1. Introduction

The automotive industry has been subject to many changes in its industry structure and sourcing operations in recent decades. The adoption of new production methods by Western car manufacturers and the openness of global markets, together with an increasing sophistication of individual components and systems have resulted in new relationships between a reducing number of car manufacturers and a reducing number of suppliers capable of performing under changing conditions (Sutherland, 2005; Sturgeon et al., 2009; Lampel and Giachetti, 2013).

The importance of product innovation for successful firm performance has been well established in many industrial sectors (Hult et al., 2004; Gunday et al., 2011) and the automotive sector is no exception. Automotive suppliers are a critical source of innovation for major vehicle manufacturers (Gerken and Moehrle, 2012). As innovation cycles in the automotive sector shortened in the 1990s, the specialisation of suppliers on specific product categories has strengthened the performance of car production networks as cars became increasingly complex products (Dyer, 1996). These trends have continued (Ili et al., 2010; Xie and Miyazaki, 2014). They pose challenges to the sourcing and procurement departments of automotive companies in seeking to keep up with innovation trends in the industry, in understanding their impact on future product sourcing categories, and on future product sourcing strategies.

Future procurement and sourcing strategies need to be considered some time in advance to allow sufficient time to identify potential suppliers, to judge and evaluate their capabilities, and to engage in appropriate negotiations and agree contractual arrangements with selected suppliers. Sourcing and procurement departments use a range of data sources, knowledge and information to support sourcing strategies and decisions (Cousins et al., 2008, Lysons and

Farrington, 2016). One potential source of information to assess the level of innovation in a product category is the extraction of knowledge from patent data through a patent analysis (McGahan and Silverman, 2001; Gupta et al., 2007). Patent analysis has been widely used in technology and innovation research (Basberg, 1987; Abbas et al., 2014). Fabry et al. (2006) demonstrate the usefulness of patent analysis to identify partners for acquisition or collaboration at the same supply chain level (i.e. horizontal collaboration). However, its use to support future procurement and sourcing decisions has not been discussed in the literature to date. Patent analysis has not yet entered the procurement profession as a method to provide information to support strategic sourcing portfolios or as a managerial tool for supplier selection decisions.

In this paper we argue that innovation is a key part of procurement decisions, particularly in sectors such as the automotive sector that compete on technology and functionality of products. We examine how patent data may support procurement and sourcing strategies across a sourcing portfolio where product innovation is a factor in supplier evaluation. The analysis of patents provides indicative information on innovation in a sourcing category and therefore can aid procurement and sourcing decisions. Patent analysis is not without technical difficulties but is capable of providing rich information that can inform procurement decisions, particularly when judgement can be exercised by knowledgeable and experienced procurement executives. We are not aware of any other study that has examined the potential for innovative procurement and souring decisions in the automotive sector using a patent analysis.

The paper is organised as follows. We first discuss relevant literature on sourcing portfolios, emphasising the importance of product innovation particularly in the context of the automotive sector. We discuss the potential of patent analysis to provide greater

understanding of innovation in the context of sourcing decisions. The approach taken for the study is then explained. A case study is conducted with a leading European premium car manufacturer and a patent analysis is carried out for two important supply categories for the company – car body technologies and car seats – for the period 2004 to 2014. The use of patent analysis to provide insights on innovation to support the case company's sourcing processes is then discussed. Broader issues on the potential of patent analysis to inform and support procurement and sourcing processes are discussed in the concluding section.

2. Background and literature

We first consider sourcing strategies discussed in the purchasing, procurement and supply chain literatures. We then discuss patent analysis as an indicator of innovation and introduce the case company.

Sourcing portfolios

Positioning suppliers and sourced products into portfolios is a common approach in supply management in theory and practice. Arguably, the most widespread approach is based on Kraljic's (1983) work that categorises sourced items against the dimensions of complexity of the supply market and the importance of the item being sourced. Depending on the positioning in the portfolio along these two dimensions, different sourcing strategies and tactics are recommended. The portfolio is structured into quadrants - strategic, leverage, bottleneck, and non-leverage – and makes strategic recommendations for supply managers for each quadrant (Cousins et al., 2008).

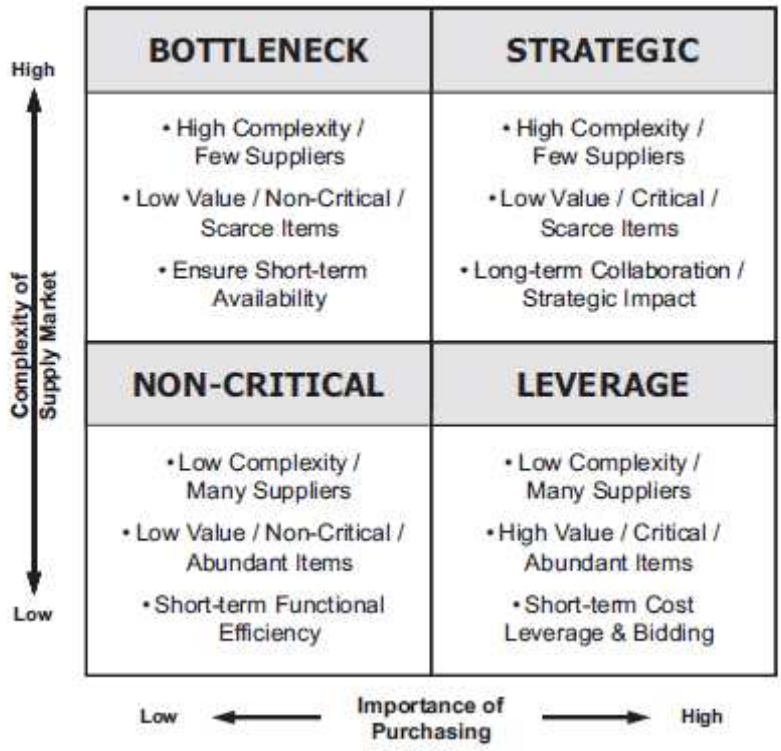

Figure 1: Kraljic purchasing portfolio (from Cox, 2015)

Albeit widely used, the portfolio approach is not without criticism (e.g. Cox, 2005; Hesping and Schiele, 2016). In particular, the focus on the current situation in the portfolio tends to be retrospective and thus side-lines opportunities for developing the supply market in a way that improves power relationships for the buyer (Cox, 2015). Innovation potential or capabilities have not been strongly addressed in Kraljic-type portfolio segmentation strategies. Looking at the portfolio in Figure 1, our research is focussed on supply options that are typically positioned in the bottleneck or strategic quadrant as the suppliers are selected for their innovation capabilities. The power relationship may therefore be tilted towards the supplier and requires the focal firm in our research to consider alternative ways to analyse and shift power in the sourcing relationship.

Sourcing strategies are a key component of an organisation's decisions that ultimately determine its supply chain design or architecture. The sourcing strategy feeds into investment

decisions and is derived from influencers such as the overall the nature of the supply market, the business model, and customers (Melnyk et al., 2014). The sourcing strategy therefore should be based not only on an organisation's overall positioning but should help to translate its business model and strategies into investment decisions. Kotula et al. (2015) however see a large potential for misalignment between business strategy and sourcing strategy. The potential for misalignment often lies in procurement personnel focusing just on the purchase price, which is the easiest supplier criterion to measure in the supplier selection process. Criteria such as innovation potential or innovation capabilities are arguably more important to the business strategy and to the long-term health of an organisation (Gunday et al., 2011). However, it is much harder to measure and include innovation in the supplier selection process. Choi and Krause (2006) highlighted the importance of supplier innovation capability in general and in the automotive sector in particular. This view is further supported by Prajago (2016) who emphasises the importance of aligning an organisation's innovation strategy with its overall strategy and its business environment. In a sector in which innovation is a key capability, the ability of the procurement function to identify and select innovative suppliers becomes a competitive advantage.

The strategic selection of a supplier is a multi-dimensional decision that needs to consider the ability to create value between the purchaser and the supplier (Nudurupati et al., 2015). Multiple criteria, stemming from multiple internal and external stakeholders, are typically traded off against each other in the supplier selection process by evaluating the selection criteria on a performance scale (Liu and Hai, 2005; Ho et al., 2015). Whilst Liu and Hai (2005) consider only operationally measurable criteria, the strategic selection of suppliers has to consider strategic imperatives such as the potential for product innovation, the perspective of company stakeholders and the overall business strategy (Oke et al., 2013; Ho et al., 2015). Strategic relationships with suppliers not only give access to the innovation potential of the

supplier for new products but also allow the creation of an innovative climate between supplier and purchaser, thus improving the innovation potential at the purchaser also (Lii and Kuo, 2016).

Relationships with suppliers can be very diverse as Kim et al. (2011) show in a social network analysis of material flow and contractual relationships in three automotive supply networks. Suppliers in the second or third tier may actually be important for the successful operation of the supply network. In the investigated supply networks, more often suppliers than car manufacturers are central to the network, and upstream suppliers can have direct links with both tier 1 suppliers and the focal firm at the same time. Suppliers therefore do not need to remain in their initial position in the supply network – they can shift tiers and roles within the network. Whilst Kim et al.'s (2011) work does not consider the strength of the relationships in the supply network, Autry and Griffis (2008) look into the structural and relational capital in supply networks. The cultivation not only of strong relationships with suppliers but also of consciously losing relationships in the supply network at the same time is noted. The strength or weakness of ties within the network can cause the network to support efficiency or innovation or a mix of both.

Whilst buying organisations find a range of supply chains with diverse characteristics across their procurement portfolio, innovative product portfolios require a larger number of supply chains than functional product portfolios. The larger number of supply chains in an innovative product portfolio is caused by individual suppliers arranging their supply chains along the particular functional needs of their niche capabilities and not along the efficiency needs of their customers (Langenberg et al., 2012). With such an increase in the supply chain diversity and complexity in innovative categories, established procurement approaches with a broad view across a procurement portfolio are not as suitable for innovative categories.

Whilst the Kraljic matrix offers some basic guidance for the categorisation of suppliers, the research literature shows that a wider range of considerations come into play in developing a strong supply base to support innovation. Although the use of suppliers as a source of innovation is highlighted in the literature and is particularly important for the automotive sector, the literature is relatively silent in discussing how innovation should be considered in supplier selection decisions.

Patent analysis

With the car industry facing shortening of product lifecycles, the speed of innovation is increasing (Von Corswant and Frederiksson, 2002), leading to an even stronger pressure on premium car manufacturers to innovate in order to maintain their competitive advantage (Gerken and Moehrle, 2012). The automotive industry, in which this paper's study is based, shows the third highest patenting filing activity from twelve major technology sectors after Telecommunications, and Computers and Peripherals (Thomson Reuters, 2015). Innovation and patent filing activity may stem from many sources including scientific discoveries and technological advancements, identified product functionality needs or gaps in competitive marketplaces, but also may be stimulated by regulatory pressures in areas such as emissions control, fuel efficiency and safety (Oltra and Saint Jean, 2009; Pilkington et al., 2002). In order to ensure their vehicle ranges remain at the forefront of technological advances, car manufacturers face the options of either developing innovation in a particular category in-house or of sourcing it from a supplier that has, or can demonstrate, innovation capabilities. The increasing proportion of outsourcing means that much of this innovation will enter the supply chain from outside the car manufacturer's own organisational boundaries (Dyer, 1996).

Patent analysis is a commonly used approach in technology management to strategically monitor developments in an industry sector, technology lifecycle or an economy (Basberg, 1987; Haupt et al., 2007). Under the umbrella of analysing patent filings a multitude of approaches and techniques exist on how patents can be analysed and the results interpreted (Abbas et al., 2014). Although patents are an indicator of innovation or an output indicator of innovative work (Freeman and Soete, 1997), Basberg (1987) highlights that organisations can use various ways to protect their intellectual property and that patenting activity mainly occurs at a stage in the innovation process close but prior to commercialisation.

Haupt et al. (2007) investigated the patent filing activity across the life cycle stages of a technology and concluded that there were variations between the stages. However, their study focussed on one technology specifically –pacemakers- and they caution that industry innovation characteristics such as patents as a competition and bargaining tool between competing businesses, mean that patent analyses must be seen in their contextual settings.

An example of the impact of the patent data source is given by Abraham and Moitra (2001) from a patent analysis conducted in the Indian telecommunication sector. Their study showed that only some of the global telecommunication technology companies filed patents with the Indian Patent System whereas others did not, but in contrast they had higher filings in the US patent system. A further discussion point in patent analysis is whether or not sufficient meaning can be concluded from the number of patent filings and how the quality of patents can be quantitatively evaluated (Ernst, 2003). It is therefore important to note that the results from a patent analysis do not provide an absolute understanding of innovation in isolation but must be interpreted and triangulated along the entire analysis process in conjunction with other information sources. Notwithstanding, Gerken and Moehrle (2012) argue that patent

analysis is able to identify inventions of high novelty and demonstrate this with a case study in the automotive sector.

Abbas (et al. 2014) noted ten different uses of patent analysis by organisations including technological road mapping, strategic technology planning, and the identification of technology competitors. The use of patent analysis to help organisations in future sourcing and partnering decisions is not highlighted. Here we examine the potential of patent analysis to inform and support sourcing decisions here in the context of the automotive industry.

Case company

The case company for this study is a European premium car manufacturer which, despite its significant size and production volume, is relatively small in comparison to its main competitors, other European premium car manufacturers. The company has less financial resources available to invest in technological innovations in-house than its competitors. As a consequence it sees a key challenge in identifying which parts of its cars should be developed in-house and which should be sourced from suppliers. As a result of its relatively low in-house research and development activities it believes that it is more reliant than its competitors on acquiring innovation from its suppliers. A key challenge for its procurement activities is therefore the identification of innovative suppliers who can add competitive advantage to its future ranges of vehicles. In its particular supply market position the case company also perceives itself as having less procurement power than some of its main competitors and therefore needs to be more active in identifying innovative suppliers and engaging with them in future innovative product development.

In contrast to the case-based evidence in Kotula et al.'s (2015) work about the misalignment between business strategy and sourcing decisions, the senior procurement management in our

case company is very conscious that their procurement activities need to support the development of a premium product and it is clear to them that innovation capability should be an essential part of sourcing and procurement decision making. Identifying, building relationships and accessing the most innovative suppliers in product categories where competitive advantage can be gained is a key feature in supporting this procurement strategy. These procurement activities start before the actual supplier selection process and can look at products and product categories that may not yet even be included in any sourcing portfolio approach such as the Kraljic matrix.

To date the innovative capabilities of potential suppliers have been based on the procurement department managers' individual perceptions and judgements. The question posed was whether a systematic analysis of patents could aid and/or inform future sourcing and procurement decision making with respect to the innovation potential of suppliers. A patent analysis was therefore conducted in close interaction with the car manufacturer to seek to develop a more objective indicator for its potential future suppliers' ability to innovate. After conducting a patent analysis study, the results and findings were discussed with senior procurement management for validity confirmation and for interpretation in the setting of the car manufacturer's future sourcing and procurement strategy.

3. Data collection and analysis

Our research uses publicly available patent data but interprets the results from its analysis in the setting of a single case company. A case study approach is particularly suitable for exploratory research that requires a high level of contextualisation (Pagell and Wu, 2009; Yin, 2013). The supplier selection decisions and approaches in the focal firm of our research cannot be understood without the contextualisation of the organisation's strategic positioning

in its industry, supply market conditions, and the resulting supply activities. A case study approach is therefore an appropriate research strategy.

A case study research strategy can be used under various methodological paradigms and approaches and therefore a diverse range of applications of case study research can be found across the objectivism-subjectivism research continuum (Burrell and Morgan, 1979; Kuhn, 1996) using quantitative and qualitative data. A key differentiator in the application of case study research is the decision whether one or multiple cases are included in the investigation. Multiple cases usually lead to a less deep investigation but with potentially more generalisable outcomes whereas individual case investigations allow a stronger contextualisation of the investigation and its findings (Stake, 1994). Single case studies are particularly valuable when the case organisation is an important source of information in a new study context and can provide detailed information and critique on the results. In this paper a single case company based on a leading premium automotive producer is investigated allowing the understanding and consideration of the company's underlying strategic sourcing and procurement context, which is essential to understand the study's relevance and managerial value for the case company and for the interpretation of the study's findings. To create a contrast for comparison we use two supply categories with substantially different characteristics, which we elaborate on later.

The advantage of relevance in a single case bears the risk of a potential loss of rigour in the research according to Kieser and Leiner (2009) who see the rigour-relevance gap as unbridgeable and researchers having to choose between either or. However, Hodgkinson and Rousseau (2009) argue that it is already being bridged by much academically rigorous research conducted in collaboration between academics and practitioners. Starkey et al. (2009) argue further that management research needs interaction and shared understanding of

concepts and language between objects and researchers. Hence management research requires high levels of contextualisation to enable the interaction between researcher and manager. Rigour and relevance are therefore intertwined in the research process as one cannot exist without the other. They conclude that in modern management research rigour needs to *"be reconceptualized as the appropriate combination of different types of interaction between the researcher and his/her object of study"* (p. 555). In our study rigour is addressed by using objective patent data that is analysed in a reproducible way along a frame derived from interaction with the case company to ensure strong relevance of the analysis to the case. The findings from the analysis are also interpreted together with senior purchasing and procurement management personnel in the case company, thus further strengthening relevance and validity of the case study research findings (Ellram, 1996; Easterby-Smith et al., 2002).

Based on discussions with the focal firm we selected two supply categories for the study based on the expected heterogeneity between them: car bodies and car seats. Since the beginning of the automobile car bodies have been a core activity of car manufacturing. Although car body design, the materials used, and the manufacturing processes have changed significantly, they remain a critical part of vehicle design and construction (Livesey and Robinson, 2013). Car body manufacturing has therefore remained in-house by and large across the industry and also in the case company. In addition, the nature of the product results in a relatively straightforward supply chain and manufacturing process with only few tiers. In contrast, car seats have developed from being a commodity item to a technology item that interacts strongly with the car and has a strong bearing on comfort and safety. As a consequence, car seats have become a specialised component of the car made from a large number of items that are combined together for a modularised manufacturing process. The increase in complexity and specialist separation of car seat production has led to a small

number of first tier suppliers from which car manufacturers source complete seats (Lara Rivero, 2006).

The expected heterogeneity between these supply categories allows the identification of differences and commonalities and the extraction of their causal embeddedness in the context studied (see Wu and Pagell, 2011; Trautrims et al., 2012). The research uses publicly available patent filings data and analyses the data in a quantitative way. Notwithstanding the interpretation of the analysis data in the situational context of the focal firm, the research is ontologically and epistemologically situated in a positivist frame (Cunliffe, 2011).

Patent data

We have analysed all patents filed with the United States Patent and Trademark Office (USPTO)[1] under the two categories for the time period 2004 to 2014. Although patents can be submitted to numerous national bodies across the world, the USPTO can be considered as the primary patent filing body for organisations seeking global protection. We follow a structure proposed by Abbas et al. (2014) which is illustrated in Figure 2.

Abbas et al. (2014) explain that a patent analysis follows three steps:

- pre-processing, the extraction of patent data from a database and the formatting of data
- processing, the analysis of the prepared data for patterns and structures
- post-processing, the interpretation of the patent data in the research context for the research purpose.

[1] https://www.uspto.gov/

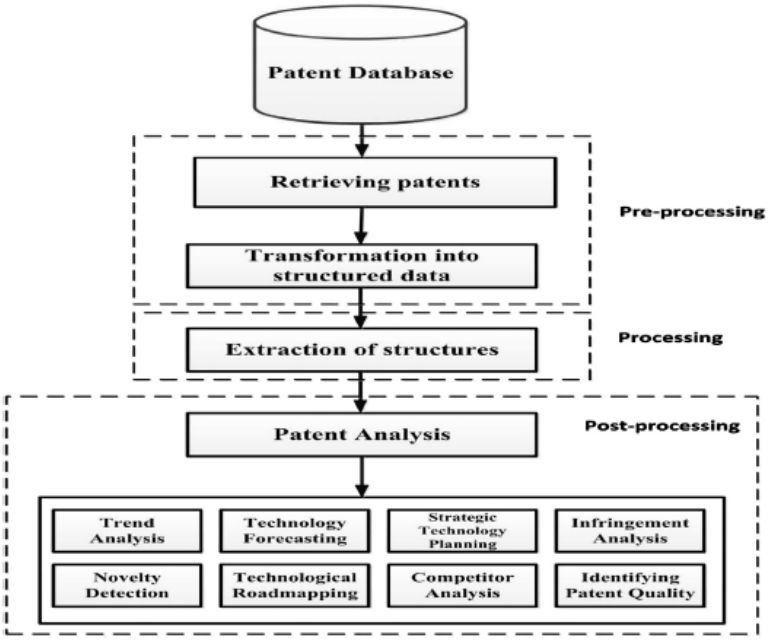

Figure 2: Generic patent analysis workflow (from Abbas et al., 2014)

Pre-processing

As noted above, the study focused on two supply categories - car bodies and car seats – that would be expected to display different characteristics in terms of their innovation landscapes. The relevant patent filing classes in the USPTO are class 296, 'Land Vehicles: Bodies and Tops', and class 297, 'Seats and Chairs'. Each class's scope spans wider than the sourcing category of the focal firm and even beyond the automotive sector. As patent classes are arranged along product categories they are relatively well aligned with sourcing categories typically used by purchasers. However, the fit is not good enough to simply use the data as it. Data cleansing is required to ensure the relevance of patents for the focal firm's sourcing categories. In the data extraction phase we ignored patent applications and included only granted patents in our dataset. The data were then transferred into a spreadsheet arranged by patent owner and the year the patent was granted.

Processing

From the pre-processed dataset we then excluded all patent owners that filed less than ten patents in the patent class over the investigated period of ten years in order to exclude inactive companies and to exclude individual patent holders with little ability to commercialise a patent to a requisite scale for an automotive company. Patents granted to companies that were taken over or merged into another company were added to the patents of the acquiring company. Each remaining patent was then individually checked for its relevance to the sourcing category. For example, for the bodies and tops class this meant including only patents for bodies and excluding tops. In the seats and chairs class we ignored patents for children seats, aerospace seats and furniture manufacturers as these were all technologies too significantly different to be potentially relevant as car seat suppliers.

We then categorised the patent owners with respect to their position in the automotive supply chain, i.e. as car manufacturers or as suppliers. Patent owners from other industries are not excluded as they may provide opportunities for the development of new supply options, which we discuss later. We present an analysis of variance for a comparison between the car manufacturers and the suppliers in patent filings, as this comparison provides insight as to where in the supply chain innovation is located. Additionally, we take a wider perspective on supply alternatives and other patent holders in the discussion of the findings.

Post-processing

The results from the pre-processing and processing steps are then discussed in the post-processing step in the light of the car manufacturer's management of, and innovation strategy for, its future supply portfolio.

4. Findings

In this section we first present the results from the processing step of the patent data analysis for body technology and seats and then discuss them in the light of the case company's purchasing and procurement context. Table 1 presents the number of relevant patent filings by car manufacturers (OEMs) and suppliers in the body technology category.

Table 1: Body technology summary 2004-2014

Groups	Count	Number of years	Sum	Average filings per year
Car manufacturers	12	11	1193	108.45
Suppliers	7	11	209	19

Over the time period of eleven years 2004-2014 included in Table 1, twelve car manufacturers filed 1193 patents in the body technology class, whereas the seven tier 1 suppliers filed only 209 patents. For both groups the number of patent filings has increased strongly in recent years, leading to a high variance being observed across the patent granting years. This is shown in Figure 3, which compares the patent filings for car manufacturers and suppliers for car body technologies. As patent filings increased in recent years the effect is more apparent to observe by limiting the portrayed data to this more recent time period. Figure 3 hence shows the filings for the years 2008 to 2014.

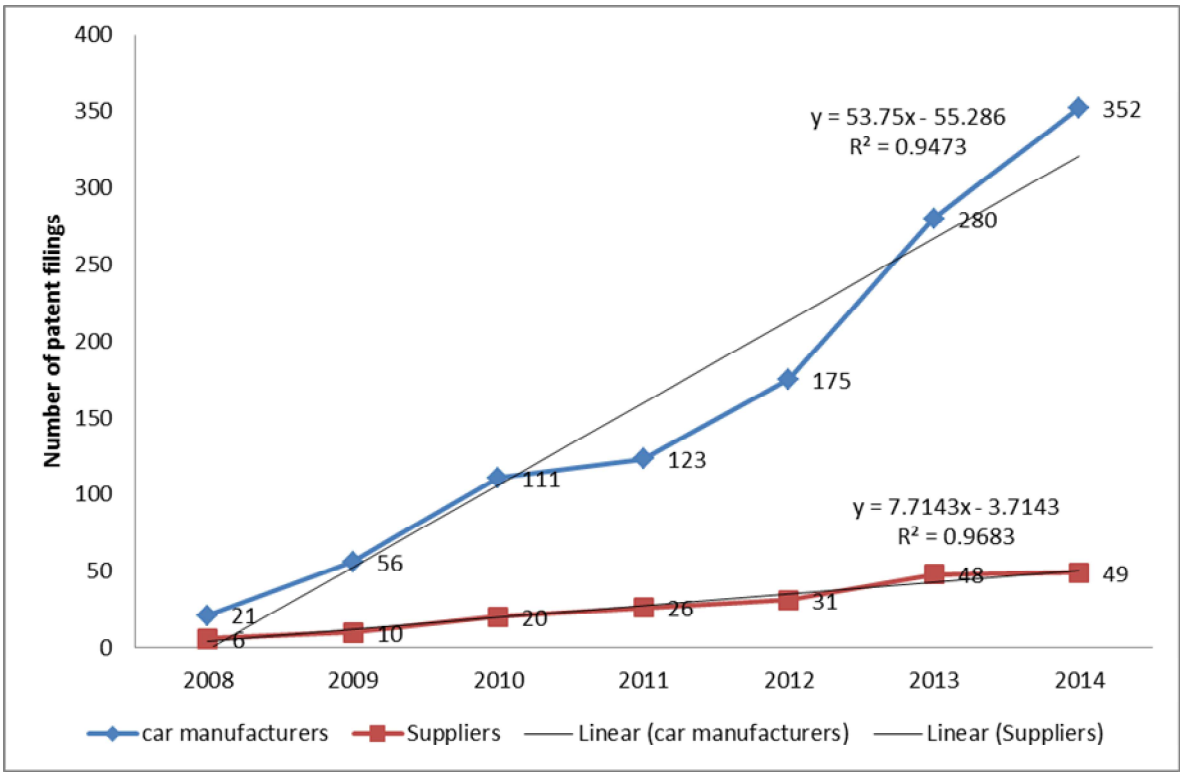

Figure 3: Patent filings for body technology 2008-2014

The difference in the number of patent filings between car manufacturers and suppliers widens from 2008 onwards as shown in Figure 3. With a much stronger growth in patent filings from the car manufacturers, innovation in this area has shifted towards the car manufacturers themselves, indicating the importance of body technology to the car manufacturers. We can see from Table 2 that the variances between car manufacturers and suppliers are not equal and that the general patent filing activity of suppliers is much lower than that of car manufacturers over the period 2004 to 2014. The most active patent filing car manufacturer had close to six times the number of patents granted than the most active supplier, as shown in Table 3.

Table 2: F test two samples for variances (body technology)

	Car manufacturers	Suppliers
Mean	99.41666667	29.85714286
Variance	6170.265152	191.8095238
Observations	12	7
Df	11	6
F	32.16871107	
P(F<=f) one-tail	0.000195748	
F Critical one-tail*	4.027442042	

**at 5% level of significance*

Table 3: Number of body technology patent filings of the top three manufacturers and suppliers

	Car manufacturers	Suppliers
1	302	54
2	145	37
3	140	30

We then conducted the same analysis for the seat and chairs category. For the eleven years observations of patent filings from 2004 to 2014 as portrayed in Table 4, it is noticeable that, in contrast to body technologies, the suppliers have filed a much higher number of patents in this category than car manufacturers.

Table 4: Seats and chairs summary 2004-2014

Groups	Count	Number of years	Sum	Average filings per year
Car manufacturers	10	11	395	35.9091
Suppliers	21	11	1563	142.0909

Looking at the industry trend in the same way as for body technology, by limiting the focus to patent filings from the more recent time period 2008 to 2014, one can see that patent filings from suppliers for the seat category are increasing much faster than from the car manufacturers. In contrast to body technology, patent filing in this sourcing category is shifting increasingly to the suppliers and away from the car manufacturers in this period.

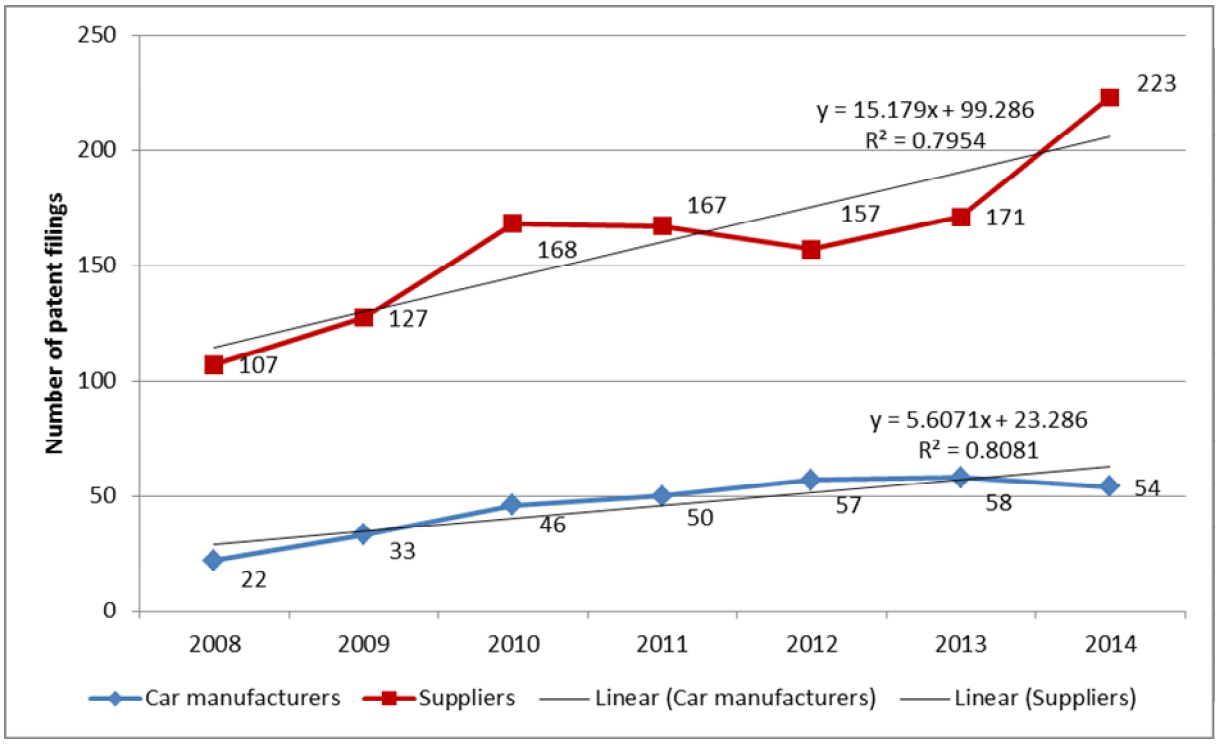

Figure 4: Patent filings for seats and chairs 2008-2014

From Table 5 below we can see that although the variances between car manufacturers and suppliers are not shown to be statistically unequal at the 5% level of significance, the general patent filing activity of suppliers is higher than that of car manufacturers over the period 2004 to 2014. When comparing the highest patent filing suppliers and car manufacturers for car seats in Table 6, one can see that the most active patent filing supplier filed more than three times the number of patents than the most active car manufacturer.

Table 5: F test two samples for variances (seats and chairs)

	Car manufacturers	Suppliers
Mean	39.5	74.42857
Variance	760.0556	7978.257
Observations	10	21
Df	9	20
F	0.095266	
P(F<=f) one-tail	0.000518	
F Critical one-tail*	0.340547	

**at 5% level of significance*

Table 6: Number of patent filings by the top three (seats and chairs)

	Car manufacturers	Suppliers
1	94	301
2	62	261
3	57	256

A particular distinction between the body technology class and the seats and chairs class is the patenting activity of suppliers further upstream than tier 1, as shown in Figure 5. These component suppliers deliver into the tier 1 suppliers, who eventually assemble the seat and deliver it to the car manufacturers. Although the component suppliers are not as active in patent filings as the tier 1 suppliers, their activity in combination with the car manufacturers' patent filings activity may provide opportunities for supplier development to side step tier 1 suppliers.

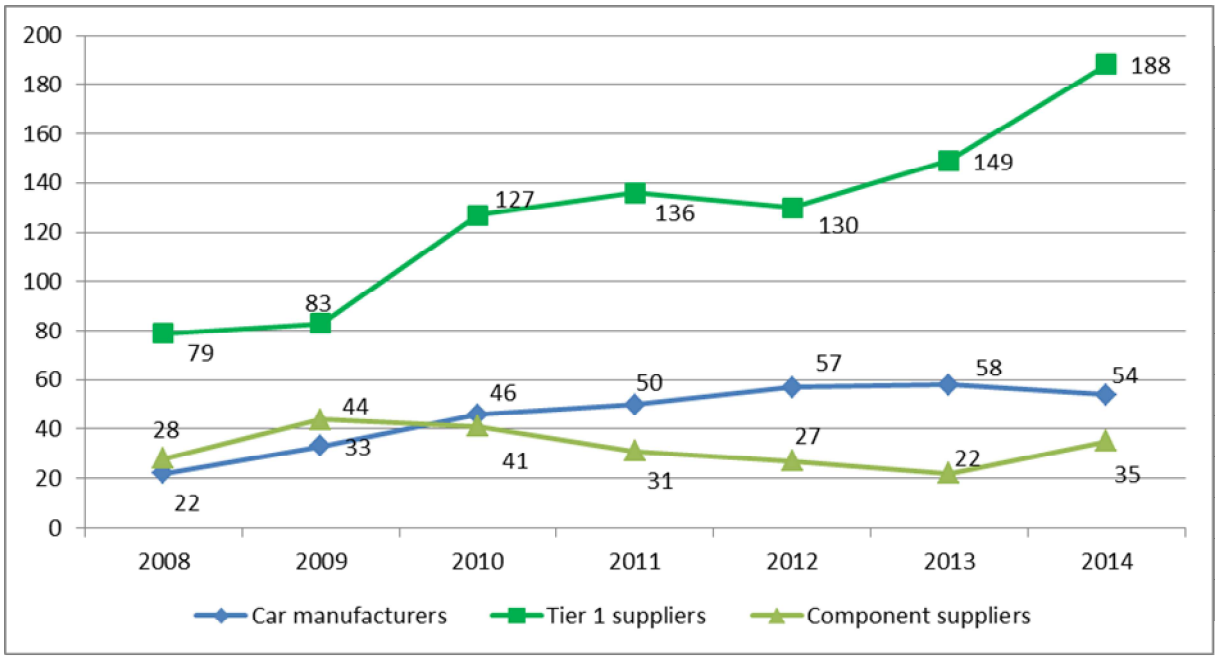

Figure 5: Comparison of patent filings in seats and chairs under separation of supply chain stages

The analysis of results above show that patent filing in the two supply categories is occurring at different stages of the supply chain. In the seats and chairs category patent filings lie strongly with the tier 1 suppliers, whereas patent filing in body technology is heavily tilted towards the car manufacturers. In both categories the trends and rankings for patent filing show an increasing separation between car manufacturers and suppliers with faster growth in recent years for the already dominant supply chain tier for each category. The results show an increasing concentration of innovation leadership in each of these categories. In the following section we discuss how the findings of the patent analysis impact the company's sourcing portfolio and decision considerations within it.

Using patent analysis to support the case company's sourcing processes

The results from the patent analysis can be used by the case company for its procurement activities at several levels: at a supplier portfolio level information gained from patent

analysis can be used to identify innovation-active product categories and to make strategic investment decisions into a category in the portfolio; at a product category level information gained from patent analysis can be used in the assessment of the innovativeness of individual potential suppliers in the supplier selection; and at a supply chain level information gained from patent analysis can be used to locate innovativeness to a tier in the supply chain.

In our study, patent analysis was applied to two contrasting product categories but it can be rolled out across the sourcing portfolio to identify sourcing categories that are dominated by car manufacturers using the level of patent filing activity as an indicator for innovation. The patent analysis is not the only consideration when the case company makes its sourcing decision but it is a key information source for analysing and judging the innovativeness of potential future suppliers in a supply category. In the discussions of the patent analysis results the case company's senior procurement personnel contextualised the insights gained from patent analysis with considerations of capital availability for investment, the supply market structure for the sourcing category, the attractiveness for suppliers to invest in the category, and the approach taken by competitors. From discussions of the results between the case company's procurement management and the researchers, managerial decision making considerations were extracted. A structured view on the managerial decision making considerations is captured in the decision process illustrated in Figure 6 below.

The categories in which patent filing is heavily dominated by car manufacturers, such as body technology, may be considered core to the car manufacturing industry and one may generally assume that the case company's competitors would be unwilling to share their innovation with the case company. The case company's first decision step therefore needs to be to consider whether and how much it wants to invest in the research and development of this sourcing category in-house and investigate what external supply alternatives exist that may offer

innovative capabilities. In categories where car manufacturers dominate innovation, the external suppliers find it harder to compete on innovation and they may therefore focus on investing into more attractive categories. For our case company it can make sense to emulate its competitors in building up its own operations in such a category or product instead of partnering with a supplier as its demand volume may be too small for the supplier to invest sufficiently into the category or product. Collaborating with a supplier in such a situation may also lead to dependency on the supplier, as there may not be sufficient demand volume from other car manufacturers to keep the supply market competitive. Partnering with a supplier in such a category or product would therefore require high levels of trust and a shared strategy for development and investment into the category or product. The patent analysis can be used in such situations to establish how concentrated the supply market is with regards to innovation and to understand the level of risk related to supplier dependency.

In categories where patent filing is dominated by suppliers, such as the seats category, the patent analysis can be used to identify which suppliers are the most active in patent filing and can hence be seen as having higher levels of innovation capability. Social network analysis of automotive supply networks by Kim et al. (2011) shows that tiers in the supply chain can be sidestepped and that suppliers in remote tiers can be accessed directly by car manufacturers. Using a patent analysis as a base, key patents can be identified and linked with suppliers and tiers. The use of patent analysis in sourcing can therefore contribute to overcoming a key criticism made by Cox (2015) of the Kraljic matrix by developing supply options based on innovation capability and by shifting old and new suppliers into other quadrants dynamically over time rather than maintaining a static frozen picture of the supply market.

Our case company used the results from the patent analysis to reflect on the suppliers they selected and to reflect on whether their initial perception of their innovation activity could be verified. When looking in more detail into the supply market the patent analysis also

identified the patent filing activity of upstream suppliers. In the situation of dependency on tier 1 suppliers, the case company can also consider to source components directly from the upstream suppliers and, for example, use a contract manufacturer for the seat assembly as a supply alternative.

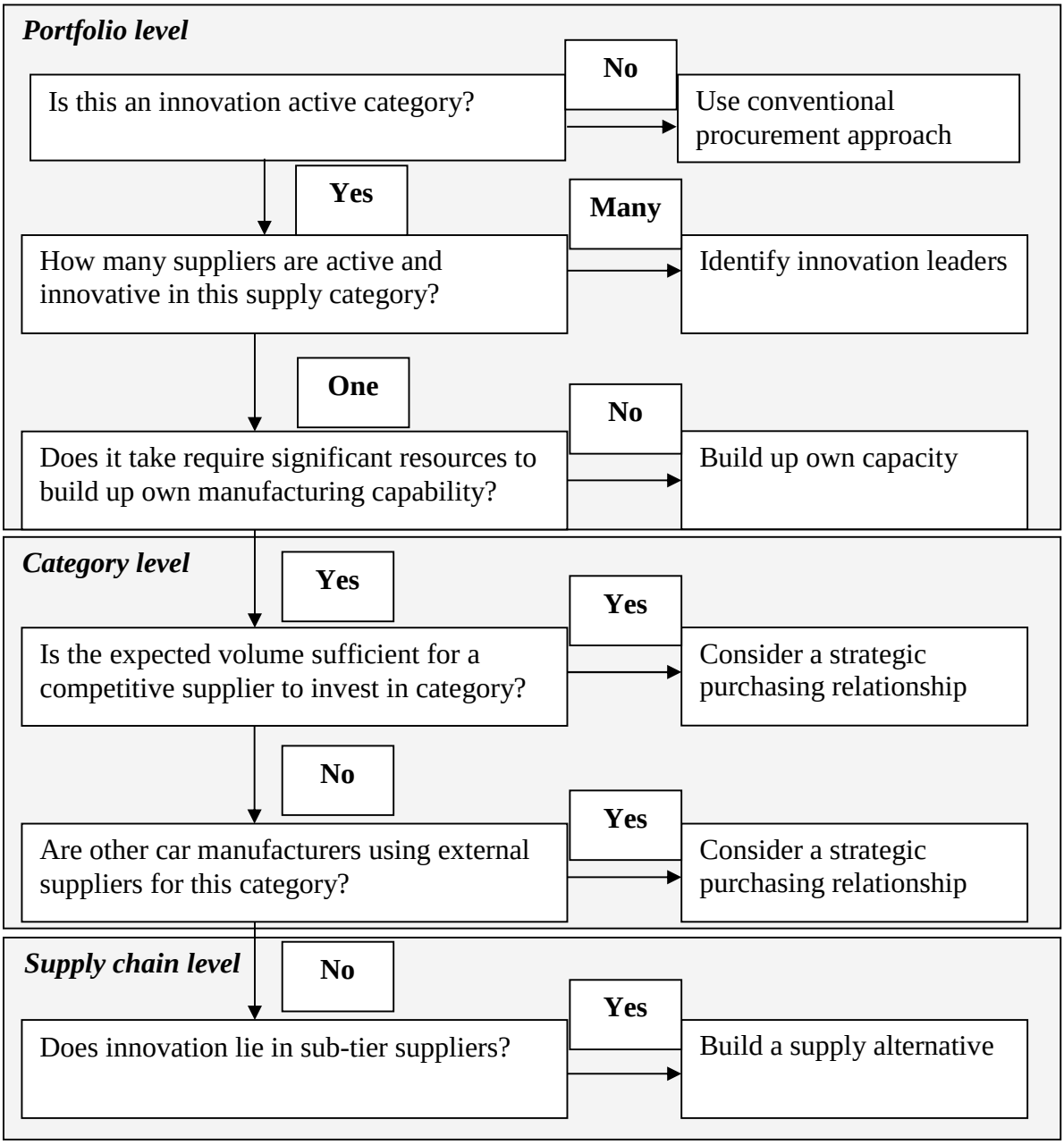

Figure 6: Decision Process for Supplier Innovation Procurement Decisions

5. Conclusions and managerial implications

Traditional supplier selection processes using approaches such as the Kraljic matrix tend to be retrospective, and may be static and myopic. Additionally, they do not explicitly consider innovation potential or capabilities, which is a critical aspect in strategic purchasing decisions in sectors such as the auto industry. Contemporary purchasing, particularly for premium products, needs to take a stronger prospective view, examining the potential for new innovative suppliers that have the potential to enhance a car company's products. The paper has presented the use of patent analysis as a tool to support procurement, sourcing and investment decisions including make or buy decisions and in the strategic management of the sourcing portfolio.

Innovation is a key consideration in the supplier selection decision of premium car manufacturers. The use of patent analysis provides a quantitative indicator to identify innovative suppliers and to support supplier selection decisions and take a strategic view on the sourcing portfolio. Cox (2015) explicitly makes calls to move beyond a static view that is prevalent with many procurement managers in managing their sourcing portfolios. Patent analysis gives procurement managers an important indicator of innovation potential and may signal upcoming developments in various sourcing categories. Patent filing activity may also be an indicator for future market leading products in a particular supply category and may assist in forecasting market power developments in a supply category. However, further empirical studies, and preferably longitudinal studies, are required to provide more insights on how power relationship can change in supply categories.

We have shown the use of the patent analysis to support several aspects of supplier selection with regards to innovation. The patent analysis allows monitoring of innovation in a supply category and the development of competition in a supply category by illustrating innovation

visibility along the supply chain tiers. We contribute to innovation in the supplier selection process by highlighting the stage prior to the selection process described in Kotula et al. (2015), which filters potential suppliers based on their innovation potential before a trade-off between other procurement considerations and criteria commences. Whereas procurement departments may generally monitor competition in supply categories, approaches focused on innovation in procurement portfolios have not been sufficiently theorised yet. Patent analysis gives companies a tool to monitor innovation across the portfolio and evaluate supply options based on criteria that include innovation potential.

Our work also contributes to the theoretical development of procurement and supplier selection in particular as we are using a setting of a customer that sees itself in a weaker position than some potential suppliers. Much of the procurement literature looks at customers who are selecting from a number of suppliers whereas in our case the car manufacturer is in a position where it needs to attract the most innovative suppliers to work with it. In the analysis of a supply market a patent analysis may allow the identification of potential supply alternatives from outside the traditional automotive supply market. Examples where such a sourcing strategy may be important include in-car electronics and entertainment and information systems where many key innovations may happen outside the automotive sector. A patent analysis then also enables procurement managers to systematically analyse a supply category outside their traditional supply base.

Whilst our patent analysis gives mainly indicative information on sourcing categories it does not quantify the impact or significance of individual patents. Additional qualitative judgement and supply market knowledge is therefore required together with the patent analysis. The patent analysis also requires technical knowledge to cleanse the data from patents that are not relevant to the focal firm's sourcing category. Future research studies can examine the

automation of patent analysis, which is a growing area of study (Abbas et al., 2014). In particular the automation of textual and semantic analysis of patent content may allow routine use of patent information (Gerken and Moehrle, 2012) to inform and support future purchasing and procurement decisions.

6. References

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