEDISH MINING SECTOR

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ABSTRACT

The aim of the article is to examine the choice of in-house operations versus buying maintenance in the context of the Swedish mining industry. The operation of maintenance has become a critical strategic business concern. On the one hand, from a customer perspective the costs of maintenance is becoming increasingly more significant and the costs of large production stops that may occur when maintenance fails is indisputably damaging. Consequently, maintenance must be handled with skill and caution. On the other hand, from a supplier perspective maintenance is an important strategic component and is often more profitable and reliable than sales from new business. In an attempt to maintain and increase revenue for maintenance, suppliers are bundling maintenance into integrated solutions by offering different packages of maintenance or widening the offering to include equipment from competitors or even to give performance guarantees for entire production systems. We analyze the rational for choice of suppliers, types of relationship and the contractual conditions when settling maintenance deals through a qualitative case study approach. Three theoretical lenses are used to examine the operationalization of maintenance: industrial network theory; resource based view/extended resource based view and transaction cost analysis. The findings reveal that there is a strong tendency to out-source maintenance. Based on the empirical findings, we comment on strength and weaknesses of the different approaches.

Keywords: Maintenance, supplier relationships, sourcing, bundling, mining industry

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INTRODUCTION

The operation of maintenance has become more and more of a strategic issue, both from customer and supplier points of view (Laaksonen et al., 2009; Stremersch et al., 2001). From a customer perspective the costs of maintenance, including wear and spare parts could be substantial and rising, but perhaps even more important is that the costs (or rather lost revenues) of large production stops have a tendency to take increasingly serious proportions. This development could be seen as a consequence of bigger, fewer and more integrated production systems governed by lean principles (Bergenwall et al., 2012). Therefore, maintenance must be handled with more professional care in order to balance these higher stakes of a worst-case scenario.

Also from a supplier perspective maintenance is an important strategic component. Perhaps most important is that maintenance (or more specifically the wear and spare part business) is and has been rather profitable, often more profitable than new sales business. Consider the lift and escalator industry as a case in point; margins on maintenance are 25-35%, compared with 10% for new equipment. Revenue from maintenance is far more stable than that from installations, which are affected by the ups and downs of the economy (Economist, 2013). For present and future strategies, the suppliers are bundling, more often than not, maintenance into total offerings or integrated solutions (Ulaga and Reinartz, 2011). Although defining maintenance can be ambiguous (Mathews, 2003), an extended strategy for maintenance as a stand-alone strategy could also be interesting. For example, different packages of maintenance could be offered; the offering could be widened to include equipment from competitors or performance guarantees could be given for entire production systems (e.g. Windahl and Lakemond, 2010).

In this article, we include three types of activities: (1) service operations on installed facilities and equipment, (2) the handling of wear and spare parts and (3) specialized consultancy and service work that leads up to better performance of installed equipment and infra-structure. The aim of the article is to examine different options of operating maintenance. More specifically, we have three research objectives:

1. To describe and analyze the choice of in-house operations versus buying maintenance
2. To describe and analyze the rationale for choice of suppliers and type of relationship to secure maintenance, and
3. To describe and analyze the contractual conditions when settling maintenance deals.

We address these objectives through a qualitative investigation in the context of the Swedish mining sector. In the mining industry, about 80-85 percent of suppliers' revenues come from the wear and spare parts business and almost all the rest from different kinds of service

operations. The sales of different kinds of consultancy services, such as technical audits or special monitoring services, only count for a few percent of total maintenance cost.

The theoretical perspectives are somewhat eclectic; three different theoretical lenses are used to examine the operations of maintenance. The perspectives used are industrial network theory (INT), resource based view/extended resource based view (RBV/ERBV) and transaction cost analysis (TCA). These theoretical perspectives are applied on the issues of make or buy and choice of suppliers and include the nature of supplier relation and type of contractual agreements that have developed. Furthermore, based on the empirical findings, we comment on the explanatory strength of the different approaches.

CONCEPTUAL BACKGROUND

The theoretical underpinnings of make or buy and outsourcing will be used as a conceptual background. When reviewing the literature on outsourcing, there are two prominent theoretical frameworks in focus: Transaction Cost Analysis (TCA) and Resource Based View (RBV).

The question of make or buy is at the core of Transaction Cost Analysis (TCA) and the theoretical framework sets out to analyze under what situational factors an in-house hierarchy is to be preferred and vice versa when a market solution is seen as more favorable (Williamson, 1979; 1985). The deciding factor in regards to the choice of hierarchy versus market is the sum of production and transaction costs.

A market solution can be advantageous in many ways through the pooling of resources and economies of scale through specialization. The main argument against the market solution is the risk for supplier opportunism and bounded rationality of decision makers leading to incomplete contracts. Moreover, when supplier opportunism is present, there could be a huge difference between the calculus of transaction costs in the planning stage and after the execution.

An interesting question that is raised by TCA is: 'what is the *real* transaction cost'? For example, it is important to look at the costs of setting up and monitoring contracts and to look at safeguarding a contract in a worst-case scenario? Another aspect of the risk for supplier opportunism is lock-in effect created by a supplier who aims to sell solutions and also tries to create a sort of local monopoly. Lock-in-effect makes the customer dependent on the supplier for services and the customer is unable to use another supplier without substantial switching costs. The resource-based view of the firm (RBV) is a theoretical framework for a better understanding of sustainable competitive advantage (e.g. Barney, 2001; Wernerfelt, 1984). Contrary to the worldview of Michael Porter (e.g., 1998), RBV stresses the importance of internal resources, which are hard to imitate and give value to customers; competitive advantage is built inside out. According to RBV proponents, it is much more feasible to exploit external opportunities using existing resources. Thus, in opposite to INT, RBV is inherently firm centric. An extended version of RBV, such as the dynamic capabilities approach (e.g. Teece, 2007), further stresses the importance for a focal company to link

themselves to competent suppliers and customers. Unlike the conventional RBV, which remains tied to the analysis of the resource choices of incumbents, an extended RBV perspective sees the firm drawing on a wide array of external resources, through various kinds of relationships (Mathews, 2003).

When addressing the make or buy issue or more often the issue of outsourcing, RBV is often used to put forward the arguments to keep core-competences in-house and to outsource and source products and services that are based on complementary competences or more simply are looked upon as standard products (cf. Cox, 1996). Therefore, an interesting question raised by RBV is whether maintenance is seen as part of core competence that should be kept in-house. If not, however, it could still be of important strategic value and as a consequence handled within strategic partnerships.

Nordigården et al. (2007) have summarized the different drivers towards outsourcing that can be derived from TCA and RBV in five categories:

- Cost driven, with the aim to reduce cost
- Financially driven, with the aim to avoid large fix costs and investment costs
- Core competence driven, with the aim to improve profitability by focusing on resources that are imperative for competitive advantage
- Capacity constraints driven, with the aim to cope with operational flexibility and efficiency
- External capabilities driven, with the aim to make use of and learn from external actors and external resources.

Industrial network theory (INT) is a framework which is used less frequently for analyzing outsourcing. INT presents another way of looking at markets; instead of a micro-economic view, there is a network of relationships view that has its roots in sociology (e.g. Ford, 1990; Håkansson & Snehota, 1995). However, INT gives us very little guidance in the choice between make and buy. The network perspective is very critical towards the TCA rather simplistic view of a choice between market and hierarchy. Instead the INT stresses the importance of viewing markets as networks of relationships, where the dominant relationships between main actors often are long-run and based on interdependence of activities and resources, and of mutual trust, which is seen as an accumulative process over time. However, INT lacks concepts like core competence found within the RBV framework, to guide the choice of what activities to keep in-house. But contrary to TCA, the INT perspective looks at the cooperative aspects of relying on external relationships. Instead of warning for opportunism, the advantages of inter-organizational cooperation are put forward.

Interesting questions raised by INT include how ‘make or buy decisions’ and ‘supplier selection decisions’ are made or are formed in a less planned fashion, over a longer- time frame and within a relatively stable relationships between customers and suppliers. Through the lenses of this perspective, every new business transaction is made in the context of long run and stable relationships between a relatively few number of customer and suppliers in each market segment. This also raises questions about the effects of locked-in commitment

(Sharma, Young, & Wilkinson, 2001). For example, what does it take to break the bonds and mutual trust that is likely to exist between the supplier and the customer? In summary, the comparisons between different options in make or buy considerations and supplier selection could be seen as *calculi*, that is trying to present “hard facts” from comparisons between cost, quality, lead times, availability, flexibility and other operative variables. At the core of the decision is also the contractual agreement and what type of bonuses, penalties, and guarantees that are written into the contracts. There is also of interest if the contracts follow a revenue model that is performance based or more focused on the execution of certain activities (with flexible or fixed prices).

To place these decisions in a strategic context, we need our theoretical lenses with different kinds of strategic thinking. TCA wants us to safeguard from supplier opportunism. INT gives a perspective of doing business within the context of markets as networks, where cooperation between external parties should primarily be seen as an advantage and as leverage for development. Finally, RBV raises the question of core-competence for sustainable competitive advantage and in that what activities and processes that should be kept in-house or outsourced.

METHOD

The empirical context of this article is the Swedish mining sector. Mining fits very well into the description of an industry where maintenance is becoming more and more strategic. From a mining company (customer) perspective, they have to handle operations in very rough working environments with lots of potential production disturbances. Production stops are increasingly expensive, not the least in periods of booming demand. Investments in different equipment and installations are also expensive and buying is often done in large projects. Suppliers of equipment are increasingly trying to offer solutions, including investments, financing and maintenance – life-cycle offerings - and business is done in a context of long-term relationships between the mining companies and their major suppliers (Biggemann et al., 2013).

The study is of an exploratory nature, with the ambition of identifying different make or buy and supplier selection patterns (strategies) but also to increase our understanding of the underlying factors (an explanatory interest). The overall research design is a multiple case study (Woodside, 2010) covering five buying companies (one studied through the lenses of one of their major suppliers) and six suppliers of different kinds of mining equipment and services. In all, 18 interviews with executives and managers were made – three in a pilot study and 15 in the main study of the ten case companies. The sampling process ceased at saturation, as indicated by information redundancy (cf. Eisenhardt, 1989). Complementary data were also collected as a desk study. The empirical material is presented in five case studies of the mining companies. Within each case, there are descriptions of the relations to different suppliers, those included in this study, but also other suppliers.

The case companies

The five case studies of mining companies represent a majority (close to a total study) of Swedish actors. From a supplier perspective three out of four major Swedish and Finnish suppliers are included together with two smaller suppliers. Taken together, our sample covers a large proportion of the Nordic mining industry. The customers could be divided into three categories: (1) Large and established mine corporations: LKAB and Boliden. LKAB is Europe's largest iron ore company (but still only about one tenth of the world's largest) and Boliden (copper, zinc and other minerals) is among other things the owner of Europe's largest zinc mine, the Tara mine in Ireland. (2) Small and established mine companies: Zinkgruvan. Zinkgruvan is part of a larger company Lundin Mining, but is mostly run as an independent company. As the name indicates, the main minerals are zinc and copper. (3) Small start-up mining companies: Northland Resources and Dannemora. Northland Resources is starting up the exploitation of two (virgin) iron ore projects in the north of Sweden and Finland. Dannemora is reopening an iron ore mine in the middle of Sweden, which has been closed down for some twenty years.

The six suppliers could also be divided into three categories: (1) International suppliers of mobile equipment: Atlas Copco. Atlas Copco is a world-leading supplier of different kinds of mobile equipment, including drill rigs and different kinds of trucks. The other Swedish supplier Sandvik, Atlas Copco's closest competitor, will be studied through the lenses of their customers. (2) International suppliers of installations and fixed equipment: ABB, Metso Mining & Construction, and Outotec. ABB is a world-leading supplier of electrical power infrastructure, mine hoists and electrical engines. Metso and Outotec are process equipment manufacturers and especially Outotec have focus on engineering services (a buy-out from Boliden). (3) National and local suppliers of service: Monitoring Control Center (MCC) and BEFAB. MCC is a consultant in maintenance development and condition monitoring. BEFAB is a local provider of underground transportation services.

EMPIRICAL RESULTS – FIVE CASE STUDIES

The mining process and the objects for maintenance

First we provide a brief description of the different steps in the mining process and the type of investments in installations and equipment that are executed. To better understand the mining process, a schematic view of LKAB's sub-surface mining process is used (see Figure 1). The firm is running Europe's largest iron ore business.

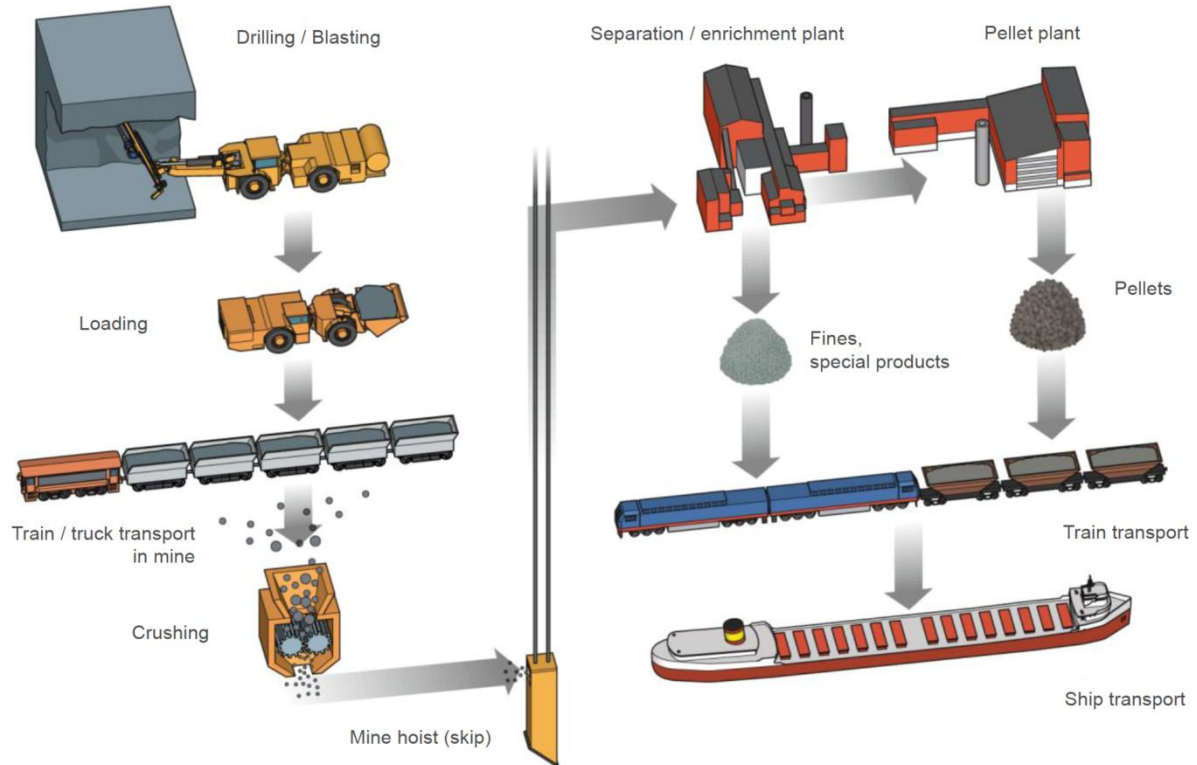


Figure 1. Schematic view of LKAB's mining process (LKAB, 2011).

- **Step 1: Drilling/blasting.** The mining operation starts with drilling and blasting. Typical equipment that is used is drilling rigs and vehicles carrying explosives. Among important suppliers are Atlas Copco and Sandvik.
- **Step 2: Loading (hauling).** The rock material that has been loosened by the blasts is lifted away to a truck or a train. This is done by an underground haul truck called “scooptram”, with a typical capacity of some 17 tons. Among important suppliers are Sandvik, Atlas Copco.
- **Step 3: Material transport in mine.** This transport below ground is done by train cars or trucks. If the drilling level could be reached by a ramp down into the mine, the transport could go directly to the surface. Among important suppliers are Sandvik, Atlas Copco, and Caterpillar
- **Step 4: Transport through the mine hoist.** The mine hoist is a key component and one of the single largest investments of a mine. In Sweden ABB has supplied virtually all mine hoists.
- **Step 5: Separation and enrichment of ore.** The separation process could already start underground, (e.g., a first step of crushing). Above ground the concentration process to obtain higher mineral content before transportation continues. This is done in a processing plant, which also constitutes a significant share of total investments, between 30 to 50% of total capital expenditure. The ore is further crushed and grinded and then the mineral has to be separated from rock (by a magnetic process and/or

floatation). The processing plant is always customized to the special conditions. There are many types of equipment in a process plant (different processing machines and conveyor belts) and typical suppliers are Metso and Outotec.

- Step 6: Further value added refinement. Value added refinement can be taken another step closer to the mine. In the case of LKAB, about 80 percent goes to pellets and the rest to fines, before transportation.
- Step 7: Transportation. Mining companies very often have to invest in different kinds of transportation facilities and infrastructure, often in cooperation with the (government) national transportation agencies. Investments cover terminals at the ports, railway cars etc.

From a maintenance perspective there are different types of objects – moving equipment, fixed equipment and infrastructure (such as ventilation, drainage, and electricity). Maintenance can also be more or less broadly defined from single motors and trucks up to entire processing plants.

Case 1: Start-up company 1 - Northern Resources (NR)

NR is a relatively newly started mining company with the ambition to become a major European supplier of iron ore. Business is based on the development of two iron ore projects in the north of Sweden and Finland. An option contract for the Swedish project (the Kaunisvaara project) was signed in 2004 and a feasibility study was successfully finished at the end of 2010. A go-ahead decision was taken to start up two open pit mines and production was started in the beginning of 2013. Turnover for the fiscal year 2013 was approximately 10 M Euro and losses were heavy. At present (first half of 2014) the company is struggling with a weak financial situation and is facing substantial operational problems when ramping up production and logistics. Planned production volumes for 2014 are 2,5 million ton and, when fully developed, NR expects to achieve an annual production of 12 million ton.

The Kaunisvaara mines have been developed and equipped in close cooperation between NR together with major suppliers. Our focus in this case description is the processing plant. Metso was chosen as the supplier of the entire processing plant (turn-key) and was responsible delivering all mineral processing equipment and also maintenance. Since the two pits differ in mineral content, there are two separate processing lines which are joined at the end of the plant, before final filtration and loading on trucks. According to plan, the first processing line was installed in 2012 and the second will be in place in 2014. About 70 percent of all equipment was (and will be) Metso products and the remaining 30 percent were taken from sub-contractors, but also from Metso's competitors such as Sandvik and FL Smith.

An outright demand from NR forced Metso to sign an agreement that guaranteed the performance of the entire plant. Failures to live up to the agreed performance levels would have been considered as a legitimate cause to cancel the contract. The turn-key project could also have included operating the plant, an assignment that Metso turned down. That decision

was partly due to earlier bad experience. And when signing the agreement, it was also obvious that Metso could not bear the entire operational risk in case of an equipment failure, which could stop the entire plant and even worse the entire mine. But a sort of process guarantee was required from the investors for Metso to sign.

This demand for a process guarantee was also a major reason for choosing a single supplier for installing a turn-key plant. The supplier, in this case Metso, would never have signed a process guarantee if the responsibility for some installations had been placed in the hands of other suppliers, which differs from including products from other suppliers in a systems solution. The construction work was done by a contractor hired by NR. All design work was carried out by Metso and also all procurement and integration of equipment from other suppliers. The development and construction (of the first part) of the plant was a lengthy process spanning over more than two years.

Metso and NR have signed a maintenance contract (with a five year time horizon) that includes a service and inspection program called Life-Cycle Services program. This contract was signed one year later than the “new sales” turn-key contract. There was never an option for NR to take care of maintenance as an in-house operation; this was due to financial viability, lead times and a lack of internal competencies. The revenue model for Metso is on a “cost per ton” basis; that is, maintenance fee is paid in proportion to the output from the processing plant. The per ton maintenance fee was based on an estimation of production volumes and was supposed to be adjusted at the production start and after six months and thereafter on an annual basis. During negotiations it was concluded that “tonnage is the easiest thing to measure”, but the outcome is dependent upon different factors such as how ore is processed in the mine and ore grade etc. Many of these factors are outside the control of Metso, so the maintenance contract had to be complemented with different clauses adjusting the price paid to Metso. This was a complicated process, but the contract negotiations were held in a good and cooperative atmosphere. The commercial manager of Metso concluded that the maintenance contract was “as close to open books as you can come”. When fully into production, Metso will have a maintenance staff of 17 employees on-site and will have an office co-located with the management of the mill. Metso will also keep a consignment stock of wear and spare parts on site.

By the time the contract was signed between NR and Metso, they already had a history that started at the beginning of the project. Actually, that the management team of NR had extensive experience from other mining companies and other mining projects, and that Metso knew them, was a prerequisite for Metso to engage and to take initial risks in the project. The intimate relations between NR and Metso date back to the stage where Metso was providing services during the feasibility study phases. Metso provided expert knowledge in process management, cost calculations and choice of equipment, already before the DFS (Definite Feasibility Study). Metso got paid as consultants, the only unpaid part were the cost calculations to be included in the DFS. During these initial phases Metso had a large staff working and the commercial manager visited the head office of NR about once a week. When the request for proposal was launched, there were no surprises for Metso. Metso also won the

tendering contest against Outotec, another Finnish company. Prior to the production start, NR had problems coming up with pre-production funding, which could potentially delay the entire process. During this time, Metso continued to work according to plan and was willing to take the financial risks, which was part of that obligation.

Case 2: Start-up company 2 – Dannemora Mineral

Dannemora Mineral is a Swedish newly started mining and exploration company, which was founded in 2005. Their initial and primary objective was to reopen the Dannemora iron ore mine, which was closed down in 1992. Thereafter, the business scope has been somewhat widened to include other exploration activities in the local and regional area. Mining production started in 2012 according to plan. But due to recession in the mining industry, business has been slow and finances are under immense pressure. Turnover for 2013 was a slightly above 50 thousand Euro and the margins and results were in the red. Up till production start Dannemora was primarily run as a project organization. In parallel, a production organization was started up, headed by a mine manager and an operations manager. The project organization was driven by some 10 people, out of which only the project leader and one person working with safety issues were internally employed. The rest were consultants, including those involved in purchasing. After production start-up, the project organization was dissolved.

Three suppliers were selected as partners for operations. One company, Sandvik, who had delivered equipment underground, was also contracted as responsible for maintenance of their installed machinery (setting up an underground workshop). However, employees from Dannemora will also be participating in order to better learn how to operate and to do basic maintenance. The second partner was chosen to be responsible for all explosives and blasting. The third partner was ABB, who was selected to be responsible for all maintenance of equipment above surface; that is, the processing plant and also for all electrical installations, ventilation, HVAC and similar. The processing plant was designed as an integration of equipment from many different suppliers, crushers from Sandvik, screeners from Morgensen, magnetic separators from Metso etc. Systems integrators were Dannemora together with Skanska. The construction company, Skanska, was hired for building the processing plant. ABB was the supplier of the mine hoist, which was a large installation with very long delivery-times (up to two years for gear boxes). ABB won the maintenance contract in competition with suppliers that wanted to do maintenance on their own equipment. But if Dannemora had chosen that strategy, they would have been forced to employ in-house maintenance staff. Basically, this situation was avoided by using only one maintenance provider. ABB plan to have 11 employees on site.

All maintenance contracts (above and below ground) are of “open book” character. Negotiations start with determining service levels in terms of uptime and availability connected to the different kinds of equipment. The supplier presents a cost calculus at given performance levels and an add-on margin is allowed from the customer. Price always has a variable part depending on the outcome of different key factors. ABB, for instance, makes a

promise of certain performance levels (97 percent uptime) and if maintenance has underperformed, there will be price deductions. So far, in the start-up phase, the contracts are not entirely performance based, such as “cost per ton”. Dannemora states the reasons for using partnering agreements for maintenance relate to saving time and cost in a build-up phase. From a cost perspective, when maintenance is up running, management at Dannemora regards outsourcing and in-house maintenance as about equal. The Mine manager states “ABB can just pull a ready-made solution out of the drawer that they have used at other processing plants”.

Case 3: Established small company - Zinkgruvan

Zinkgruvan is a small Swedish zinc mine owned by Lundin Mining. Zinkgruvan has been operating since 1857, producing zinc, lead, silver and copper. The mine has about 320 employees and in 2011 about 1000 kt zinc ore and 100 kt copper ore were extracted. Turnover is about 100 MEuro. Zinkgruvan is located in the middle of Sweden and within close range of the equipment supplier Atlas Copco’s global center for underground rock excavation. Zinkgruvan and Atlas Copco have been development partners in a longstanding relationship and Zinkgruvan is seen as an informal test mine for Atlas Copco.

Zinkgruvan reported that when they invest in new equipment, maintenance is very seldom included in the first discussions. Dialogue usually starts with discussions about what equipment to purchase and after that is done, they start to focus on whether they should handle maintenance as an outsourcing arrangement or handle it in-house. “Honestly, we don’t take service into much consideration when selecting machines”, the Purchasing manager claimed. Overall, Zinkgruvan has a mixed strategy regarding in-house or outsourcing of maintenance. Some are solely conducted by the supplier, which is primarily the case with Atlas Copco equipment. Maintenance on some of the machines are split between the supplier and Zinkgruvan, as in the case of powertrain on scoop-trams together with Caterpillar and for some equipment maintenance is solely handled with in-house resources.

A few years back, an entire fleet of vehicles was leased from Atlas Copco and sourcing of maintenance was also part of the deal. What could seem like a package deal was actually separated into two decision processes, first the decision to lease was taken by financial reasons and secondly the decision to source services was taken. Since Atlas Copco historically has been very close to Zinkgruvan, the decision to place the order in their hands instead of in the hands of the major competitor, Sandvik, was probably rather straightforward. In this case the primary reason to outsource service was that it would enable more rapid deployment of the new machines. The partnership with Atlas Copco is considered very productive, for instance suggestions on development of new products or product upgrades are presented frequently to Zinkgruvan. The contracts are of cost-sharing types with a base line for cost. If the costs deviate from the base-lines, they are split between the two parties. Negotiations are “open book” and Zinkgruvan knows what profit margins that Atlas Copco operates under.

In the recent purchase of a processing plant, where Metso was chosen as supplier, there were also sourcing of maintenance included, especially the conveyor belts, the mills and the pumps. The revenue model in this contract was “cost per ton” with no profit sharing. Metso took on a process guarantee, but at liability levels far below the losses of Zinkgruvan in case of a production stop. “It is not a guarantee in that sense, that’s the wrong term to use”, says the Purchasing manager. The Metso deal is less transparent than the one with Atlas Copco, but at Zinkgruvan management has the feeling that Metso would open up more if demanded.

At Zinkgruvan, the reason underlying whether to source or keep maintenance in-house is not primarily considered as a cost-issue. According to the Mine manager there are other questions asked: “Which resources do we have?”; “Are we buying a single machine or a fleet?”; and “Can we accept becoming dependent upon the supplier?” There could also be other considerations such as technical issues or time-constraints on building internal competence. It is often regarded as difficult to build a service organization for something new. In many cases Zinkgruvan goes directly to sourcing even without considering the internal alternative. A comparative cost calculation is of less importance compared to the difficulty and risk profile of the maintenance task.

The balance between outsourcing and in-house is swinging over time. Today, the Mine manager feels it is leaning towards in-house, to avoid the lock-in effects of suppliers. At the same time and from a maintenance point of view, solution contracts seem very attractive, but as already mentioned the lock-in effects are very obvious.

Case 4: Established large company 1 - Boliden

Boliden is a Swedish large company that is running several mines and smelters in Sweden, Ireland, Finland and Norway. Turnover in 2013 was 3,8 bn Euro. Out of the seven mines, three of them are more significant – Aitik is the largest copper mine in Sweden (a surface mine), Garpenberg is a large Swedish underground mine and the Tara mine on Ireland is the largest zinc mine in Europe with more than 700 employees. Boliden has different outsourcing vs. in-house strategies regarding maintenance services in their different mines. Overall, the strategy is a mixed one and based on what is best for availability. The purchasing manager states that “our entire thinking on service issues is based on availability.”

At the Aitik mine, maintenance of mill linings and associated services, including electrical motors has been outsourced to the supplier of new equipment, Metso. This arrangement will at least be running during the warranty period, but when the warranty expires the contract will be renegotiated. In other mines, Boliden has chosen an Indian supplier of mill lining with the ambition of keeping competition up. Even though cost reduction is not the main target Boliden wants to stress the price issue by not always and automatically selecting the supplier of equipment as also the supplier of services. It should also be mentioned that at the Aitik mine all other services except mill linings and associated services are performed in-house.

The outsourcing contract at Aitik has a revenue model priced as “cost per ton”, with bonus and penalty clauses. As always, the penalty fee is much lower than the value of lost

production in case of a breakdown. But as one manager puts it: “They are negligible numbers today – but it always stings to pay penalties”. The atmosphere in the contract negotiations are described as collaborative, at first the two parties focus on the contract terms, but rather soon focus is switched to improving the solution and to reduce the stop times.

At the Aitik mine Boliden uses a number of huge Caterpillar trucks and for these trucks Boliden has a ten year full-service contract with the Swedish representative of the brand. In this case, full-service includes all maintenance and all wear and spare parts except for tires. When it comes to tires, Boliden has better supplier contacts on a scarce world market for large tires. In fact there are only two suppliers available in this market segment. The service contract with the Caterpillar representative is priced as cost per engine hour, with cost increasing over time according to an index. The contract also includes a re-build of the trucks, in order to keep life-cycle cost down. Managers at Boliden believe that they could handle this contract at a lower cost in-house, and that the big advantage of the outsourcing is availability. The purchasing manager expressed the opinion that “you put tougher demands on entrepreneurs than on your own people.” Boliden has used Sandvik as a supplier of rock drilling tools, mostly drill steel which is among the most frequent wear parts. Sandvik also employs so called “drill masters” who inspects the performance of drilling and calls for improvements.

Boliden usually tries to avoid open-book contracts, except for some construction and civil works projects. The purchasing manager stated the opinion that open books contracts could be expensive for the buyer, since the suppliers add high overhead margins (perhaps over 40 percent of direct costs) and that open books were hard to “penetrate” (open books were not really open books). From that perspective it is deemed as a better purchasing strategy to go into tough price negotiations. The firm has never bought a turn-key solution as encompassing as NR (Northern Resources) did with Metso concerning the processing plant. When it comes to system integration competence in designing and building an entire plant, Boliden views themselves as equals to the large suppliers. “We possess the same competency as Metso - NR does not”, as on Boliden manager expressed it. One reason for purchasing turn-key is the possibility to pinpoint one single supplier with a process guarantee. However, Boliden does not see the advantage since they believe that a turn-key solution will overall lead to higher costs.

Boliden also feels that they are at an advantage from having good and long-term relationships with their major suppliers. One example was when they could “by-pass delivery times” and get deliveries of spare parts directly from the production line of the supplier. Boliden are discussing the advantages of fewer but multi-year negotiations, something that maintenance planning could benefit strongly from. Long-term perspectives in negotiations and contracts would avoid problems with long lead-times and delays. Besides availability, Boliden also sees other advantages from sourcing. One is that an external partner could be better at solving “small problems”, problems that are overlooked in a large organization such as Boliden. But at the same time, the feeling of becoming too dependent on suppliers is always a problem and the balance between sourcing and in-house is always a dilemma.

Case 5: Established large company 2 - LKAB

LKAB is running Europe's largest iron ore business including several iron mines in the northern part of Sweden. In addition LKAB also owns logistics operations, production of drilling equipment and commercial competence within mineral technology. The outputs from the iron ores are pellets and fines. LKAB is wholly owned by the Swedish state. LKAB employs about 4.200 people and revenues for 2013 amounted to around 2.6 bn Euro. The balance between handling maintenance as sourcing or in-house production is 80-20. A two-year guarantee is commonly given when purchasing new equipment and maintenance is executed by the supplier during that period (in order to make the guarantee valid). LKAB often tries to prolong the initial contract period for maintenance with the ambition to hold down prices. LKAB sometimes also use different maintenance suppliers to enhance competition. Such is the case for conveyor belts which is shared between the equipment supplier, Metso, and two local contractors. LKAB sees it as of strategic importance to keep local actors in business.

Since LKAB has strong finances, they are generally not very interested in leasing deals. But in some cases leasing could be chosen for non-financial reasons. Sourcing of mill lining (wear parts used in grinding mills) is one such example, where the supplier can switch mill lining at any time, but gets paid a fixed price. This gives incentives to develop better and more durable linings. "It's a win-win situation, if the supplier can develop a better mill lining he will make money and we will have a higher availability", as one Technical manager puts it. A similar sourcing agreement is running concerning drill steel. They are owned by the supplier and the supplier is paid "per meter drilled". If the supplier decreases operating costs, including maintenance, there is a win-win situation and surplus can be split between LKAB and the supplier. But in case of a cost development above targets and what is getting paid for, the supplier stands all the risk.

A couple of years back, functional sales was a hot topic at LKAB and a lot of effort was put into finding suitable and measurable indicators of good performance expressed in functional terms. However, there were considerable difficulties in finding these indicators. The basic problem was that the same functional failure could have very many causes and depending on what cause different suppliers could be held responsible and the problem could also be internally generated within LKAB. Except for drilling supplier getting paid by the meter drilled, management at LKAB seems opposed to functional pricing and especially profit sharing. One problem, which is mentioned above, is the unclear cause-effect relationship of what is leading up to good or bad performance. Another problem is that the supplier could "too easily earn their money" in the eyes of LKAB when engaged in a profit-sharing agreement.

LKAB has a purchasing strategy that gives priority to keeping up relationships with several suppliers, but in many supplier segments there are only a few to take into consideration. Sometimes, the specific situation calls for a single supplier choice. But in a case such as mobile equipment that is used underground, LKAB would prefer to establish some sort of

balance between the main suppliers Sandvik and Atlas Copco. But in the specific case, it is the best offer that is the winner and not the need for balance.

The maintenance contracts are usually related to performance the most straightforward is that drilling is getting paid by “meters drilled”. For other equipment and applications which face a more varying demand, the contract often includes a fixed part. The supplier gets some payment regardless if the equipment is used or not. Commonly the contracts also include bonuses and penalties, but the purchasers at LKAB somewhat plays down the importance of these instruments. Instead, they put forward the importance of having good relationships with their main suppliers and atmosphere were the two parties could have open and constructive discussions without repeatedly going back to what is written in the contract. For example, if problems with poor availability of equipment are an issue, it is better to tell the supplier to come up with an action plan instead of having a discussion of what is stipulated in the contract.

LKAB never or very seldom use open book contracts. In the view of purchasers at LKAB, these contracts give very little incentives for suppliers to pay attention to details. It is too easy for the supplier to add another component or activity and to get reimbursed in full plus say 8 percent added margin even if this extra was totally unnecessary. This requires strict control which is possible to uphold for a small mining company with few machines and other equipment. For LKAB it quickly becomes overwhelming to accomplish this sort of large-scale monitoring that would be necessary. The open book concept also demands regular meetings between the parties involved and it is a complicated task to master that type of scheduling.

At LKAB, sourcing of maintenance is viewed positively from a flexibility point of view. Instead of hiring 15 maintenance workers for running a new drill rig during all shifts, a sourcing contract would not extra complicate the in-house organization. Outsourcing could also be used as a capacity regulator in different phases of a business cycle. From a cost perspective, outsourcing in general is seen somewhat more expensive compared to in-house, but the difference is deemed rather insignificant. The pendulum between outsourcing and in-house is always swinging, for the moment perhaps a bit towards in-house.

Table 1 abridges data from the case companies of this study and their suppliers.

Table 1: A comparison of the companies

	NR	Dannemora	Zinkgruvan	Boliden	LKAB
	Start-up	Newly started: Reopen	Small (part of a mining corporation)	Large	Large State owned
Mineral	Iron	Iron	Zink, Copper	Copper, zink	Iron
2013 Revenue	10 M Euro	50 K Euro	100 M Euro	3,8 BN Euro	2.6 BN Euro
Financial state	Weak-loss	Weak- loss	Positive	Positive	Strong
Maintenance- Inhouse vs. sourcing	Sourcing/ outsourcing	Sourcing/ outsourcing	Mixed strategy Sourcing dominant	Mixed strategy Sourcing dominant	Mixed strategy Sourcing dominant

Supplier/s	Few key suppliers	Few key suppliers	Few key suppliers	Many suppliers (corporate level) – also uses third party suppliers	Many suppliers (corporate level)- also uses third party suppliers
In-house vs. sourcing	Sourcing is preferred to avoid fixed costs. Process guarantee important	Sourcing is preferred to avoid fixed costs. Availability and skills better when sourcing	In-house could be lower in cost. Availability better, especially in start-up phases when sourcing.	In-house could be lower in cost. Availability most important. Avoid too complex org.	In-house could be lower in cost. Availability most important. Avoid too complex org.
Contracts	Open book	Open book	Open book	Closed book	Closed book
Contracts Measurement	Performance based: Cost per ton	Not entirely performance based	Performance based: Cost per ton	Performance based: Cost per ton, bonus and penalty clauses	Performance based: meters drilled. Flexible

ANALYSIS

In-house operations vs. sourcing of maintenance

From an overall company perspective, all five case study companies have treated the issue of in-house vs. sourcing of maintenance as strongly in favor of the sourcing alternative. Despite that, maintenance is viewed of high strategic importance since the mining companies are financially vulnerable in case of major production stops. Taking a closer look at the differences in in-house operations, there are differences between the three established mining companies on one hand and the two small start-up companies on the other. The three established miners, LKAB, Boliden and Zinkgruvan, handle a substantial part of maintenance in-house, even though in-house operations are in minority compared to sourcing (at LKAB the in-house part is estimated to some 20 percent and Boliden and Zinkgruvan are also close to that figure). Going back in time, there are well-established maintenance organizations in all three companies, so even if the pendulum between in-house and sourcing is swinging over time, in-house maintenance will always be a viable option. In comparison, the two start-up companies, Northern Resources and Dannemora, handle very few in-house operations and both companies try to avoid establishing in-house maintenance organizations.

The type of equipment most reliant upon sourcing was mobile equipment; probably as a consequence of strong lock-in effects from suppliers and that mobile equipment are suitable objects for defining maintenance assignments. But also maintenance on fixed equipment was mostly operated by different kinds of suppliers.

Arguments for keeping these smaller parts of maintenance as in-house operations span over a rather broad spectrum of factors. However, these arguments were not very forcefully brought forward, which partly explains why in-house operations are not the dominant maintenance strategy. It seems that in-house maintenance is not always considered a core competence or seen as an important prerequisite for creating competitive advantage.

From a cost perspective, the three established mining companies thought it was, or could be, a small advantage to keep activities in-house. But the cost argument was overruled by the fact that availability was seen as a more important criterion and that the sourcing option showed better figures regarding availability, or at least was thought to do so. The main arguments for keeping some operations in-house were related to competence and to avoid suppliers to become too dominant. Especially, the large mining companies regarded their own competence as in many cases as equal to the supplier's. This fact, objectively, or at least their expressed opinion, subjectively, had its roots in their long-term experience in the mining business. Especially for the established companies with built up maintenance organizations, there were pressures to reach a certain level of in-house maintenance, at least to take care of basic maintenance, expressed by both management and unions. For the start-up companies it was more a question of how to avoid building up an internal maintenance organization and to keep fixed costs down.

As customers, the large miners have been reluctant to hand-over responsibilities to suppliers in turn-key projects and large life-cycle service contracts. However, there are exceptions. Outotec provides life-cycle services to one of the LKAB mills and to the floatation cell at Boliden's Aitek mine. Especially, the larger mining companies have also tried to avoid being too dependent upon specific suppliers, one solution to this problem was to keep operations in-house and another was to source from multiple suppliers. There was a clear awareness of the risks of lock-in effects from equipment suppliers, but there were no serious criticisms towards these suppliers for misusing their single source positions, what Williamson (1985) refers to as opportunistic behavior.

Another argument in favor of sourcing was its potential to reduce the internal organization complexity and increase internal productivity as employees focus on their core competencies. To build up specialized maintenance organizations for different kinds of equipment and other infra-structure, under and above ground, is a complicated undertaking. Furthermore, to have all this differentiated maintenance organized in an internal function could be very complex. The alternative, to let suppliers set up more specialized workshops was often considered as a better alternative.

The small mining companies, especially the two start-ups, were even more reliant upon suppliers. They also involved fewer suppliers and defined broader scopes for the maintenance assignments. The largest turn-key project was defined by Northland Resources when sourcing its process plant from Metso. The other start-up, Dannemora, was themselves involved in the development and construction of a similar processing plant, but selected ABB as supplier of maintenance for the entire plant. Also, Zinkgruvan, the third small mining company keeps down the in-house maintenance operations, especially maintenance that demands high competence is sourced from the equipment suppliers; as in the case of the powertrain of the scoop tram where maintenance is done by Caterpillar.

Supplier selection: equipment suppliers vs. third party suppliers

In two cases, there were especially strong bonds between the mining company and specific suppliers. Zinkgruvan was regarded as a test plant for Atlas Copco equipment and the same type of relationship existed between Boliden and ABB. Atlas Copco for instance has landed life-cycle service agreements with Zinkgruvan regarding their equipment used underground. Zinkgruvan, is aware of the potential risk of the lock-in effects, but the rewards in development are viewed as higher. What is seen as a risk, apart from the obvious risk for opportunistic behavior, is that the supplier all of a sudden starts to fall behind its major competitors. Therefore, all five case companies state the importance of balancing main competitors, which in the case of drilling rigs, for example, would lead up to a balance between Atlas Copco and Sandvik.

In some cases companies prefer to leave maintenance contracts for a second negotiation step with suppliers of the new equipment, despite all focus on selling and buying solutions with after sales services included. Maintenance in some new equipment sales is treated separate and contracts are negotiated at different times. Equipment suppliers are at advantage during the warranty period because customers feel compelled use original spare parts and work with original equipment maintenance teams to ensure that the conditions of warranty are upheld.

There are different factors behind this separation of new sales and after market activities – mentally, organizationally and tactically. Mentally, there are several decision makers that have a hard time to accept the advantages of bundling everything into the same negotiation. Organizationally, there are different people responsible for investing in new equipment and infra-structure and those who are sourcing maintenance. Also from a more tactical point of view there could be different opinions about the advantages of bundling versus unbundling of offerings with or without maintenance included. In addition, a fourth aspect is complexity; purchasing equipment and purchasing maintenance could be regarded as complex taken separately and even more complex when combined. From our case studies, we can deduce two types of situations when a third party supplier comes into play. One situation is when there are large volumes being purchased, for example buying drill steel or mill linings, then a third party actor could increase competition and keep prices down. Another situation is when the maintenance assignment covers different kinds of equipment and installations, delivered from different suppliers.

Contractual aspects

The service contracts most often have one fixed part and one variable. The variable part usually includes performance-based components that are linked to bonuses or penalty fees. Performance could either be related to target levels, and deviations from these levels, up or down, could be share between the parties in different ways. In other cases the variable part could be outcome-based, e.g. often in terms of production volumes. The problem with outcome-based measures is that underlying causes are not always easy to track. Therefore suppliers try to safeguard themselves with different clauses to compensate for events taking place that is outside the control of the supplier. The outcome or process guarantees, that normally comes together with the outcome-based agreement. This guarantee is never of the

caliber to insure the customer from severe losses if a worst case break-down occurs. So, in terms of a transfer of risk from customer to supplier, these guarantees are rather lame. Nonetheless, they could signal that the supplier feels confident and to pay penalties will at least sting.

The small mining companies, especially Dannemora and Zinkgruvan, try to avoid “rigid” outcome-based contracts. Instead they go for open-book agreements with performance measurements expressed in base-line figures. The advantages of these kinds of contracts are their ability to function in unknown territory. This seems to be particularly valid where the relationship between different kinds of input and the resulting performance (output) is hard to predict. This is a typical situation when starting up new operations. The large and established mining companies, both LKAB and Boliden, are reluctant to sign any open-books contracts. They seem to think, that open books despite its name is not really open books, but rather a type of cost-plus calculus that tend to become too expensive. Open books agreements lack in incentives for the suppliers to improve. Instead, these large customers opt for using their bargaining power to negotiate low prices. They also claim that in large and complex organizations, the monitoring of single open book contracts become too difficult. In these contracts, performance is usually measured either as the availability of the equipment, or as the production achieved (e.g. tons processed or meters drilled). The bonuses and penalties are normally relatively small and as one purchaser said, only resulted in small discrepancies from the target cost level. In some cases deviations from a cost base-line, on one or both sides, is split.

Despite contractual arrangements, focus in the cooperation between Swedish customers and Swedish and Finnish suppliers are more on cooperation and improvements than on spending time on interpretations of contracts. This is part of national and corporate cultures based on team-playing where hierarchy is largely absent, with everyone’s role in the group seen as important (cf. Hofstede et al., 2010) and also a consequence of long-term relationships between the mining companies and their major suppliers.

Summing up: Four maintenance packages

Based on our case studies four different types of maintenance “packages” could be identified. The packages are defined by two dimensions – one is the knowledge content and the other is the scope of the package.

Figure 1. The scope of maintenance

Knowledge content	Advanced	Advanced equipment/ installation specific maintenance <ul style="list-style-type: none"> - Mobile equipment - Electrical installations - Drainage pumps etc - <i>New sales suppliers at an advantage (lock-in)</i> 	Functional and system-integrating maintenance <ul style="list-style-type: none"> - Processing mills - Underground operations - <i>Often one new sales supplier but third party and in-house also possible</i>
	Simple	Standard maintenance on specific equipment and installations <ul style="list-style-type: none"> - Mobile equipment - Underground infra-structure - <i>In-house among the large customers</i> 	Cost and scale efficient maintenance <ul style="list-style-type: none"> - Underground repair shops - <i>In-house among the large customers; new mines avoid starting up maintenance organisations</i>
		Focused	Broad
Scope of maintenance bundling			

The four packages are:

Standard maintenance on specific equipment and installations, for example mobile equipment and underground infrastructure. This package is often handled in-house among large and established customers, but also among small customers (also start-ups) who want to have at least some maintenance competence in-house. In-house maintenance on specific equipment could often be a kind of mixed strategy, where more advanced maintenance on the same equipment is handled by the supplier.

Cost and scale efficient maintenance, for example underground repair shops covering a broader scope of maintenance. This package is also often handled in-house among large and established customers and start-up, on the contrary, go directly to the sourcing alternative.

Advanced equipment/installation specific maintenance, for example mobile equipment, electrical installations and drainage pumps. This package is often handled by the supplier, which has a sort of first mover advantage.

Functional and system-integrating maintenance, for example processing mills or underground operations. This package is often outsourced to one of the main suppliers (generalizing from our five cases), but the in-house option could also be viable and also a third –party supplier option.

THEORETICAL CONCLUSIONS

This study has investigated different options of operating maintenance in the Swedish mining sector, such as in-house operations vs. sourcing of maintenance decisions, supplier selection criteria, and key contractual aspects. Although the mining industry maintenance can be understood in terms of the three complimentary theories, overall, the analysis gives a lot of

support to industrial network theory (INT); INT has the best explanatory ability among the three theoretical streams discussed, transaction cost analysis (TCA) and the resource-based view (RBV).

Industrial network theory (INT) offers a helpful understanding of the dynamics at play in the Swedish mining industry. INT theory helps illuminate why the mining industry in Sweden operates as a networks of relationships. The theory clarifies that these relationships (usually long-term) are typically based on sharing activities and resources and mutual trust. Trust in particular has been found to be the main element of relational social capital as it strengthens the relationship between the individual and his contact ties (Reiche, 2012) and also facilitates the sharing of strategic and tacit knowledge. The perspective of INT helps to recognize how new business transaction convert to long-run and stable relationships. It demonstrates that there is a network of relationships employed. Although risk for supplier opportunism is always present; the long-term orientation and network structure works against opportunistic behavior; if firms fail in one transaction they could destroy entire relationships.

The resource-based view of the firm (RBV), more particularly the extended resource based view (ERBV) cannot be overlooked and does have specific relevance for the mining industry maintenance dynamics. Whilst, the RBV explains that the larger firms put some importance on maintaining a degree of service in-house to upkeep form capabilities and pacify a wider range of stakeholder (management and unions for example); the ERBV helps elucidate why the firms draw on a wider range of external resources, through various kinds of relationships. In line with the arguments of ERBV, it is senior management and unions who argue that it is important to keep some core-competence in-house. It is evident then that the larger firms do see maintenance capabilities as part of the firm's core competence that should be kept in-house. However, perhaps the smaller firms do not perceive maintenance as a vital strategic component. Transaction cost analysis (TCA) also supports that the larger firms will have some in-house maintenance in order to pool resources and take advantage of economies of scale.

The long-term orientation and focus on relationship and on longer-term development aspects in the evaluation and selection of suppliers, rather than on short-term contract resonates with the business practices and views of managers in the mining and supplier firms. This view also concurs with recent issues and concerns expressed by business leaders and academics about an excessive and endemic short-term orientation to business (Aspen Institute, 2009).

Nonetheless, INT gives very little guidance in normative matters and, hence, is weak when it comes to calculus. Given that national and corporate cultures influence firm behavior and managerial thinking, and thereby sourcing decisions, future research should examine other, more dynamic industries and national contexts.

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