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An Outlook on Automotive OEMs' Positioning in the Value Chains for Power Electronics Systems

A case study of an automotive OEM

Master's thesis in Quality and Operations Management

JOHN BROFORS
ALEXANDER GREER

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF INNOVATION AND R&D MANAGEMENT

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Supervisor: Gouthanan Pushpananthan, Department of Technology Management and Economics
Examiner: Maria Elmquist, Department of Technology Management and Economics

Report no. E2021:063
Department of Technology Management and Economics
Chalmers University of Technology
SE-412 96 Göteborg
Sweden
Telephone +46 (0)31-772 1000

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SUMMARY
The automotive industry is undergoing a major transformation due to electrification. Original equipment manufacturers within the industry are not exempt to this transformation. The shift toward production of battery electric vehicles will change how value is created in the automotive value chains. New value chains need to be formed, and the original equipment manufacturers need to ask themselves which activities they should perform in these value chains. Also, power electronics systems suppliers originating from the consumer electronics industry are entering the industry, which requires new relationships to be formed between original equipment manufacturers and these suppliers. Given this background, this study's research questions are (i) how is the bargaining power distributed between an OEM and its tier 1 suppliers in the value chains for power electronics systems? and (ii) How should an OEM organize its value chains for PE systems? This research is a case study of an automotive OEM, and semi-structured interviews, conversations, and internal documents were used as data collection methods.

The study concludes that the studied OEM is in an unfavorable bargaining power position in relation to its tier 1 power electronics systems suppliers. In addition, premium OEMs are expected to backward integrate in their value chains for power electronics systems and start to perform the development activities in-house.

Keywords: value chain positioning, automotive OEM, bargaining power, vertical integration, battery electric vehicles, electrification, power electronics systems.

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1. Introduction

This chapter provides the background of the study. Following this, the aim and the specific issue investigated are described in detail, as well as the research questions of the study. The chapter concludes with the study's limitations.

1.1 Background

The electrification of the automotive industry is a major transformation for its incumbents and society as a whole, and with it comes both challenges and opportunities (Offer, 2015). Original equipment manufacturers (OEMs) in the automotive industry are not exempt to this transformation; they are substantially affected in terms of new technology, knowledge, and investments as OEMs shift from producing internal combustion engine vehicles (ICEVs) to battery electric vehicles (BEVs) (see McKinsey & Company, 2019).

A shift toward BEVs will change how value is created in the automotive manufacturing value chains, moving value adding activities from OEMs to its suppliers (Boston Consulting Group, 2020). This is also supported by Sandström (2016), who points out that a new platform (in this case BEVs) and ecosystem can result in both competitive turbulence, and changes in value creation and appropriation amidst assemblers and the manufacturers of components. Internal combustion engine (ICE) manufacturing will eventually be replaced by manufacturing of electric powertrains, an area that traditionally has been outside the scope of automotive OEMs. This structural change impacts the classical OEM business model, and automakers are required to redefine how they vertically integrate in the value chains of the new electric powertrains (McKinsey & Company, 2019). Going forward through the electrification of the industry, the automotive OEMs need to ask themselves the following question: What should we produce? (Boston Consulting Group, 2020).

The automotive industry has been subject to structural changes before, where the US industrial architecture (i.e., the division of labor and profit) underwent a transformation in the late 90s (see Jacobides et al., 2016). The authors state that the automotive OEMs pushed for a more modular product and industry architecture with high degree of outsourcing. As a result, suppliers got an opportunity to break free from the constraints created by the OEMs' hierarchical supply chains and were given more autonomy and greater power to influence the automotive OEMs (Jacobides et al., 2016). The architectural change exposed the automotive OEMs to new risks, involving losing control of their value chains (Jacobides et al., 2016).

The story of the US automotive industry demonstrates the importance of managing the industrial architecture. This importance is backed by Peppard and Rylander (2006), who highlight the industrial architecture's impact on the firms' performance (see also Jacobides et al., 2006). Jacobides et al. (2006) state that a firm may be able to affect the industrial architecture in favor of the firm. However, the authors point out that it is difficult to change an industry architecture once it has stabilized (e.g., many industries have rules about what activities each actor should perform, and how the profit in the architecture should be shared). In contrast, when an architecture is less mature and not yet sharply defined, firms may be able to affect the industrial architecture (Jacobides et al., 2006).

Today, the incumbent OEMs' value chains are mature and optimized for production of ICEs, which creates several challenges when the OEMs need to handle new types of systems and components for producing BEVs. When moving from production of ICEs to BEVs, new value

chains need to be constructed and new actors will position themselves in these value chains. The power balance between the OEMs and these actors are not yet known, hence opportunities for investigation arise.

Dyer (1996) shows the importance of not solely taking the firms' performance into consideration, but to also consider the whole value chain's performance. Moreover, Jacobides et al. (2006), Peppard and Rylander (2006), and Jacobides et al. (2016) highlight the value of managing industrial architecture. Hence, the design of these new value chains, and the OEMs' position within these will affect their future success. However, how the value chains could be structured and how the OEMs could position themselves within these are not known, which creates research opportunities.

1.2 Aim and Specification of Issue Under Investigation

This research study aims to examine the value chains for three power electronics (hereinafter referred to as PE) systems, which are all related to the powertrains of BEVs. Due to confidentiality, the names of the systems are not specified. The study investigates the current power balance between an OEM and its tier 1 suppliers in the value chains for PE systems, as well as its drivers for performing activities in these value chains.

This study's research questions are:

> *How is the bargaining power distributed between an OEM and its tier 1 suppliers in the value chains for power electronics systems?*
>
> *How should an OEM organize its value chains for PE systems?*

1.3 Limitations

Due to time and data constraints, the study investigates a section of the value chains for the systems. More specifically, the development activities of the PE systems are evaluated, and no other activities. Additionally, we studied the value chains from an OEM's perspective, and not the perspective of any other actor.

2. Theoretical Framework

The chapter begins with providing theory about vertical integration. This is then followed by a summary of theory regarding bargaining power.

2.1 Vertical Integration in the Automotive Industry

Cambridge University Press (n.d.) defines vertical integration as "the degree to which a company carries out the different stages in an industrial or commercial process, rather than depending on outside suppliers and customers". Backwards integration is synonymous with upstream integration and means that a firm vertically integrates in the direction of its suppliers. Meanwhile, forward integration is identical to downstream integration, and implies that a firm vertically integrates in the direction of its customers. A firm's approach to vertical integration is likely to change over time, depending on the changing industry conditions and the need of control (Harrigan, 1984).

The core motives for a firm to backward integrate is to control product quality and knowledge, capture more of the value adding work, and to overcome competitors' advantages in the case that the best suppliers are working with competitors (Harrigan, 1984). Additionally, building entry barriers and improving scheduling and coordination are motives for firms to integrate (Rothaermel et al., 2006). Moreover, Harrigan (1985b) highlights that vertical integration can be used to raise the value added margins for specific value chains (all the way from raw materials to final products).

The automotive industry has been subject to vertical disintegration where the automotive OEMs continuously were giving up parts of the value chain (Jacobides, 2005). The author states that vertical disintegration usually happens when the underlying products, services, and technologies remain the same. Schwabe (2020) supports Jacobides' view on the automotive industry and states that the sector is characterized by incremental improvements, and that the car has fundamentally remained the same for a long time. Furthermore, Schwabe (2020) describes the automotive industry as mature, both within products and markets. However, the automotive industry is undergoing a transformation where new technologies are being adapted. Harrigan (1983) states that "industries differ as they develop, mature, and decline, and so should vertical integration" (p. 30). The following subsections describe the advantages and disadvantages of vertical integration, the approaches of vertical integration, the dimensions of vertical integration, and lastly, the factors that affect vertical integration strategies.

2.1.1 Dimensions of Vertical Integration

According to Harrigan (1985b), there are four dimensions of vertical integration: *stages*, *degree*, *breadth*, and *form of ownership*.

The first dimension, stages of integration, refers to the number of steps in the value chain from raw materials to final products in which a firm operates (see Harrigan, 1985b). The second dimension, degree of integration, is defined as the fraction of the total output of a product which a firm buys from or sells to a sister firm (Harrigan, 1985b). As the minimum efficient scales are most often not the same for firms in different parts of a value chain (it is usually larger for upstream than for downstream firms), the degree of integration is important to consider (Harrigan, 1985b). Three different approaches regarding the degree of integration are described by the author: *nonintegration*, *taper integration*, and *full integration*. Nonintegration entails strategies for acquiring materials without conducting transfers internally, and with no

ownership (Harrigan, 1984). These types of strategies are very appealing when firms do not want to acquire specialized assets, cannot reach economies of scale, or can organize their shipment schedules with suppliers in the same way the firm would have if the supplier was fully owned (Harrigan, 1984). Taper integration is when a firm chooses to source inputs from external sources as well as internally (Harrigan, 1984). Rothaermel et al. (2006) argue that successful taper integration (i.e., balancing vertical integration and strategic outsourcing) enhances a firm's performance and new product success. In addition, it allows a firm to integrate knowledge with its complementary asses, leading to an increase in strategic flexibility (Rothaermel et al., 2006). Full integration is when a firm moves all its needs for particular goods or services in-house (Harrigan, 1984). A full integration approach exposes a firm to an increased risk of e.g., strategic inflexibility through mobility and exit barriers, along with higher capital costs (Harrigan, 1984). This is supported by Rothaermel et al. (2006) who state that full integration reduces a firm's strategic flexibility.

The third dimension, breadth of integration, is defined as "the number of activities firms perform in-house at any particular level of the vertical chain" (Harrigan, 1985b, p. 401). The author states that when a firm is broadly integrated, its value added margin increases significantly as a result of producing more products in-house. Moreover, Harrigan (1985b) continues by highlighting that this dimension is critical as economies of scale may be lost because of plants attempting to produce too many products in the same product line.

The fourth and last dimension, form of ownership, regards the ownership share a firm has in an upstream or downstream company (Harrigan, 1985b), where a firm can either fully own another firm, or be quasi-integrated. A fully owned vertical integration is when a firm fully owns an adjacent business (Harrigan, 1984). Meanwhile, a quasi-integrated business is when a firm has less than full ownership (i.e., joint ventures and minority ownership) (Harrigan, 1984), A quasi-integration allows firms to benefit from advantages of vertical integration without assuming the risks or the rigidity of ownership that vertical integration brings (Blois, 1972). In other words, a firm can utilize another firm's assets (e.g., its knowledge, products, and materials) without owning it entirely (Harrigan, 1985b). However, having a quasi-integration setup requires a high bargaining power relative to the adjacent upstream and downstream actors (Harrigan, 1984).

2.1.2 Factors Affecting Vertical Integration Strategies

There are several factors which affect a firm's vertical integration strategy, and the most appropriate vertical integration strategy varies over time (Harrigan, 1986). Harrigan (1983, 1984, 1985b) proposes a framework for predicting changes in vertical integration strategies. The author elaborates four forces affecting a firm's strategy; the firm's environment, which in turn consists of the two forces *phase of industrial evolution* and *volatility of competition*; and a firm's needs or abilities to pursue different types of vertical integration strategies, which in turn entails the forces *corporate strategy* and *bargaining power*. In addition to Harrigan's framework, the *characteristics of the systems* has been showed to be important by Monteverde and Teece (1982), Mahoney (1992), Jacobides (2005), and Rothaermel et al. (2006), and it is therefore added as a force. All forces are described in more detail below.

Phase of Industry Evolution. Klepper (1997) claims that industries follow cycles and stages. Afuah and Utterback (1997) use the Utterback and Abernathy model (the U-A model) (see Utterback & Abernathy, 1975) to illustrate that industrial change is undergoing three phases,

each with distinct characteristics. An implication of the model implies is that firms are required to pursue different strategies for responding to industrial change. Moreover, the three phases that are described in the U-A model are the *fluid phase, transitional phase,* and *specific phase*. The fluid phase is characterized by market and product uncertainty, and no dominant design is yet determined (Afuah & Utterback, 1997). Furthermore, the authors argue that threat of new entrants is very high during this phase, and that it is likely that many new entrants enter the market. The fluid phase in the U-A model is followed by the transitional phase, during which a dominant design has emerged (Afuah & Utterback, 1997). The authors state that the product and market uncertainty in this phase is reduced, which drives the rivalry among existing competitors. Moreover, the authors highlight that the focus shifts from product innovation to process innovation. The third and last phase during an industry life cycle is the specific phase. Afuah and Utterback (1997) state that in this phase, competition becomes oligopolistic, meaning that a few firms supply the market with commodity products with dominant designs.

Depending on the rate of technology innovation and a firm's position as technology leader or follower, different vertical integration strategies will be favorable (Harrigan, 1984). Technological innovation is a major driver for industry evolution and demand uncertainty (Harrigan, 1984). Technology leaders will, according to Harrigan (1984), be more likely to vertically integrate compared with followers. In the early phases of an industry's evolution (i.e., the fluid phase), low degree of vertical integration is expected due to high demand uncertainty (Harrigan, 1984, 1985b). However, when the industry becomes more stable and when the market is no longer changing rapidly, a higher degree of vertical integration can be undertaken (Harrigan, 1983). Hence, the overall vertical integration pattern for a given industry is according to Harrigan (1984) expected to have the shape of an inverted U-curve. In other words, during the early stages of an industry it starts of being disintegrated, but as the industry matures, it becomes more integrated; in the end, the industry becomes disintegrated again (Harrigan, 1985b).

The phase of industry evolution impacts the uncertainty which the firms within it face (Afuah & Utterback, 1997). This in turn escalates the risk for firms if they commit to internal integration early, as production processes with high integration constrain the firms to internally acquire most of its outputs (Harrigan 1985b). Uncertainty can stem from both changes in technology at a processing stage and sales growth trends (Harrigan, 1985b). The author highlights that when the output demand varies significantly, it decreases the probability of sufficient sales volumes, thus creating a risk of excess capacity. If the infrastructure of an industry is under development, or a new technology has the capacity to change the demand rapidly, utilizing high degrees of vertical integration is risky (Harrigan, 1985b). The author notes that integrated stages and activities will be more common under the circumstances where demand is rising steadily, while the opposite will occur when demand varies heavily. Successful firms have acted like pioneers; they were active in numerous stages and activities during the early stages of an industry and when changes in technology occurred rapidly (Harrigan, 1986).

Volatility of Competition. Harrigan (1984) states that vertical integration should in general be avoided in volatile industry structures, with the exception of firms pursuing technological leadership. The author elaborates the statement by explaining that volatile industry structures increases the probability of competitors pursuing tactics that can potentially eliminate long term profitability in the industry, and hence vertical integration should be avoided at this point.

An example of such a tactic is to use price cutting with the purpose of utilizing a firm's full plant capacity (Harrigan, 1985b). Where industry conditions were stable, the successful firms have been broadly integrated and had high degrees of transfers internally (Harrigan, 1986). The electrification of the automotive industry is disrupting the OEMs' value chains for power trains, where the boundaries of the suppliers are fluid and the tier 1 suppliers are experiencing increased competition from higher tiers but also from the OEMs (McKinsey, 2020).

Bargaining Power. If a firm requires a high control of the activities in a value chain, the firm can move these activities in-house though vertical integration (Harrigan, 1984). Monteverde and Teece (1982) state that Ford and General Motors brought component design and manufacturing in-house since relying on suppliers to perform development activities provides suppliers with a first-mover advantage. The authors conclude that this is due to high switching costs, and they argue that vertical integration tends to occur when high switching costs would lock an assembler into dependence upon a single supplier. By being dependent on a single supplier, the assembler is exposed to the risk of losing transaction specific know-how and risk being subject to opportunistic recontracting (Monteverde & Teece, 1982). Jacobides (2005) has a similar reasoning, but instead takes a supplier's point of view, and mentions that the risk of opportunistic recontracting emerges when investments are needed but are only valuable in a specific relationship and not in other contexts (i.e., high degree of asset specificity). As a result, the supplier is not willing to make the investment, unless guarantees of no opportunism are given by the assembler. However, these guarantees of no opportunism is, according to Jacobides (2005), not economically feasible in a dynamic and unpredictable environment. Thus, to make specialized investments in these types of environments, vertical integration is required (Jacobides, 2005).

Moving activities in-house adds assets to the firm's balance sheet, which will increase the firm's asset exposure and decrease its strategic flexibility. Harrigan (1984, 1985b) states that a strong bargaining power can, instead of vertically integrating, be used to persuade sequent businesses to perform activities the firm itself is unwilling to do. Thus, a firm can control suppliers and distribution channels while maintaining a low asset exposure and increase their strategic flexibility through reducing ownership in the value chain (Harrigan, 1984). A more in-depth description of bargaining power is presented in section 2.2 Bargaining Power.

Corporate Strategy. A firm's decision toward vertical integration must be considered in relation to the overall corporate strategy. A decision to vertically integrate is more complex than a decision of making or buying a specific product, because the decision to make means that the firm must bring in capabilities which may be very far from its core businesses strengths (Harrigan, 1986). Harrigan (1984) claims that the core determining factors whether a firm should participate in a stage in a value chain is the stage's importance to the corporate mission and the quality of goods the suppliers can deliver. In general, firms that are pursuing a cost or technology leadership strategy are more suitable for higher degree of vertical integration compared with firms pursuing generic focus strategies (Harrigan, 1983). As regards to corporate strategy, successful firms protected valuable knowledge and reached higher profit margins by engaging in an increased number of stages with a high degree of integrated activities, and also utilized more intrafirm integration (Harrigan, 1986). This was the case during circumstances where neighboring industries performed a lot of value added to their products (Harrigan, 1986). Lastly, the author affirms that during the early stages of an industry

(or when unpredictability occurs), successful firms have accepted the risk of being too highly integrated with the benefit of attaining their strategic objectives.

Characteristics of Systems. Harrigan (1984) argues that noncritical systems and components offering poor economics should not be produced in-house, but rather be purchased from an external firm. However, the author highlights that products offering good economics or are critical should be produced in-house. Harrigan (1984) continues the argument by stating that purchasing noncritical systems and systems offering poor economics will free up both space and resources, allowing a firm to undertake a more profitable mix of activities. In addition, for products that are subject to trade secrets, a higher degree of vertical integration is recommended (Harrigan, 1984). If quality uncertainty is problematic for key systems, the degree of backward integration may increase (Mahoney, 1992). Moreover, when systems are firm specific, backward integration is more likely (Mahoney, 1992). Furthermore, systems that are complex, specialized, and require much engineering effort when designing the system increases the likelihood for the firm to backward integrate (Mahoney, 1992). In addition, if the design of systems is required to be highly coordinated with other parts in the cars, assemblers tend becoming more vertically integrated (Monteverde and Teece, 1982).

Suppliers in technological advanced industries often control vital technology (Rothaermel et al., 2006). Firms acting in these industries can through internalization of these technological capabilities gain control and access to required knowledge (Rothaermel et al., 2006). The authors continue by arguing that integrating external and internal knowledge allows a firm to build a larger and broader product portfolio and gain competitive advantages. Harrigan (1984) argues that vertical integration cuts off a firm from benefiting from outsiders' innovations, and further suggests that in environments where competition is rooted in a high degree of innovation, firms should be careful to pursue backward integration. Rothaermel et al. (2006) have a similar argument and claim that firms tend to source necessary knowledge for new product development in high-technology industries through strategic alliances rather than vertical integration. Hence a balance between control through internalization and access to external knowledge is required.

2.1.3 Advantages and Disadvantages of Vertical Integration

A firm can gain several advantages, but also disadvantages, when vertically integrating. Vertical integration can reduce costs in value chains, improve coordination of activities, and allow firms to get superior control over their economic environments (Harrigan 1984, 1986; Blois, 1972). Moreover, firms can improve their technological intelligence, reduce uncertainty, enjoy synergies, achieve technological leadership, and guarantee raw material access by managing vertical activities efficiently (Harrigan, 1984).

However, there are also drawbacks. One example is that vertical integration creates mobility and exit barriers (Mahoney, 1992; Porter, 1980a), both limiting the strategic flexibility of firms (Harrigan, 1984, 1985a). These types of barriers prevent firms from changing their strategies even if they do not receive optimal return on their investments (Harrigan, 1984, 1985a). By lowering these types of barriers, a firm can reposition itself and supply more attractive market segments or exit easier (Harrigan, 1985a). When technologies change rapidly, or when frequent modifications of products are necessary, a high degree of vertical integration could be problematic (Harrigan, 1985a).

In addition, the author suggests that during these types of conditions, moving processing steps to external suppliers can be beneficial. Vertical integration can also increase overhead coordination costs, and synergies sourced from vertical integration might be exaggerated and not compensate for its costs (Harrigan, 1984; Blois, 1972). In addition, there may be excess capacity created by unbalanced plants as different stages in value chains often have different volume requirements to reach economies of scale (Harrigan, 1984, 1986). Nonetheless, a balance between vertical integration and strategic outsourcing is required (Rothaermel et al., 2006). Blois (1972) has a similar reasoning and argues that when a firm considers becoming more vertical integrated, it must evaluate both the advantages and disadvantages, both financial and non-financial.

2.2 Bargaining Power

The following chapters describe bargaining power and the factors that influence it.

2.2.1 Bargaining Power and its Effects in Automotive Value Chains

OEMs have traditionally had many advantages of sourcing components from external suppliers, which Cho and Chu (1994) refer to as OEM contracts. By outsourcing manufacturing and development activities, the OEMs had the opportunity to reduce the ownership in these processes (i.e., reduction of fixed costs), which allowed the firms to respond rapidly to changing market environments (Cho & Chu, 1994). In addition, outsourcing can according to Cho and Chu (1994) reduce the production costs more than a joint venture setup can. However, sourcing components from external suppliers can also bring disadvantages. Cho and Chu (1994) state that sourcing through OEM contracts implies more risk and instability compared with a situation where the OEM performs the operation in-house. When suppliers are performing more and more tasks, Cho and Chu (1994) argue that the suppliers potentially can develop required knowledge to start to compete with the OEMs.

When a supplier has high bargaining power relative its buyers, it can utilize this power to increase the price toward the buyer (Klepper, 1997; see Porter 1980a, 1980b, 2008). Cho et al. (2019) point out that having strong bargaining power can reduce a firm's inventory expenses by pushing the burden of stocking raw materials to suppliers and finished goods to customers. In addition, Harrigan (1985b) argues that a firm possessing strong bargaining power against its outsiders is not as likely to transfer the same amount of its outputs internally. Concerning bargaining power, successful firms have transferred a large proportion of their products in-house during circumstances where few outside customers were available (Harrigan, 1986). Furthermore, successful firms engaged in a larger range of activities in-house when a significant amount of the firms' purchases were from a small number of suppliers, and when the firms' sales were dependent on a few buyers' purchases (Harrigan, 1986). The author explains that the reason for doing so was to lower the bargaining power of these neighboring firms in the value chains.

Cho et al. (2019) take a broader perspective on bargaining power and problematize the concept. The authors argue that the activity of bargaining is, in contrast to cooperation, a zero-sum game. For instance, the benefit for a firm to exploit bargaining power, e.g., pushing inventory and risks toward its customers and suppliers, is limited to the specific firm and does not add any value in the value chain. Cho et al. (2019) argue that building relationships and collaborations throughout a value chain is favorable for the value chain's responsiveness toward the market and its degree of innovativeness. However, the authors conclude that a wide usage of

bargaining power over a firm's value chain might damage these crucial relationships and collaborations, and hence firms choose to restrain the usage of power. Crook and Combs (2007) have a similar reasoning and state that the use of power drives conflicts, reduces satisfaction, and can diminish firms' willingness to be part of the value chain. Thus, bargaining power is not just something a firm can exploit once given the opportunity; a careful consideration between potential gains and damage to relationships and collaborations is required.

2.2.2 Factors Influencing Bargaining Power

The potential benefits and drawbacks of the OEM contracts are depending on the distribution of bargaining power between the OEMs and its suppliers (see Cho & Chu, 1994; Crook & Combs, 2007; Porter, 1980a, 2008). There are many factors influencing the bargaining power of suppliers relative to an OEM. Harrigan (1984) claims that the most crucial factors for determining bargaining power are; how specific the product is to the industry; if there are any alternative suppliers; if the firm is able to produce the product itself; and how dependent the supplier is on the firm. Cho and Chu (1994) have a more holistic view on determining the bargaining power, and the authors describe a set of determinants of bargaining power which are highly influenced by Porter's (1980b) framework of industry competition. The section's categories are based on the factors described by Cho and Chu (1994) and Porter (1980b, 2008). Moreover, Porter (1980a) argues that the factors which make a supplier powerful are the inverse of those that make customers powerful. Hence, the following section describes which factors that influence both a supplier's and its customers' bargaining power.

Ability to Vertically Integrate. If industry participants earn too much money relative to their suppliers, incentives are created for the suppliers to vertical integrate and take the position of their customers (Porter, 2008). When a buyer poses a threat to backward integrate, the supplier will lose bargaining power (Cho & Chu, 1994).

Number of Suppliers and Buyers. When a buyer has many suppliers to choose from, the buyer will be less dependent on a particular supplier and the suppliers' bargaining power will be lower (Cho & Chu, 1994). In addition, if there are few buyers on the market, the buyers' relative bargaining power will be higher (Porter, 2008).

Purchasing Volume. If a supplier's revenues are highly dependent on a single buyer's purchases, the supplier will be dependent on the buyer, and hence the buyer's bargaining power will be higher (Cho & Chu, 1994). Porter (2008) has a similar reasoning and states that if a buyer's purchasing volume is high in relation with the supplier's size (i.e., its total production volume), this will increase the buyer's bargaining power toward the supplier.

Switching Costs. If a buyer has low switching costs to replace a supplier, the buyer will have stronger bargaining power than its supplier in this aspect (Porter, 2008). On the other hand, if the buyer has a high switching cost, the supplier will have a strong bargaining power over the buyer (Cho & Chu, 1994). A situation for OEMs that is characterized by high switching costs is when a supplier has located production lines close to the car factories (see Porter, 2008).

Product Differentiation and Substitutes. If the products offered by the suppliers are not differentiated (i.e., standardized/off-the-shelf products) buyers can find similar products which can replace the suppliers', and hence the buyers' bargaining power is stronger than their suppliers' (Porter, 2008). Contrarily, if a buyer demands a differentiated product, the suppliers bargaining power will be increased since the customization requirements will reduce the

number of potential suppliers. In addition, Porter (2008) argues that if there are no substitutes for the offering the suppliers are providing, the suppliers will have stronger bargaining power than the buyers.

Suppliers' Involvement in Sales and Marketing. If a supplier has no direct sales or marketing activities toward the buyer's customers, the buyer will have a stronger bargaining power since the supplier can only access this market through the buyer (Cho & Chu, 1994).

Technology Leadership. If a supplier is a technology leader, buyers has no or few alternative suppliers to choose from if the firms want this technology, and hence the bargaining power of the supplier is high (Cho & Chu, 1994).

Information. Cho and Chu (1994) state that when a buyer has full information about a supplier, the buyer will be in a position of high bargaining power since the buyer is enabled to place orders when the price is most favorable. A similar situation is created if the supplier has full information of the buyer (Cho & Chu, 1994). Porter and Millar (1985) state that information technologies affect the power distribution caused by information asymmetry. The authors argue that information technologies increase the power of a buyer that assembles purchased parts, such as an OEM. By requesting quotation and using automated bill of materials (BOMs), the buyer can evaluate make or buy decisions easier (Porter & Millar, 1985).

2.2.3 Factors Influencing Propensity to Exert Bargaining Power

Above mentioned factors of bargaining power cannot, according to Cho and Chu (1994), explain the complete distribution of bargaining power between an industry's actors. The authors argue that the bargaining power is a combination between *intrinsic bargaining power*, (i.e., the power sourced from the industry structure, as described above), and *propensity to exert the power* (rooted in firm-specific variables). A firm's propensity to exert power is dependent on whether the firm is acting as a supplier or a buyer in the studied situation (Cho & Chu, 1994). If a firm in a transaction acts as a buyer, the propensity to exert its power will, according to Cho and Chu (1994), be influenced by the following factors:

Supplier's Contribution to Quality. A buyer will be less likely to exert its power over a supplier if the suppler significantly contributes toward a high quality of the buyer's goods, and when the buyer is aiming for a position as quality maker (Cho & Chu, 1994). Moreover, Porter (2008) argues that if the quality of a buyer's products is influenced by the suppliers' input, the buyer will be less price sensitive. However, Porter (2008) would not classify this as a separate factor affecting the propensity to exert power, but rather as a force sourced from the industry's structure.

The Buyer's Profitability. If a buyer is earning small profits, it is more likely to exert its bargaining power over suppliers in order to cut costs (Cho & Chu, 1994). Porter (2008) has a similar reasoning and states that a buyer is price sensitive if it has low profits or is under pressure to reduce purchasing costs and that buyers in these cases are more likely to exert its bargaining power over its suppliers.

The Buyer's Motivation in Procurement. When a buyer's incentives in procurement are not focused on minimizing costs, but rather focused on e.g., retaining or creating a long term relationship with a supplier, the buyer is less likely to exert its bargaining power over the supplier (Cho & Chu, 1994).

Business Philosophy. The factor of business philosophy impacts both the buyer's and the supplier's propensity to exert power. If the actors view the relationship as transactional between the buyer and supplier, and that each transaction is a zero-sum game in the sense that the profit of the transaction is fixed and has to be shared, the actors are more likely to exert its power against each other (Cho & Chu, 1994). Contrarily, if the actors view the transactions as more of a collaborative relationship, they are less likely to exert their power over each other (Cho & Chu, 1994).

If a firm acts as a supplier during a transaction, its propensity to exert power will, according to Cho and Chu (1994), be influenced by the following factors:

Slack in Production Capacity. Cho and Chu (1994) argue that one of the core reasons for a supplier to enter the automotive market and serve the OEMs is due to a willingness to utilize its full capacity. Hence, when a supplier has excess capacity in its operations, the supplier will be less likely to exert its power over the OEMs and will accept less attractive orders to reach higher utilization (Cho & Chu, 1994).

Rapid Growth. One of the easiest ways to ensure fast growth for a supplier is to get an OEM contract and start serving the automotive industry (Cho & Chu, 1994). The authors argue that firms with a not yet established brand name have a hard time to build sales volumes. The suppliers can ensure higher volumes by serving OEMs, and the more focused suppliers are on rapid growth, the less likely they are to exert their bargaining power over the buyers (Cho & Chu, 1994).

2.2.4 Influencing the Industry Structure

As mentioned previously, the industry structure has great influence over the bargaining power of suppliers and buyers. Porter (2008) argues that firms have the possibility to shape the industry structure, and hence alter the distribution of bargaining power between the actors. According to the author, the industry structure can be reshaped in two different ways: change how profits are divided, or expand the overall profits in the industry. The former, can according to Porter (2008), be achieved by e.g., reducing the profit share earned by suppliers through neutralizing their power by using more standardized systems. The latter can be achieved by e.g., finding and serving new latent customers (Porter, 2008). In contrast to changing how profits are divided, expanding the overall profits can be viewed more as a win-win situation. Porter (2008) argues that changing or improving the industry structure is no job for smaller actors since the resources required only are possessed by large players. Crook and Combs (2007) describe bargaining power as dynamic and highlight that it changes over time. For instance, weak members that are participating in a value chain have the opportunity to build switching costs against their customers and suppliers, and thus accumulate bargaining power over time (Crook & Combs, 2007). Finally, Porter (2008) also state that shaping industry structure might trigger new types of competition which the incumbents cannot win. Hence, before setting an industry structure change in motion, managers must carefully examine long term effects of the change (Porter, 2008).

3. Methodology

This chapter describes the research strategy and approach used in this study. Following this, the quality criteria and data collection methods are presented. In addition, the sampling and data analysis methods are described. Lastly, the chapter concludes with an ethical discussion.

3.1 Research Strategy and Approach

Bell et al. (2019) state that a qualitative research strategy "usually emphasizes words rather than quantification in the collection and analysis of data" (p. 355). A qualitative research strategy was deemed appropriate as we were going to describe the power distribution in value chains, as well as how the OEM should organize its value chains for PE systems. This was performed by using an explorative approach since these areas were not completely known for the PE systems studied.

Wallén (1996) states that a study can be characterized as explorative if fundamental knowledge about the dynamic and complex context in which the OEM studied is active in is missing; these are the circumstances surrounding this study. To gain a broader understanding of the context, a pre-study was conducted. The pre-study was carried out by utilizing unstructured interviews (see Bell et al., 2019) with managers across different departments. By conducting these interviews, we got a broader understanding of the area and identified which systems we would study.

According to Bell et al. (2019), a case study design "entails the detailed and intensive analysis of a single case" (p. 63). Moreover, the authors state that such a design emphasizes the particularities and complexities of the case being studied. Bell et al. (2019) point out that a case can be a single organization, a single location, or a person. As the research questions are about analyzing the power distribution and what drivers an OEM has for performing activities in the value chains for PE systems, we deemed it appropriate to conduct a case study of a single organization in combination with a theoretical perspective because of the complexities surrounding the domain.

Bell et al. (2019) differentiate between two types of approaches to research: *deductive* and *inductive*. The deductive approach is when researchers deduct hypotheses based on what is known within a specific area, which then have to be empirically tested (Bell et al., 2019). In addition, the authors explain that this approach is typically associated with quantitative research, follows a linear process, and that it can be described as following: "Theory and the hypotheses deduced come first, and they drive the process of gathering data" (p. 20). On the other hand, the authors describe research as inductive when the outcome of it is theory. Adding to this, the authors point out that the inductive approach uses an iterative process, going back and forth between data and theory, and that the process contains generalization of findings. In contrast to the deductive approach, the inductive approach starts with observations, which then feeds into theory (Bell et al., 2019). The authors assert that the inductive approach is frequently linked to qualitative research. Research using the inductive approach usually engage in describing the conditions under which the findings are valid (Bell et al., 2019). Instead of deriving hypotheses from existing literature as researchers using the deductive approach do, researchers using the inductive approach often utilize a grounded theory approach when it comes to generating theory and analyzing data (Bell et al., 2019). This research has taken an inductive approach due to that it started with gathering empirical data, which was followed by a literature study of related theory. More specifically, the empirical data was gathered through

conducting interviews, having conversations, reading internal documents, and scanning literature. The iterative character of this data gathering process can be exemplified in multiple ways; for example, after we had conducted a couple of interviews, we scanned the literature again, which could result in a change of the interview guide and an identification of overlooked areas. Just as described above concerning the iterative nature of the inductive approach, the research process in this study was iterative, going back and forth between interviews, conversations and internal documents on the one hand, and the literature on the other hand. Lastly, the findings and conclusions are meant to feeding back into the theoretical domain, as well as describing the circumstances under which they are true.

3.2 Quality Criteria

Bell et al. (2019) argue that *trustworthiness* and *authenticity* are the two most important quality criteria when evaluating qualitative research. These criteria will be described in further detail, as well as how this research has taken them into account.

3.2.1 Trustworthiness

Bell et al. (2019) explain that trustworthiness in turn consists of the four criteria *credibility*, *transferability*, *dependability*, and *confirmability*.

Bell et al. (2019) clarify that credibility is about ensuring that the research has been utilizing good practice and guaranteeing that the findings are correct. Moreover, the authors highlight that this can be done by conducting the technique of either triangulation or respondent validation, whereas this research has utilized triangulation. More specifically, triangulation is a way of using multiple sources of data and methods with the goal of increasing credibility (Salkind, 2010). In order to satisfy the criterion of credibility, this study uses what Salkind (2010) refers to as "data triangulation", where multiple sources of data (i.e., interviews, conversations, and internal documents) were used.

The transferability criterion points out the issue that research findings from qualitative research only are true during similar circumstances of the studied situation (Bell et al., 2019). The authors propose that researchers should give rich descriptions of the social world being studied with the purpose of enabling others to make a correct judgement if the findings are transferable to other contexts or not, which is what this study has intended to do.

The criterion of dependability refers to making sure that all records are saved in an accessible manner during the study, all the way from notes regarding the problem formulation and fieldwork, to notes taken during interviews and data analysis decisions (Bell et al., 2019). The authors explain that by doing so, peers are enabled to audit the records with the purpose of evaluating how well the researchers have followed procedures. In order to satisfy the criterion of dependability, this research has made sure to meticulously and continuously save all records in an accessible manner.

Lastly, confirmability is about ensuring that the researchers have not allowed personal values to influence neither the way the research was conducted, nor the findings of the study (Bell et al., 2019). In other words, the criterion refers to making sure that the researchers have acted in good faith (Bell et al., 2019). This study satisfies the criterion of confirmability as the researchers are prepared at all times to be critically assessed regarding the way in which the study has been conducted and how the conclusions were reached. Moreover, as Salkind (2010) highlights that interviews might be influenced by the interviewer's style of communication and

that internal documents might be biased, we have sought to mitigate this issue by utilizing triangulation.

3.2.2 Authenticity

Bryman and Bell (2011) clarify that the quality criterion of authenticity "raise a wider set of issues concerning the wider political impact of research" (p. 398). The authors state that authenticity can be broken down into the five criteria *fairness*, *ontological-*, *educative-*, *catalytic-*, and *tactical authenticity*.

Fairness raises the question if the findings of the research are consistent with a fair representation of the different perspectives within the social world being studied (Bryman & Bell, 2011). Examples from earlier studies provide good reasons for why this is important, e.g., when a researcher only interviewed department heads and chief executives, and not front-line workers or customers (Bryman & Bell, 2011). Additionally, ontological authenticity refers to if the research helps the members of the social world being studied to reach a better understanding of it, while educative authenticity questions if the research helps the members of the social world being studied to acknowledge other members perspectives (Bryman & Bell, 2011). This research has sought to mitigate these three issues by having interviewed numerous people within multiple settings, which in this case meant interviewing various people at different levels and departments of the OEM. See Table 1 and Table 2 for the full list of interviewees and their positions within the studied OEM.

Catalytic authenticity refers to if the research has facilitated the members of the social world being studied to change their own environment (Bryman & Bell, 2011). Lastly, the authors explain that tactical authenticity is about ensuring that the members of the social world being studied are going to be empowered by the research to engage in changing their own environment. This research aimed to satisfy these criteria by contributing with suggestions to how the OEM which activities it should perform in the studied value chains and providing the OEM with a description of the distribution of bargaining power between it and its suppliers.

3.3 Data Collection

The following section describes the types of data collected along with the methods used to collect the data. The study has utilized interviews, conversations, internal documents, and a literature study.

3.3.1 Interviews

Bell et al. (2019) state that there are two main types of interviews in qualitative research: *unstructured* and *semi-structured*. The authors explain that during an *unstructured interview*, the interviewer has a short list of loose questions with the purpose of covering specific topics. Moreover, the authors state that the interviewer can start the interview with as few as one question. Bell et al. (2019) describe that this question is then answered by the interviewee, and that the interviewer asks a new question based on what he or she deems interesting to find out more about. In a *semi-structured interview*, the interviewer will have a set of predefined questions (Trost, 2010), also referred to as an interview guide (Bell et al., 2019). The questions are structured in a way which gives the interviewee considerable freedom in how to reply, and the questions must not follow the same order as in the interview guide (Bell et al., 2019). Additionally, questions outside of the interview guide can be asked, depending on what the interviewees answer (Bell et al., 2019). Bell et al. (2019) state that this type of interview is

more flexible than structured interviews and allows the interviewee to answer questions more broadly. The interviewing technique gives the interviewee the possibility to explore issues they feel are important (Longhurst, 2003) and allows the researcher to have an open mind about what he or she needs to know (Bryman & Bell, 2011). Since the study is of an explorative nature, semi-structured interviews were deemed to be appropriate.

We did not define in advance how many interviews that were going be conducted, but instead we continued the interviewing until saturation was reached (see Bell et al., 2019). According to Trost (2010), a semi-structured interview should not be longer than 90 minutes with respect to the interviewee, which the study followed in general.

Bell et al. (2019) state that an interview should be conducted in a quiet and private space where the interview can be performed without interruptions. Trost (2010) adds to this statement that the interview should be conducted in an environment where the interviewee feels comfortable. Therefore, all interviews were planned to be performed at the OEM in specific bookable conference rooms. However, 14 of the 29 interviews and conversations were conducted through online video interviews by utilizing the software application Microsoft Teams. The reason for why many of the interviews were not conducted face-to-face was due to the Corona pandemic, which meant that many of the interviewees were working from home. Researchers have according to Bell et al. (2019) had broadly positive experiences of using software applications such as Skype in qualitative interviewing. The authors suggest several advantages with using these types of software applications. They mention some limitations, mainly regarding technological problems, e.g., connection quality and interviewees familiarity with the software. This was not a problem in this study since the interviewees were used to using Microsoft Teams in their daily work and were provided with hardware suitable for interviewing.

The interviews and conversations conducted can be divided into the two categories *pre-study* and *study*. See Table 1 to view the complete list of interviewees during the pre-study, and Table 2 to examine the interviewees of the study.

Table 1

List of Interviewees During the Pre-study

Role	Department	Format	Length (mins)	Face-to-face or online
Senior Manager	Strategy	Interview	60	Face-to-face
Senior Manager	Strategy	Interview	60	Face-to-face
Senior Manager	Strategy	Interview	60	Face-to-face
Senior Manager	Strategy	Conversation	30	Face-to-face
Sum		Interviews: 3, Conversations: 1		

Note. This table shows the role of the interviewees, as well as the department they are working for. The table also shows the length of the interviews and conversations, along with if they were conducted face-to-face or online.

Table 2

List of Interviewees During the Study

Role	Department	Format	Length (mins)	Face-to-face or online
Senior Manager	Strategy	Interview	100	Face-to-face
Manager	R&D	Conversation	120	Online
Senior Manager	Strategy	Interview	60	Face-to-face
Engineer	IT	Conversation	60	Face-to-face
Manager	R&D	Interview	60	Online
Manager	Strategy	Conversation	60	Face-to-face
Manager	R&D	Interview	30	Online
Manager	R&D	Interview	30	Online
Senior Manager	R&D	Interview	30	Online
Senior Manager	R&D	Interview	45	Online
Senior Manager	Strategy	Interview	90	Face-to-face
Senior Manager	Strategy	Interview	90	Face-to-face
Senior Manager	Strategy	Conversation	20	Face-to-face
Senior Manager	Strategy	Conversation	120	Face-to-face
Engineer	R&D	Interview	30	Online
Senior Manager	Procurement	Interview	60	Online
Senior Manager	Procurement	Interview	45	Online
Buyer	Procurement	Interview	30	Online
Buyer	Procurement	Interview	30	Online
Buyer	Procurement	Interview	40	Online
Manager	Strategy	Conversation	35	Face-to-face
Manager	Strategy	Conversation	35	Face-to-face
Buyer	Procurement	Interview	30	Online
Senior Manager	Procurement	Interview	45	Online
Senior Manager	Strategy	Interview	60	Face-to-face
Sum		Interviews: 18, Conversations: 7		

Note. This table shows the role of the interviewees, as well as the department they are working for. The table also shows the length of the interviews and conversations, along with if they were conducted face-to-face or online.

3.3.2 Conversations

Trost (2010) points out that interviewing should be combined with other methods when collecting empirics. Hence, conversations were used as a complementary data collection method. Bell et al. (2019) suggest that conversations tend to be similar to unstructured interviewing. During the pre-study, we noticed that informal conversations in combination with semi-structured interviews were an effective and efficient method to collect data that drove the study forward.

3.3.3 Internal Documents

Bryman and Bell (2011) state that internal documents can provide the researcher with valuable background information about the OEM. The research topic is tightly coupled to the OEM which the research project takes place at, and therefore internal documents were an important data source used in this study. Examples of such documents which Bryman and Bell (2011) refer to are firm regulations, external consultant reports, and firm newsletters. However, Bell et al. (2019) suggest that managers (the usual authors of organizational documents) are likely to have an agenda, potentially making such documents biased. Hence, researchers need to interrogate and examine these data sources in a context together with other sources of data (Bell et al., 2019). This research has followed these guidelines by reviewing the data and authors of internal documents. The reviewing of data was conducted through (i) assessing if the author could have an agenda when creating the data, (ii) understanding if the data are estimations or actual facts, (iii) ensuring that the data are the latest version, and most importantly, (iv) by asking others if it is accurate and whether it can be trusted or not.

3.3.4 Literature Study

The most important part in a study is to review already existing literature regarding the study's topic (Bell et al., 2019). This study had two phases of literature studies. In the first phase, data were collected regarding the topic to gain a broader understanding of the theoretical domain as well as finding out what has been concluded in previous research. This part of the literature study helps the researchers to understand what already has been done and what concepts and theories that are relevant for the research (Bell et al., 2019). In the second phase, literature was studied more in-depth, which was aimed to support in answering the research questions, and consequently formed the theoretical framework. Reviewed literature consisted mainly of academic journals (see Bell et al., 2019). The literature search was conducted though the databases Google Scholar and Chalmers Library. The keywords used when searching for literature were: electrification automotive industry, electric mobility, change automotive, vertical integration, electric power train, bargaining power, industrial change, OEM negotiation, supplier networks, value networks, exit barriers, and strategic outsourcing.

3.4 Data Validity

To ensure data validity of interviews, recording and transcribing them are in general recommended, and the methods have several advantages (Bell et al., 2019). By doing so, it will help correct the natural limitations of the human memory and enable a more thorough examination of what interviewees have said. Due to the criticality and confidentiality of studied topics, recordings were not possible. Firstly, recordings would have set restrictions of what the interviewees could talk about. Secondly, recordings might have influenced the willingness to discuss sensitive topics. This argument is supported by Jacobsson and Åhlström (2007) who

suggest that interviewees are more willing to discuss sensitive topics when recordings are absent. In our pre-study, we asked the interviewees on their view of recording the interviews, and they stated that the willingness and capability to discuss sensitive topics were hindered.

Bell et al. (2019) state that even if an interviewee refuses to be recorded, the interview should be conducted anyway since useful information still is likely to be revealed. The authors refer to a study where the interviewees were discomforted with recordings or refused to be recorded, and hence the interviewer chose to not record the interviews. Due to this study's difficulty to record interviews, a method inspired by the one described by Bell et al. (2019) was used to ensure data validity. Two interviewers were always present during the interviews and both took notes. Directly after each interview, the two interviewers discussed their collected data to reduce the possibility of misunderstandings. If any discrepancies arose between the interviewers' notes, the interviewee was once again contacted for clarification and the interviewees version got interpretive precedence, and the notes were corrected. In total, this type of discrepancy occurred three times.

3.5 Sampling

The snowball sampling method entails that the researcher contacts a small group of key individuals who are relevant to the study and ask these individuals to recommend a set of interviewees (Bell et al., 2019). In an iterative manner, the interviewees are asked who the researcher should interview next (Bell et al., 2019). This sampling method was utilized in this study as it was deemed appropriate to help us find interviewees who had knowledge and insights within the topic.

3.6 Data Analysis

The Affinity-Interrelationship Method (AIM) as described by Alänge (2009) was used to analyze the collected data, however with some modifications. Bell et al. (2019) state that coding should be done as soon as possible after the data have been collected. This can, according to the authors, improve the understanding of the data. In line with this statement, the data were codified as short sentences onto post-it notes directly after each interview and conversation. After one week of interviewing we conducted our first AIM workshop.

In line with AIM, two overall questions were formed which the workshops intended to provide answers to. The questions were: *How is the current power dynamics structured in the studied systems value chains?* and *What is the OEM's drivers for vertically integrating?* The questions were intendedly formed broader than our research questions to ensure that as many aspects as possible relevant to our study were discovered.

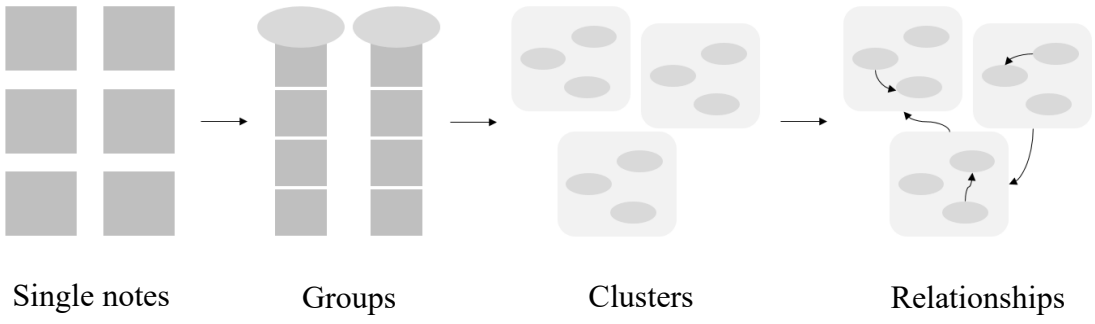
At the beginning of the first workshop we had approximately 50 notes which we spread onto a table. Under silence we put the notes on a whiteboard where we put similar/related notes close to each other (based on our intuition of the notes actual meaning) and groups were formed. At this stage we allowed each other to move the notes between different groups or form new ones according one's own opinion. When all notes were placed on the whiteboard and agreement was reached on the notes' placement, we started to discuss the different notes and the groups. A separate group was created for notes that were identified to contain data that was not at all related to the study's aim. The groups contained between two and ten notes each. One of the groups was separated into two new ones since, after a discussion, it was concluded that the group had two different underlying meanings. Groups that contained similarities were placed

into larger clusters. At the end of the workshop, arrows were drawn between both groups and clusters which illustrated the identified cause and effect relationships.

Every other week a similar procedure, as described above, took place. At these occasions we placed all previous notes into the previously identified groups and clusters on a whiteboard. Then we, again under silence, placed new notes onto the white board in either the already existing groups, or into new ones which we created when notes contained new data. Based on the interviews, conversations, and internal documents, a total of approximately 160 post-it notes were written and used in the workshops. Moreover, some interviews were conducted in Swedish and some in English. The notes taken during interviews with English speakers were translated into Swedish prior to the AIM workshops. In total, four workshops were conducted. Post-it notes were written and used during the workshops. See Figure 1 for a depiction of the analysis method used.

Figure 1

A Depiction of the Data Analysis Method Used During the AIM Workshops



3.7 Ethical Discussion

Bell et al. (2019) state that potential ethical issues can arise during several occasions throughout a study. Hence, it is important to take these issues into consideration early and plan how to address them. In this study we addressed and followed the four ethical principles described in Bell et al. (2019): *avoidance of harm, privacy, prevention of deception,* and *informed consent.* What the specific principles mean and how they were addressed is described in more detail below.

The first principle described by Bell et al. (2019), avoidance of harm, is not solely related to physical harm but also related to harm of the participants self-esteem, career paths, and stress. According to the authors, researchers should reduce the probability of participants being harmed to the smallest extent as possible. In this study, harm towards participants could occur if sensitive information was leaked. Hence, all collected information was handled under confidentiality and the names and titles of the interviewees were masked. In addition, Bell et al. (2019) state that harm to non-participants needs to be considered. In this case, the studied OEM could be severely harmed if sensitive information was leaked. Therefore, this type of critical data have been removed in the final report. Furthermore, prior to sending any information to the university, the supervisor at the OEM reviewed the content in order to ensure avoidance of harm.

The second principle, privacy, is about protecting the privacy of the participants (Bell et al., 2019). Even though this study was not centered around topics concerning the participants privacy, this ethical issue was taken into consideration. The interviewers allowed participants to refuse answering questions if they felt that it invaded their privacy. Furthermore, the researchers were clear toward the participants that they always had the opportunity to withdraw from the study.

The third principle described by Bell et al. (2019), prevention of deception, is about not presenting the study as something else than it is. To avoid deception, a brief description of the study was created in consultation with the supervisor at the OEM, with the purpose of ensuring that the description was representative for the study. The description was then presented for all interviewees prior to the interviews.

The fourth principle, informed consent, is about giving the participant enough information about the research study so that he or she can make an informed decision whether he or she wants to participate or not (Bell et al., 2019). To avoid a situation where participants are misinformed, the interviewers gave information about the aim of the study and why the specific individual is approached prior to the interviews. In addition, interviewees were also informed about how the data they provided were going to be managed and used.

4. Results

This chapter describes the findings of the study. First, the studied systems and which activities the OEM currently performs are described. After this, the chapter is structured according to the themes found during the AIM workshops and is divided into two broad areas: the power balance between the OEM and its power electronic suppliers, and drivers the OEM has for changing activities it performs in the studied value chains.

4.1 Description of the Studied Systems

All the studied systems are part of the powertrain of BEVs. They are subject to high degrees of specification and have many requirements regarding integration with other systems. In addition, the three studied systems are technological advanced and consist of more than one thousand sub-components each. The OEM studied currently performs neither development, final assembly, nor production of the systems and is acting in the premium segment. The knowledge required for developing any of the systems in-house is not related to the OEM's existing knowledge regarding combustion engines.

4.2 Factors Affecting the Power Distribution Between the OEM and its Power Electronic Systems Suppliers

This chapter describes factors explaining the current power distribution between the OEM and its PE systems suppliers. One of these factors is the new suppliers' inexperience with the OEMs' requirements. Additionally, the competitive environment for the PE systems suppliers and the size of these suppliers is described. Moreover, the knowledge possessed by the OEM and the power distribution between the OEM and its power electronic systems suppliers are depicted. Lastly, the suppliers' lack of transparency and the value chain trends for the OEMs and the PE systems suppliers are described.

4.2.1 Liability-, Volume- and Customization Requirements

Several managers and buyers stated that the new tier 1 suppliers for PE systems have none or limited experience in working with OEMs within the automotive industry. They stated that most of the new suppliers have roots within the consumer electronics industry. In contrast to the demands the tier 1 suppliers experiences from the consumer electronics industry, the OEM has different and more excessive demands. For instance, a manager declared that the OEM demands its suppliers to take a broader responsibility by requesting a guarantee on the reliability of their products. This guarantee implies that the suppliers' responsibility of their products is extended. Hence, the suppliers are facing a higher degree of risk; a risk which might result in astronomical costs for the suppliers, a senior manager stated. Suppliers that historically have not been working with OEMs in the automotive industry generally do not accept these conditions as they are not willing to take this risk, and therefore the number of potential suppliers for many PE systems is reduced, multiple managers and buyers claimed.

The OEM has unique physical dimensions of their cars compared with other OEMs, and it also has particular requirements on performance regarding the electric powertrain. Thus, the OEM is requesting customized systems, and hence off-the-shelf products are not feasible options for the systems studied. As a result, the OEM's suppliers are required to invest in developing these customized systems, and they are in some cases required to invest in unique production lines. By guaranteeing purchasing volumes toward the suppliers, the incorporated risk when making these types of investments is reduced, a manager explained. However, managers at the studied

OEM stated that the OEM is not willing to guarantee any purchasing volumes (which is widely adopted by automotive OEMs when purchasing any given system), which further increases the risk for the suppliers to serve the OEM.

In addition, the systems require a high degree of integration with other systems in the car. The requirement of system integration further drives the need for customized solutions, but it also increases the requirements on the suppliers. In some cases, it is not sufficient for a supplier to be specialized within a specific PE system; the supplier is required to have a broader offering and to provide more integrated solutions (i.e., integrating multiple PE systems) toward the OEM. Managers at the OEM argued that the need for integrated solutions reduces the number of possible suppliers substantially. Moreover, two managers stated that additional reasons for why the number of potential suppliers is often very low is because the suppliers do not have the resources required to supply the OEM, or that they cannot deliver the degree of customization which the OEM demands.

In summary, the various requirements and the need for customization substantially decreases the number of potential PE systems suppliers for the OEM. Based on an interview with a senior manager, the situation can be concluded as:

> *We [the OEM] have many potential suppliers for PE systems but our various requirements and our need for customization results in a situation where we often end up with one or two suppliers to choose from.*

4.2.2 Competition

The limited number of potential suppliers for the OEM affects the competitive environment between the suppliers. As described above, there are times when the OEM ends up in situations where they only have one or two suppliers to choose from. Two managers stated that the small number of suppliers decreases the competition between them, which drives up the prices of their offerings. Another manager stated that competition between suppliers is, in this situation, the only effective way to negotiate better prices. Moreover, a manager stated that in the situations where only a few suppliers were available, the likelihood that the OEM will develop their own products in-house is increased. More specifically, based on the interview with the manager, it can be summarized that:

> *Because we [the OEM] are moving toward more integration between PE systems, the complexity increases drastically. This leaves us with very few suppliers left that can satisfy our needs, and it becomes more likely that we will develop it in-house.*

4.2.3 Power Electronics Systems Suppliers

Several managers from the R&D and procurement departments stated that the typical tier 2 suppliers for PE (i.e., electronic manufacturing services suppliers) are “gigantic”, and are in many cases much larger than the OEM itself. Furthermore, they are mass producers and supply many other markets than the automotive industry. A manager outlined the typical competitive environment for PE systems beyond tier 1 by stating that:

> *“The manufacturing of standard components within power electronics are consolidated to a few very large players.”*

According to internal documents, tier 1 suppliers for PE systems are often substantially larger than the studied OEM in terms of number of employees and revenue. These large suppliers have the possibility to fulfill the requirements for customization and integration that are requested by the OEM, which for a small supplier is generally more challenging, according to a manager. In addition, two managers argued that there are more actors and stages within each of the value chains for PE systems compared with the OEM's traditional value chains. Moreover, multiple managers stated that the value chains for the systems are similar, where both first- and second-tier suppliers are often very large relative to the studied OEM.

When discussing tier 1 suppliers, two managers stated that the production processes for some of the systems are immature. After visiting suppliers' factory, the managers got the impression that the production was not optimized, given the specific volume and variants being produced. Another manager pointed out that the OEM is basically paying for the tier 1 suppliers to develop knowledge about the technologies, and that the OEM sometimes has just as much knowledge about the technologies as the tier 1 suppliers. However, the tier 1 suppliers have substantially more knowledge about how to produce these systems than the OEM, according to a manager. Furthermore, a manager claimed that when talking about developing hardware components in-house, it demands a lot from the organization, both in terms of financial investments, time and resources; it is an all or nothing situation. However, the manager explained that the software is easier to develop in-house as it can be done in smaller incremental steps.

4.2.4 Intra-firm Knowledge & Firm History

The OEM's knowledge within the area of PE is limited, in contrast with its knowledge within the traditional ICE area. One factor explaining the limited knowledge is the OEM's history. A senior manager mentioned that the OEM's knowledge historically has been aligned with its R&D focus, which until recently has not been within PE. Another manager had a similar view on the OEM's history:

"We [the OEM] have no history of being an electronics company."

Several managers described PE as a "black box" and stated that the OEM has little knowledge within this area. Another manager added that it is not only PE the OEM has limited knowledge about and declared that the OEM has an overall poor insight in all areas related to electronics. However, the OEM is not completely new to PE as it has been working with for example low voltage systems before. The limited knowledge within the OEM is preventing the OEM to get a complete understanding of the end-to-end value chains for the systems studied, two managers stated. In relation to this, a manager stated that the OEM seldom moved past tier 2 suppliers when conducting value chain analyses. This is in line with claims of multiple other managers and buyers.

The lack of understanding of PE and their end-to-end value chains puts the OEM in a disadvantageous situation when negotiating with suppliers. The OEM does not have the knowledge nor insights needed to effectively negotiate the price of systems from suppliers since the OEM cannot always verify the price data received from its suppliers, according to multiple managers. The managers asserted that the OEM neither knows exactly what components which the systems consist of, nor the processes that are applied to the components in order to create the systems, which further increases the challenges when negotiation with PE

suppliers. In addition, a manager claimed that the low intra-firm knowledge within PE makes the OEM dependent on the suppliers' development capacity for the systems, rather than relying on its own capacity.

In a broader perspective, it is not only the OEM that lacks knowledge within PE. One of the senior managers argued that the degree of maturity is low throughout the whole automotive industry when it comes to PE. The manager stated that some of the suppliers are on a similar learning curve as the OEM and that the OEM in some cases is financing the knowledge development of its tier 1 suppliers. The same manager expressed that it is irrational for the OEM to invest in developing their suppliers' knowledge instead of developing the knowledge within the OEM.

4.2.5 Power Distribution

Data from several interviews describes that the power distribution between the OEM and its suppliers is notably different from the power distribution in the value chains for the traditional systems. First, several managers stated that many tier 1 suppliers are not specialized toward the automotive industry, and that their operations are organized toward the consumer electronics industry. Hence, the tier 1 suppliers for PE systems do not have the same dependency toward the automotive industry and the OEM as the traditional tier 1 suppliers have. Second, as stated previously, many of the PE systems suppliers produce substantially higher volumes than the OEM purchases from them, which further reduces the suppliers' dependency on the OEMs. The situation was explained by a manger which can be summarized as:

> *Suppliers for the systems only need a small portion of their production lines in order to satisfy our [the OEM's] needs, thus they are not so dependent on us [the OEM].*

Third, as the OEM has limited knowledge within PE, which creates challenges in verifying suppliers' cost structures provided for the studied systems and when negotiating prices. A buyer claimed that the OEM has successfully negotiated lower prices when it has had information about the entire end-to-end value chains for other systems. Negotiations have in the past been favorable for the OEM due to that it utilized fact-based arguments regarding costs. For example, based on an interview with a buyer, it can be concluded that:

> *We [the OEM] can negotiate better prices by utilizing fact-based arguments regarding costs. This has been proved successful previously, where we have reached substantial cost reductions, but then we had to promise purchasing volumes.*

Moreover, a tactic that has proven to be successful in lowering costs for the OEM is to direct components from second-tier suppliers to first-tier suppliers in situations where the OEM had the opinion of specific components being too expensive. A prerequisite to using this tactic was that the OEM had knowledge about what components that the system consisted of, what they cost, as well as which suppliers could provide them.

Fourth, when outsourcing development activities to a supplier, a manager highlighted that the OEM experiences lock-in effects. The manager explained that once the OEM committed to a specific supplier, the supplier knew that it would be challenging for the OEM to withdraw from the development project. As a result, the manager stated that the suppliers could raise the price

for the development project when the OEM wanted to make changes in the project. These costly changes could according to the manager imply that the supplier with the lowest price at the outset of a sourcing deal might not be the most economically rational to choose in the long term. In addition, two managers stated that suppliers in some cases might undercut prices for joint development projects in order to win them, as they know that they can make profits later on when the OEM likely requests changes.

4.2.6 Supplier Transparency

The power electronic systems suppliers' powerful positions enabled them to be restrictive with which information they provided the OEM with. Several managers stated that the transparency from these suppliers is much lower compared with the traditional suppliers. One manager stated that the suppliers merged different costs (i.e., their component prices, markups, and SG&A) to avoid disclosing the products' actual cost structures. Moreover, several managers stated the suppliers that provided the OEM with cost structures may also have hidden markups by increasing the costs of components and processes. In addition to a low transparency of the cost structure, the transparency of which subcomponents the systems consisted of and the production process used is also low, according to several managers. Based on an interview with a manager responsible for providing procurement and R&D with cost estimations, the situation can be summarized as:

> *Suppliers within PE have low transparency toward us [the OEM], and it is a constant hunt for better cost split-ups, detailed bill of materials, and information about the production processes.*

The low transparency from suppliers affects the OEM's knowledge within PE. By continuously not sharing information, the supplier can hinder the OEM to effectively improve its own knowledge, and the supplier will maintain their bargaining power, stemming from a knowledge advantage, for a longer period of time. A manager exemplified the power dynamics regarding knowledge imbalances and transparency as following:

> *"When we [the OEM] have put a supplier's part in our final design, they no longer want to speak with us."*

The manager explained that the reasoning behind this behavior by the suppliers is that they have already informally secured a deal and therefore do not provide any more information which would be to the suppliers' disadvantage during the coming negotiations.

In contrast, a senior manager at procurement stated that some of the PE systems suppliers are more transparent once the OEM had signed their offer. Note that this is different from the other suppliers' behavior described above, which instead decreased its transparency toward the OEM after the deal has been made. There is therefore no clear answer to how the suppliers within PE typically behave before and after a deal is secured, but it is important to highlight that a power imbalance to the suppliers advantage often arise after a deal is made, in terms of lock-in effects.

The lack of transparency can also, according to a manager, drive risk for the OEM. The manager explained that quality problems can occur when suppliers are not disclosing every subcomponent of the systems. Linked to this, a manager highlighted that:

> *"When we [the OEM] do not understand the value chains, we risk facing problems."*

Moreover, several managers pointed out that the OEM has received deliveries late from the suppliers due to shortages of subcomponents (e.g., semiconductors). This could not have been foreseen by the OEM as it did not even know which subcomponents the system consists of. In addition, the suppliers are generally unwilling to guarantee the reliability of the systems. This puts the OEM in the position of being accountable for the consequences if something breaks, but at the same time having limited insight in what components that are placed in their cars.

4.2.7 Value Chain Trends for OEMs and Power Electronics Systems Suppliers

As the PE systems are relatively new to the automotive industry, it is not surprising that there are a lot of changes and trends present within their value chains. Not all OEMs are pursuing the same vertical integration strategy; some of the OEM's competitors are moving toward fully owned vertical integration, other are aiming toward quasi-integration or non-integration setups. Based on interviews with multiple managers, we have found that:

> *There is a trend among OEMs and PE suppliers to increase the integration between the systems. This leads to elimination of components and combines the functionalities of the systems.*

A manager stated that many OEMs want to develop one of the systems on their own, but also that the number of suppliers for the system are increasing. Another manager declared that there is strong trend among OEMs to integrate the studied PE systems to a higher degree. Linked to this, the manager explained that suppliers within PE also are moving in this direction by offering more integrated solutions. Several managers stated that the prices of PE systems will decrease substantially in the future, partly due to that the competition among the suppliers is increasing. However, several managers and buyers have also highlighted that the demand for new features and functions contribute to an increase in prices. Moreover, several managers and buyers stated that the price of the systems will decrease notably during the coming years. Several managers stated that since the OEM wants higher performance and new features in the systems over time, the amount of cost savings is uncertain.

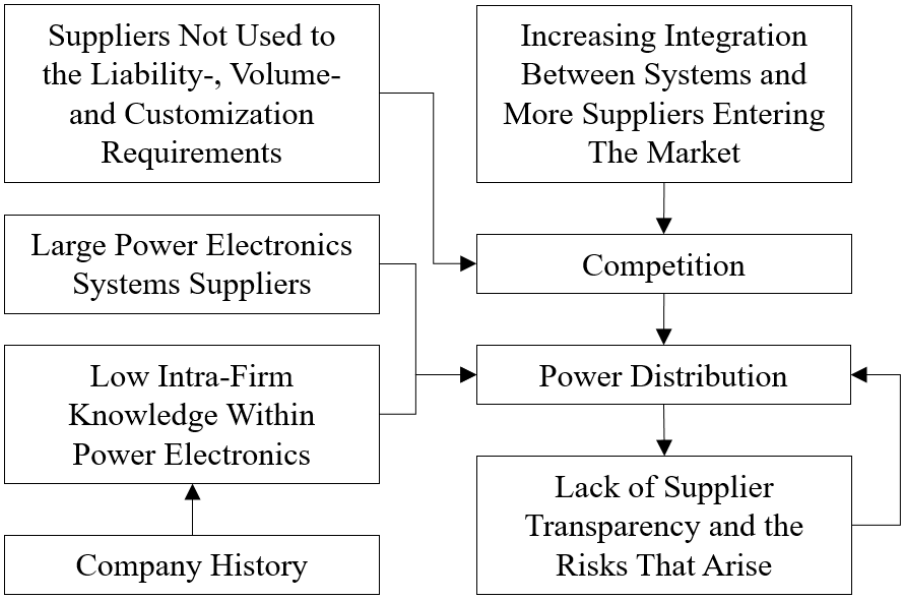
In summary, the main trends among OEMs and PE systems suppliers is, firstly, that both OEMs and suppliers are striving toward more integration between PE systems. Secondly, it is agreed upon by managers and buyers that more suppliers are entering the markets for each of the systems. Thirdly, the prices for all systems are decreasing over time due to rising competition, but because the studied firm wants new features, this might not hold true.

4.2.8 Summary

The findings described above are summarized in Figure 2.

Figure 2

A Description of the Current Power Distribution Between the OEM and Its PE Systems Suppliers



Note. The OEM studied is in a disadvantageous bargaining power position toward its power electronics systems suppliers, which is due to the low level of competition between suppliers, the suppliers not being dependent on the OEM's purchasing volumes, as well as the low level of knowledge regarding power electronics within the OEM.

4.3 The OEM's Drivers for Choosing Activities to Perform in the Value Chains for Power Electronics Systems

The OEM has many drivers for changing which activities it performs in the value chains for PE systems. The chapter starts with a description of the strategic considerations that impact these types of decisions. After this, the aspects economics, technology leadership, and performance are presented. Moreover, the factors time to market and development cycle, quality and integration between systems are depicted. Lastly, the aspects complexity and value added in-house are described.

4.3.1 Strategy

There are strategic considerations which the OEM needs to take into account when analyzing if it should vertically integrate or not, and OEMs currently use different vertical integration strategies partly due to that the automotive value chains for the PE systems are volatile, a senior manager stated. One of these considerations is that the OEM has an aspiration to become a leader within electrification in terms of range and efficiency, the manager claimed.

According to a manager, another strategic consideration expressed by the OEM is that it is becoming more and more of a software firm. In relation to this, based on an interview with a manager, it can be described that:

> *Software is important for customers, and therefore we [the OEM] must ensure hardware that enables future opportunities for software development.*

Furthermore, another senior manager claimed that it is important to control features which are close to the customer and the car. The reasons for that such features are important are because they are part of the customer's experience of using the car.

The OEM mentioned several drivers for pursuing vertical integration. For example, on the basis of an interview with a manager, it can be concluded that:

> *By performing a process in-house, we [the OEM] can easier take new steps regarding development and updates, shorten the time to market, and attain cost benefits.*

By moving processes in-house, multiple managers perceived that the latest technology would become more available, increase the end products' efficiency, and improve system integration, which in turn leads to lower costs, better construction in terms of space efficiency, and increased performance. In addition to these aspects, two managers highlighted quality (i.e., hardware and software robustness) and wanting to perform more profitable value adding activities in-house as drivers for vertical integration, respectively. In addition, the OEM does not want to let suppliers perform too much of the value added which the OEM does not control.

Another aspect regarding strategy, mentioned by managers, is that the OEM has a business philosophy regarding suppliers where the OEM views the relationships as collaborative rather than transactional. For example, the OEM collaborates with its suppliers in development projects, where the OEM performs (among other activities) lean diagnostics on the suppliers' operations, a manager highlighted. Moreover, the manager stated that the OEM's focus in procurement is not primarily on reducing costs.

4.3.2 Economics

Cost reduction has been very frequently stated as an important driver for changing which activities the OEM performs in the value chains for the PE systems. This is not due to the OEM earning too low profits to the extent that it has to pressure suppliers to cut costs, but rather because the BEVs currently being too expensive toward end customers. However, in relation to the ambition of becoming a leader within electrification, one manager acknowledged that it is expensive to be in the technological forefront. This means that the cost of the PE systems cannot be minimized without taking the technology aspect into account. Several managers were determined that it was cheaper to develop the PE systems in-house in comparison with suppliers. Founded on interviews with senior managers, buyers, and managers, the circumstances can be described as:

> *We [the OEM] expect a substantial cost reduction potential for PE systems by developing in-house compared with when suppliers do it.*

One of the rationales behind the belief that there are potentials in cost savings is described more detail in by another manager, and can be summarized as:

> *The activity of specifying what you want from a supplier requires a lot of resources as it is complex and needs to include many functional areas, e.g., both hardware and software. If we [the OEM] were to also develop build-to-print systems, we would only need to double or triple the resources.*

Related to this statement, a manager stated that when the OEM lets suppliers develop its systems, the OEM's R&D department act as specifiers, and as the activity of specifying requires approximately the same amount of personnel as development, the OEM might as well conduct the development itself. It is therefore not clear exactly how much additional resources that are required if the OEM wants to develop build-to-print systems. The amount of additional resources required can vary depending on the development type/area, e.g., a hardware enclosure and an electronics board will require different levels of additional resources, a manager pointed out.

Several managers speculated in reasons for the potential cost reductions. One of the reasons mentioned was that the suppliers have non-optimized production processes. Additionally, managers claimed that the technology uncertainty regarding PE systems in BEVs could increase the costs, and that the suppliers therefore want to quickly get their money back on their investments (i.e., the suppliers want to rapidly amortize their investments). In addition, a manager stated that if the OEM were to switch supplier, the new supplier would need to make investments in developing a new system, which would increase the piece-price of the systems in the form of amortization. Furthermore, two managers highlighted that another potential reason is that the OEM's R&D department have prioritized time and capacity over cost and transparency for the PE systems. Another reason mentioned by two managers is that the OEM continuously is making technological changes to the systems, which leads to a higher part price on the systems. Lastly, multiple managers stated that the immature markets and lack of competition indicate that there might be high margins charged by the suppliers.

4.3.3 Technology Leadership

The technology leadership driver stems from the OEM's ambition to become a leader within electrification. For this driver, a manager asserted that:

> *"If you want the latest technology, you need to have a direct relationship with the developers of that technology."*

According to the manager, the reason behind this is that more often than not, the tier 1 suppliers are blocking direct access to the latest technology. The manager also explained that when they have moved previous systems in-house, the latest technology for that system has become more readily available. This is also supported by other interviewees, who stated that suppliers within PE hide which materials, processes, and technologies they use to produce the systems; the technologies used are therefore sometimes unknown or only partly understood by the OEM, and the supplier might not even be using the latest technology. Moreover, the PE systems studied are very similar regarding the competence needed to understand and develop them. This implies that knowledge developed through having direct contact with the suppliers that are developing the latest technology for one of the systems, can be utilized in other PE systems. Regarding the PE systems suppliers' technological capabilities, various managers stated that no single supplier for any of the systems is considered to have a substantially stronger technology leadership position compared with their competitors (i.e., other suppliers).

Additionally, the potential knowledge gained from developing any of the systems in-house would increase the OEM's knowledge within PE in general, which can be leveraged elsewhere, two managers stated. They described that this knowledge for example can be leveraged during

negotiations with other PE systems suppliers and when considering performing development activities of other power electronic systems in-house.

4.3.4 Performance

In order to be a leader within electrification, performance needs to be of high priority, several managers stated. In this study, performance is described by managers as the energy efficiency and the range of the vehicles. Several interviewees have highlighted the importance of performance, and based on their statements, it can be concluded that:

> *The systems' performance increases if we [the OEM] develop it compared with when the suppliers do it. This increase in performance is caused by integrating the systems in a better way. Moreover, the development of these systems could be done in a quicker and more efficient way in-house.*

The managers gave examples that the performance would increase because the integration would lead to more efficient designs where less cables are needed and that housings can be shared between systems. This will also lead to better space efficiency, a manager stated.

4.3.5 Time to Market & Development Cycle

The drivers time to market and development cycle are connected to the OEM's strategy for technology leadership. To put it more precisely, the OEM wants to minimize the time to market and development cycles of its products. Based on interview with two managers, it was found that:

> *In-house development is a prerequisite if we [the OEM] want to enable rapid development, because if you go through your suppliers you will have to make deals and create contracts, which takes time. Moreover, adjustments from the original specification agreement becomes expensive and take even longer time compared with doing it in-house.*

Adding to this statement, another manager claimed that for some of the studied systems, the technical development cycles are a lot shorter than the platform development cycles of the OEM. Although, one manager did acknowledge that for suppliers in general:

> *"There is a long feedback loop with suppliers."*

The long feedback loops have been highlighted by managers to be a substantial bottleneck when it comes to rapid development. Furthermore, this long feedback loop with suppliers is especially problematic as of now. It is slowing the development process substantially for PE systems where many changes are made in the design relatively often. In connection to this, a manager added the dimension of ownership:

> *"It is important to own the development stage so that you can decide your own pace of development."*

This statement is in line with another manager who affirmed that software development should be conducted in-house as it is more efficient, leads to shorter lead times, and enable more continuous releases.

Moreover, two managers stated that many of the PE systems are complex and the technologies used in these are immature, which in turn leads to big risks incorporated in designing the systems from the supplier's perspective. The risk for the suppliers is that the design is very seldom final, and therefore needs to be changed frequently and substantially.

4.3.6 Quality

Another driver that was found to be important to attain technology leadership was quality. One of the managers claimed that:

> *"The quality of the systems increases if we do it in-house compared with when a supplier does it."*

The reasoning behind this was that the OEM did not know exactly what it was buying when purchasing these systems, and it is therefore exposed to a risk of purchasing insufficient components in the systems with regards to reliability. A manager also explained that by having the development in-house the OEM can more easily and faster react to and resolve potential quality issues.

4.3.7 Integration Between Systems

Another driver for vertical integration mentioned by several managers is integration between systems. Integration between systems is defined as the degree to which systems are put closely together with other systems, or combined in one physical entity (e.g., utilizing the same housing or electronics). With regards to this driver, a manager claimed that:

> *"By integrating the power electronics systems with other systems in the car, the performance increases."*

In addition, several managers were convinced that the activity of integration would be done more effectively in-house. Their reasoning behind this is that while the PE systems suppliers are good at developing single systems, the OEM has an edge when it comes to integrating systems with other systems. In a wider perspective, a manager affirmed that:

> *"Integration is generally important for all power electronics systems."*

Multiple managers believed that in-house development of PE systems would lead to better integration as the OEM knows how to effectively share components and housing for the systems, and that it also would lead to better space efficiency in the vehicle as integrated systems often take up less space. One of the managers exemplified this by claiming that the amount and length of cables can be reduced, which would also result in reduction of some energy losses. Additionally, a manager stated that:

> *"Performing development activities for power electronics systems in-house enables us [the OEM] to integrate parts in a better and easier way."*

A manager and a buyer also made economic arguments about integrating systems. A manager stated that integrating more systems is key to creating more value added for the OEM. In addition, a buyer affirmed that integration is beneficial from both a functional and a cost perspective. In contrast to this, another interviewee pointed out that:

> *"Integration drives complexity, which in turn lowers the number of available suppliers for the system in question."*

There is therefore a trade-off between integration and cost. More integration can lead to more value added for the OEM, while the increased integration lowers the competition between suppliers because not all suppliers that deliver the individual systems have the capability or competence to deliver integrated systems. This in turn increases the prices of the systems charged by suppliers.

4.3.8 Complexity

Closely related to integration, another driver for vertical integration is complexity, which has been mentioned by multiple managers. In this study, complexity means the number of systems that are integrated, as well as the number of integrated sub-systems contained in the systems themselves. The PE systems were found to be substantially more complex in comparison with many other systems in the car. Furthermore, several interviewees highlighted that complexities often bring with them many and frequent changes in mechanical and electrical design, which results in price increases charged by the suppliers. Lastly, multiple managers claimed that there are no substitutes available for any of the systems.

Regarding complexity, a manager claimed that:

> *"The complexity increases for all power electronics, and it then becomes easier to take things in-house."*

The manager's reasoning behind this statement was that because complexity implies high customization by suppliers, it therefore creates a complex and time-consuming operation between the OEM and the suppliers. The manager concluded that it is easier to handle this complexity within the OEM. The suppliers are arguably good at developing and manufacturing single systems, but the OEM considers itself to have an edge when it comes to developing and designing integrated solutions (which also is critical for reaching technology leadership), managers stated.

4.3.9 Value Added In-house

The last driver for vertical integration that was pointed out was to increase the amount of profitable value adding activities in-house.

In reference to an interview with a senior manager, the reason for why this driver is important can be summarized as:

> *We [the OEM] want to have a higher content per vehicle and value added in-house because it gives us a larger piece of the pie. However, we do not necessarily want to maximize the number of value adding activities we conduct in-house, but rather maximize our profit and return on investment.*

To further explain this statement, the manager does not want to put too much of the value added on the OEM's suppliers which it does not control. The manager stated that this is especially important when it comes to the studied PE systems as it is not yet clear which actors that will do what in these value chains; the OEM needs to capture this opportunity by carefully looking into which activities the OEM should perform itself. However, the manager cited here was the

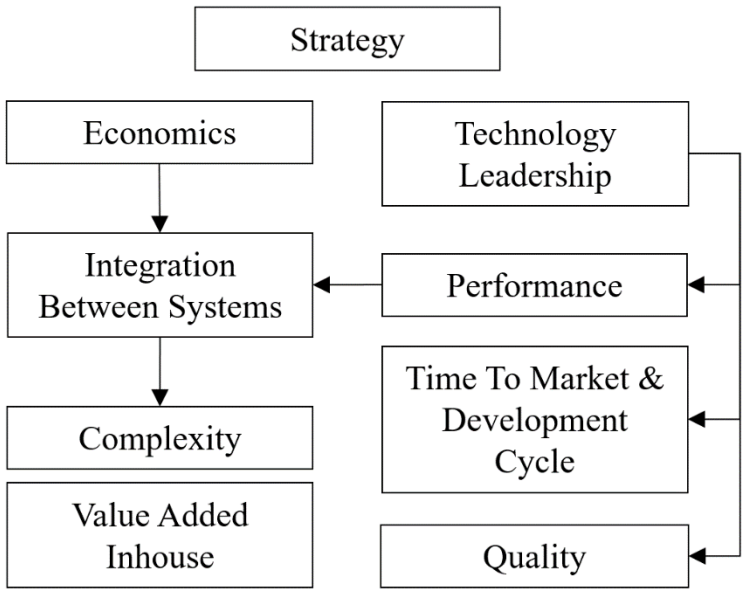
only interviewee who mentioned value added in-house as a driver for vertical integration, which is noteworthy given that several interviewees know that the value adding structure of the value chains are changing substantially in the shift from ICEVs to BEVs.

4.3.10 Summary

The findings depicted in this chapter are summarized in Figure 3.

Figure 3

The OEM's Drivers for Changing Which Activities It Performs In the Value Chains for PE Systems



5. Analysis and Discussion

In this chapter, the distribution of bargaining power between the OEM and its tier 1 suppliers for PE systems is analyzed and discussed. After this, an analysis and discussion of which activities the OEM needs to perform in the value chains for PE systems is provided.

5.1 Power Distribution

The potential benefits and drawbacks from utilizing a firm's bargaining power are many (see Cho & Chu, 1994; Cho et al., 2019; Harrigan, 1985b, 1986; Klepper, 1997; Porter 1980a, 1980b, 2008). Nonetheless, the potential benefits and drawbacks depend on the distribution of the bargaining power between the buyer and the supplier (see Cho & Chu, 1994; Crook & Combs, 2007; Porter, 1980a, 2008). The sections below analyze and discuss the bargaining power possessed by the OEM relative to its PE systems suppliers.

5.1.1 Bargaining Power Sourced from the Industry Structure

Ability to Vertically Integrate. When a set of industrial participants earns too much profit in relation to the rest of the industry's participants, forces and incentives are created for the firms in the industry to vertically integrate and earn these profits by themselves (Porter, 2008). Data show that the OEM has several incentives to backward integrate and perform the activities of its tier 1 suppliers. More specifically, these incentives are: better alignment with strategy, potential economic benefits, reaching technology leadership, higher performance, decreased time to market and development cycles, increased quality, better integration between systems, better handling of complexity, and increased value added in-house. Even though the OEM has many incentives to backward integrate, the bargaining power is determined by the ability to vertically integrate as this creates a threat toward the suppliers (see Cho & Chu, 1994).

When analyzing the tier 1 suppliers' ability to forward integrate, we argue that this is substantially more challenging compared with if the studied OEM was to backward integrate. The reasoning behind this is that the suppliers for PE systems often are rooted in the consumer electronics industry and have none or limited experience with working toward the automotive industry. This implies that it is unlikely that these suppliers have the required knowledge to start manufacturing complex vehicles such as cars. Contrarily, the OEM focuses on a rapid knowledge expansion within PE, which in the future might bring the OEM to a position where it is able to perform some of the activities the tier 1 suppliers currently are performing (i.e., development and final assembly). We do recognize that there are cases where PE systems suppliers have forward integrated and become automotive OEMs (see Korosec, 2019), but we argue that it is generally easier for an automotive OEM to start performing design activities for PE systems than it is for a PE systems supplier to start manufacturing cars. In conclusion, it is suggested that the OEM exerts a greater threat of backward integration (i.e., performing some of the value adding activities of its suppliers) than the suppliers' threat of vertically integrating forwards (i.e., by starting to develop cars). Thus, the OEM has in this aspect, a stronger bargaining power (see Cho & Chu, 1994; Porter, 2008).

Number of Suppliers and Buyers. The number of potential tier 1 suppliers for PE systems is limited, meanwhile the number of OEMs on the market are many. For the studied systems, the OEM ended up in situations where only one or two suppliers were possible to source from. This was due to a combination of the supplier's unwillingness and/or ability to fulfill the OEM's strict requirements and to take liability risks, and the already low number of potential suppliers from the outset. This situation puts the suppliers in an duopolistic or monopolistic

position, and their bargaining power relative to the OEM is high since the OEM cannot play out the suppliers against each other (see Cho & Chu, 1994; Harrigan, 1984; Porter, 1980a, 2008). Being dependent on a single supplier also exposes the OEM to the risk of being subject to opportunistic recontracting (see Monteverde & Teece, 1982). Thus, the OEM is in an unfavorable bargaining power position regarding this aspect (see Cho & Chu, 1994; Harrigan, 1984; Porter, 1980a, 2008).

Purchasing Volume. The potential tier 1 suppliers for PE systems are generally in comparison to the OEM large, in terms of number of employees and revenue. For instance, the study has identified that the tier 1 suppliers are ranging between three to eight times the size of the OEM. In addition, some of these suppliers have other main markets and the automotive industry is not their main niche. Thus, the purchasing volume the OEM offers to its suppliers is small relative to the suppliers' total production. This implies that the supplier is not dependent on the OEM's purchasing volume, hence the OEM has a low bargaining power in this aspect (see Cho & Chu, 1994; Porter, 2008).

Switching Costs. When suppliers develop firm specific systems, it creates strong lock-in effects for the OEM, however, the supplier is not as locked in by the OEM due to that the OEM only represents a small share of the supplier's total sales. In addition, it is in some cases impossible for the OEM to change supplier abruptly. A manager stated that if the OEM was to change supplier, the OEM would need to invest in developing a new system, which would require more development time and be reflected in the piece price of the system as amortization. When the OEM is being locked in by the supplier, the supplier will get a stronger bargaining position (see Cho & Chu, 1994; Porter, 2008). The power position caused by high switching costs has been witnessed in the study where the suppliers could undercut the price for a joint development project in order to win it. Once the project has started and when the OEM wants to make changes, the supplier can increase the price of the project substantially since the OEM is facing even higher costs to switch suppler. Hence, regarding switching costs, the OEM is in an unfavorable bargaining power position (see Cho & Chu, 1994; Porter, 2008).

Product Differentiation and Substitutes. The OEM is requesting highly differentiated products, partly derived from their need of integration between systems. Since the OEM's requests cannot be fulfilled with standardized (i.e., off-the-shelf) products, the number of potential suppliers is reduced, and the suppliers' bargaining power will be stronger (see Porter, 2008). In addition, no substitutes for the systems exist, which implies that the suppliers' bargaining power will be stronger (see Porter, 2008). Therefore, the OEM has a low bargaining power relative to its suppliers in this aspect (see Porter, 2008).

Suppliers' Involvement in Sales and Marketing. For the studied systems, the suppliers are not involved in sales and marketing toward the OEM's customers. Thus, the OEM blocks the suppliers from gaining higher bargaining power in this aspect (see Cho & Chu, 1994).

Technology Leadership. The OEM's strategy is to be one of the leaders within electrification, and reaching technology leadership is therefore highly prioritized by the OEM. However, no single supplier within PE systems is regarded have a substantially better technology leadership position than their competitors. Moreover, it has been identified that some of the suppliers for PE systems are rather slow in adapting the latest technology and act as a blockade for accessing this type of technology rapidly. Therefore, we conclude that the aspect of technology leadership gives the OEM a better bargaining power position as described by Cho and Chu (1994).

Information. The OEM does not have full information about the systems' prices, processes, and components. When a buyer lacks information, the supplier gains a stronger bargaining power position (Cho & Chu, 1994). Porter and Millar (1985) suggest that through requesting quotations and using automated BOMs, a buyer can evaluate a make or buy decision easier. However, data show that the suppliers are taking advantage of their power position by not sharing information with the OEM, for example through having a low degree of transparency toward the OEM by returning incomplete BOMs. Thus, the advantages mentioned by Power and Millar (1985) are not gained by the OEM. In summary, the suppliers for PE systems have a stronger bargaining power position with regards to the information aspect (see Cho & Chu, 1994).

5.1.2 Propensity to Exert Power

Supplier's Contribution to Quality. The suppliers' products are critical for the quality of the end-products (i.e., cars) produced by the OEM. The systems' reliability is important for the powertrain to work, and the systems have a direct effect on the powertrain's performance. In other words, the suppliers have a substantial contribution to the end-products' quality, which makes the OEM less likely to exert its power over them (see Cho & Chu, 1994). In this specific case, the importance of high reliability of the cars produced and the OEM's strive for a position as a technology leader makes the supplier's contribution to quality particularly important, which makes the OEM less price sensitive (see Cho & Chu, 1994; Porter 2008). Hence, it is concluded that the OEM is not likely to exert its bargaining power over its suppliers regarding this aspect (see Cho & Chu, 1994).

The Buyer's Profitability. In this case, the OEM does not earn low profits to the extent that it must pressure suppliers to cut costs (see Cho & Chu, 1994; Porter, 2008). However, the OEM is pressured by customers to reduce the price on BEVs (currently representing a small share of total sales). This increases the likeliness of the OEM exerting its bargaining power over its suppliers (see Porter, 2008). In conclusion, the OEM does not have profitability issues, but it is pressured to reduce purchasing costs due to the expensive BEVs, which in total makes it more likely to exert power over its suppliers (see Cho & Chu, 1994; Porter, 2008).

Business Philosophy and the Buyer's Motivation in Procurement. The OEM's business philosophy regarding suppliers is that the relationships are viewed as collaborative rather than transactional, and the OEM's motivation in procurement is not solely focused on minimizing costs. For example, the OEM has collaborations with suppliers in terms of development projects (e.g., performing lean diagnostics on their operations). However, there is a lack information regarding what business philosophy the suppliers have regarding the OEM, and hence a conclusion cannot be drawn on which actor is most likely to exert power over the other for this aspect (see Cho & Chu, 1994).

Slack in Production Capacity. Several of the potential suppliers withdraw from the request to serve the OEM due to lack of resources (i.e., the suppliers are lacking either development- or production capacity). This makes the suppliers more likely to exert its bargaining power over the OEM (see Cho & Chu, 1994).

Rapid Growth. Some of the suppliers are new in serving OEMs in the automotive industry. However, the data contain no indication whether or not the PE systems suppliers focus on

growth to the extent that they do not want to exert its bargaining power over the OEM (see Cho & Chu, 1994). Hence, no conclusion can be drawn regarding this aspect.

5.1.3 Summary

Based on the analysis and discussion of the differences in bargaining power between the OEM and its PE systems suppliers, it can be concluded that the OEM has three advantages sourced from the industry's structure: a future potential ability to backward integrate, no single supplier having clear technology leadership relative to their competitors, and the suppliers' nonparticipation in sales and marketing toward the OEM's customers, which all favors the OEM's bargaining power (see Cho & Chu, 1994; Porter, 2008). On the other hand, it can be concluded that suppliers for PE systems have at least five advantages sourced from the industry's structure: they are few, they are not dependent on the OEM's purchasing volume, the OEM has high switching costs, there are no product substitutes, and the OEM lacks information and knowledge, which all favors the suppliers' bargaining power (see Cho & Chu, 1994; Porter, 2008). See Table 3 and Figure 4 for an overview of the OEM's and the PE systems suppliers' advantages respectively.

Table 3

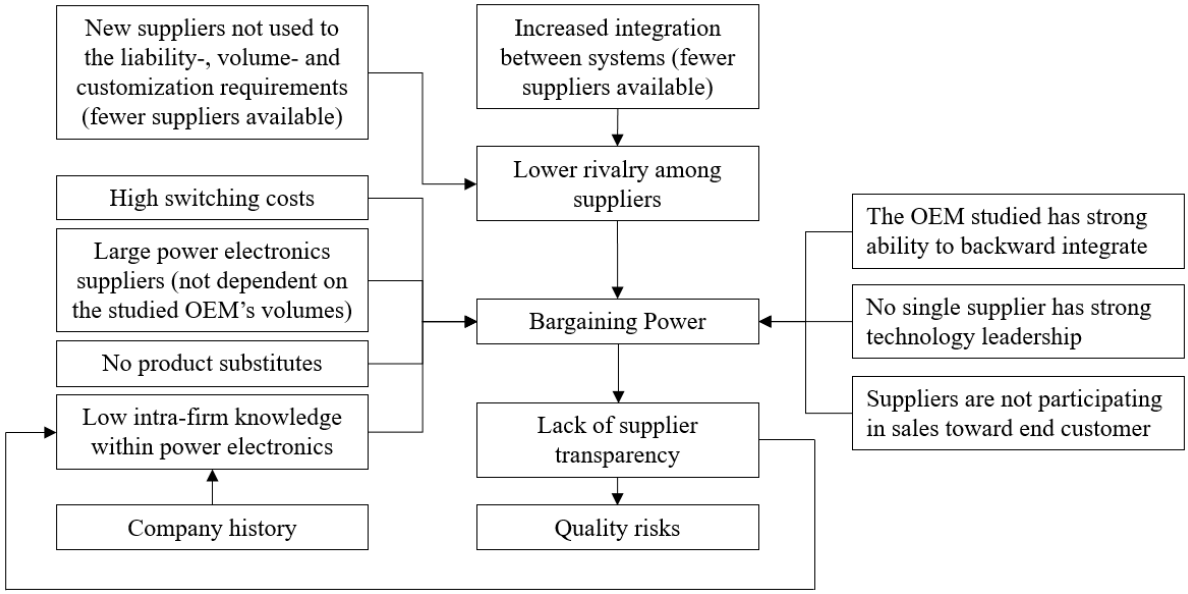
The OEM's and Its PE Systems Suppliers' Advantages From a Power Perspective

OEM's advantages	**Tier 1 suppliers' advantages**
Future potential to backward integrate	Few competitors
No single supplier having clear technology leadership relative to their competitors	Not dependent on the OEM's purchasing volume
Suppliers' nonparticipation in sales and marketing toward the OEM's customers	High switching costs toward the OEM
	No product substitutes
	OEM's lack of information and knowledge

Note. This table describes the advantages that the OEM and its PE systems suppliers have from a power perspective. Note that the advantages are not equally important.

Figure 4

A Description of the Power Distribution Between the OEM and Its PE Systems Suppliers



Despite not having information about all the aspects of the actors' propensity to exert their power, we argue that conclusions can be drawn. As discussed, the OEM has a pressure from its customers to decrease its purchasing costs from suppliers. However, the suppliers have a strong contribution to the quality of the OEM's end-products, and the OEM has a business philosophy where it sees relationships as collaborative rather than transactional. We argue that the latter factors overweigh the former and conclude that the OEM is not very likely to exert its power over the suppliers (see Cho & Chu, 1994; Porter, 2008). Regarding the suppliers' propensity to exert their power over the OEM, the study is lacking data of the suppliers' business philosophy and their desire for rapid growth. However, the suppliers have low levels of slack in their production capacity, which makes them more likely to exert their power over the OEM (see Cho & Chu, 1994).

To summarize, the power advantages that the OEM possesses is not sufficient to weight up the power advantages of the suppliers, and it is therefore concluded that the OEM has a weaker bargaining power position relative to its suppliers. Hence, it is the suppliers that enjoy the possible benefits from a power advantage described by Cho and Chu (1994), Cho et al. (2019), Harrigan (1985b, 1986), and Porter (1980a, 1980b, 2008) and it is likely that the suppliers are utilizing this power to increase the price toward the OEM (see Klepper, 1997).

To increase its bargaining power, the OEM could in theory reshape the entire industry structure for the PE systems and hence alter the distribution of bargaining power between the industry's actors (see Porter, 2008). However, this is not a job for smaller actors such as the studied OEM, since it requires resources that are only possessed by larger players (see Porter, 2008). Instead of reshaping the entire industry structure for the PE systems, the OEM could progressively build switching costs toward their suppliers and thus accumulate bargaining power over time (see Crook & Combs, 2007). However, we argue that the OEM's small purchasing volume in relation to the size of its power electronic systems suppliers will make it very hard to create

any lock-in effects. We will later discuss how vertically integrating and performing the development step in-house can favor the OEM's power position.

5.2 Drivers for the OEM to Change Activities It Performs in the Value Chains for Power Electronics Systems

The OEM has many drivers for changing which activities it performs in the value chains for PE systems, namely: better alignment with strategy, economic benefits, reaching technology leadership, higher performance, decreased time to market and development cycles, increased quality, better integration between systems, better handling of complexity, and increased value added in-house. The framework from Harrigan (1983, 1984, 1985b) is used to analyze and discuss the OEM's incentives to change which activities it performs in the value chains for PE systems. However, Harrigan's (1983, 1984, 1985b) framework takes a more macroeconomic perspective, and therefore some aspects which are specific to the studied OEM need to be taken into account. These aspects are added to the framework and are discussed and analyzed below.

Phase of Industry Evolution. Data show that the market for PE in the automotive industry is immature, since many and substantial technological and design changes are made rapidly, which is typical for the fluid phase in the U-A model presented by Utterback and Abernathy (1975). The OEM is experiencing problems during these changes, where long feedback loops from its suppliers are making them hard to perform. The reason for why this is problematic is that the OEM needs to have rapid development to be a leader within electrification, as well as unsynchronized feedback loop cycles and platform cycles. Contracts need to be negotiated between the OEM and the supplier when a supplier is responsible for development, and adjustments from the original contracts takes longer time to perform compared with if the development was conducted in-house at the OEM. In other words, the OEM favored in-house development in situations where technological and design changes are made rapidly. This is not in line with Harrigan (1984, 1985b) who argues that a low degree of vertical integration is expected in the early phases of an industry's evolution due to high demand uncertainty. However, the OEM is aiming to become a leader within electrification, and successful firms have in numerous cases been active in industries' early phases (see Harrigan, 1986). Hence, regarding the phase of industry evolution, we expect the OEM to backward integrate and take development activities in-house even though the industry is in its early phases.

Volatility of Competition. Data indicate that competition among tier 1 suppliers is volatile for the studied PE systems. Furthermore, the systems are frequently undergoing design changes since a dominant design has not yet been established. However, we do expect that there will be a dominant design in the future, and that the OEM only needs customized solutions in terms of both form and integration with other systems. In general, extensive vertical integration should be avoided in volatile industry structures since the volatility increases the likelihood that competitors use tactics that can eliminate the long-term profitability of the industry (Harrigan, 1984). However, the OEM is pursuing a technology leadership strategy and vertical integration should not necessarily be avoided (see Harrigan, 1984). Therefore, we conclude that the volatile value chains for the PE systems does not force the OEM to avoid backward integration, but does on the other hand not suggest that the OEM should vertically integrate.

Bargaining Power. As discussed previously, the OEM has low bargaining power compared with its PE systems suppliers, and it is the suppliers that enjoy the possible benefits from a power advantage (see Cho and Chu 1994; Cho et al., 2019; Harrigan, 1985b, 1986; Porter,

1980a, 1980b, 2008). Successful firms have performed more activities in-house during such circumstances (see Harrigan 1984), indicating that the OEM is more likely to backward integrate. In addition, firms experiencing high switching costs (i.e., making the firm dependent on suppliers) makes backward integration more likely to occur (Monteverde & Teece, 1982).

If the OEM would have a strong bargaining power relative to its PE systems suppliers, it could control suppliers without vertically integrating (see Harrigan, 1984) through for example a quasi-integration set-up (see Blois, 1972). However, this is not the case, and therefore backward integration is a feasible option that will give the OEM control over its economic environment (see Harrigan, 1984). If the OEM would move upstream in the value chain and for example start to develop build-to-print systems in-house (i.e., taking the development activity in-house from the tier 1 suppliers), the power distribution between the OEM and its suppliers would change. First, to develop the systems in-house, the OEM needs to acquire more knowledge regarding PE. This would close the knowledge gap between the OEM and its suppliers and thus the OEM would get a stronger power position compared with the current situation (see Cho & Chu, 1994). Second, by developing in-house, the OEM would have many more suppliers to source from since there are more contract manufacturers who can deliver according to a build-to-print specification than there are suppliers that can perform both development and manufacturing. This will further increase the bargaining power of the OEM (see Cho & Chu, 1994; Harrigan, 1984; Porter, 1980a, 2008). Third, moving toward a build-to-print setup, the cost of switching suppliers (i.e., switching costs), will be reduced since the lock-in effects are expected to be substantially reduced (see Cho & Chu, 1994; Porter, 2008). Thus, regarding bargaining power, we argue that the OEM is expected to backward integrate.

Corporate Strategy. A firm's decision whether to vertically integrate or not must be considered in relation to its overall corporate strategy, and not be isolated to particular make or buy cases. The OEM is pursuing a technology leadership strategy, which according to Harrigan (1983) implies that the OEM is more suitable for a higher degree of vertical integration compared with firms that are pursuing more generic cost leadership strategies. The development activities in the value chains are critical to the OEM's strategy and should be considered as a central driver when deciding if the OEM should perform the particular stage in the value chains or not (see Harrigan, 1983). By moving upstream in the value chains, the OEM would get advantages that increases its likelihood to reach technology leadership. For example, data suggest that feedback loops are slower when the OEM lets the suppliers perform the development activities compared with performing it in-house. By developing in-house, the OEM can more easily and rapidly test and resolve problems compared with a supplier. Furthermore, the OEM will have increased control over systems that are close to the customer and the car. Thus, given the OEM's strategy of becoming a leader within electrification, we expect the OEM to backward integrate.

Characteristics of the Systems. The quality of goods is crucial for the systems studied, and suppliers cannot always fulfill the OEM's requirements regarding this aspect. Furthermore, R&D managers expect that the OEM can reach an even higher degree of quality if the development processes were brought in-house. The reasoning behind this is that the OEM does not know exactly what specific components the systems consist of when they are developed and manufactured by suppliers, which would not be the case if it was developed in-house. The OEM is therefore exposed to a risk of purchasing insufficient systems in the cars with regards to reliability. Furthermore, data show that the OEM can respond quicker to potential quality problems compared with suppliers. The systems influence on the cars' performance and quality

suggest they should be produced in-house (see Harrigan, 1984; Mahoney, 1992). By performing the development activities in-house, the OEM will get complete control over and information about the components within each of the systems.

In addition to quality, data indicate that the systems are complex, subject to high degree of customization, and that the activity of specifying requirements is a substantial engineering effort, all increasing the likelihood for the OEM to backward integrate (see Mahoney, 1992). By performing the development activities in-house, it will be easier for the OEM to handle the complexity. This is partly due to that the OEM has better knowledge of how the systems could be integrated with other systems in the car (i.e., in terms of function and form) compared with suppliers. Another reason for why the OEM can handle complexity more effectively in-house is that it can communicate within the organization better compared with communicating with external parties (i.e., suppliers), which is important as increased complexity requires more communication. Furthermore, data indicate that the cars' performance (i.e., efficiency and range) and the position as technology leader is dependent on extensive integration between PE systems. Data suggest that suppliers are good at developing and manufacturing single systems, but the OEM is considered to have an edge when it comes to developing and designing integrated solutions, which is critical for a technology leadership position. The edge in developing integrated solutions further suggest that the development activities of the PE systems is expected to be performed in-house. That assemblers turn to vertical integration when the design of components must be highly coordinated with other parts in the car is further supported by Monteverde and Teece (1982).

Furthermore, the systems studied are also technologically advanced. By internalizing technological capabilities (i.e., development capabilities), the OEM will gain both control over and access to new knowledge (see Rothaermel et al., 2006). Integrating external and internal knowledge would enable the OEM to build a broader product portfolio and provide it with competitive advantages (see Rothaermel et al., 2006). However, vertical integration (i.e., performing the development activities in-house) cuts off the OEM from benefiting from its suppliers' innovations, and Harrigan (1984) argues that firms should be careful to backward integrate in environments where competition is rooted in a high degree of innovation. Therefore, gaining necessary knowledge for new product development in high-technology industries tends to be sourced through strategic alliances rather than through backward integration (Rothaermel et al., 2006). Contrarily, data suggest that the tier 1 suppliers sometimes block innovation rather than support it. Thus, by backward integration, the OEM is not expected to lose the benefits stemming from suppliers' innovations, but rather gain access to new external knowledge which was previously blocked by the tier 1 suppliers (see Rothaermel et al., 2006).

Given the importance of quality and the systems' complexity, impact on performance, extensive integration requirements, and technologies used, we expect the OEM to backward integrate regarding the characteristics of the systems.

Economics. There are substantial cost reduction potentials in performing the development activity in-house for the PE systems. First, the activity of specifying toward a supplier can be complex and requires expertise from many functional areas, and the step to developing the systems in-house is not a huge leap for the OEM. Moreover, the OEM only needs to double or triple the resources (i.e., number of engineers) for taking this step. Second, changes in

development programs will be easier and less costly for the OEM, which is expected to bring cost advantages since changes are frequently occurring. Third, the immature markets and the absence of strong competition are suggesting that actors might have high margins (see Klepper, 1997). In addition, when the OEM shifts from performing the development activities of ICEs to letting the suppliers conduct these activities regarding the powertrains of BEVs, less value adding activities will be conducted in-house by the OEM. The OEM wants to perform more profitable value adding activities in-house, and performing the development activities of the PE systems in-house is in line with this. With all of these aspects in mind, we conclude that the OEM is expected to backward integrate from an economic standpoint.

5.3 Activities Performed by OEMs in the Value Chains for Power Electronics Systems

Many factors strongly point toward the OEM to backward integrate and take a broader position in its value chains for PE systems. Even though new PE suppliers are inexperienced when it comes to working toward the automotive sector, and that the value chains for PE systems is volatile, we suggest that the OEM needs to backward integrate, due to its striving of becoming a leader within electrification. In addition, the OEM's weak bargaining power against its suppliers makes backward integration attractive since this will reduce the OEM's dependency on these suppliers and reduce switching costs. Moreover, the OEM's strategic considerations point toward the OEM to backward integrate. We have also seen that the systems' complexity, quality requirements, impact on performance, and requirements regarding integration between other systems, all give strong reasons for the OEM to perform the development activities for the PE systems in-house (i.e., backward integrate). Lastly, it has also been indicated that potentially substantial cost reductions can be achieved by moving the development activities in-house, which further speaks for the OEM to backward integrate. In conclusion, we suggest that the OEM needs to backward integrate and perform the development activities for the studied PE systems.

For premium OEMs in general, we argue that it is beneficial to backward integrate and start to perform the development activities in the value chains for PE systems. The aspect of having low bargaining power as a driver for backward integration is not as strong for the general premium OEM. These types of firms are generally larger than the OEM studied and hence their purchased volumes from suppliers are presumably larger, giving them stronger bargaining power (see Cho & Chu, 1994; Porter, 2008). However, the characteristics of the systems (i.e., complexity, quality requirements, impact on performance, and requirements regarding integration between other systems) are, according to us, general for premium OEMs. With respect to the corporate strategy, where the studied OEM is focusing on becoming a leader within electrification, we expect it to be similar among premium OEMs. Finally, the cost saving potential derived from moving development in-house is according to us not firm specific, but rather general for premium OEMs.

In contrast, it is not as clear whether or not OEMs pursuing a cost leadership strategy would benefit from backward integration. A cost leadership strategy often involves larger volumes, making these firms more important customers for their suppliers. In addition, OEMs with a strategy that is not focused on reaching the highest performance among its competitors can accept a higher degree of off-the-shelf products from its suppliers, and therefore more suppliers are available. Hence, an OEM with a cost leadership strategy will have a stronger bargaining power compared with the OEM studied and thus not have as strong incentives to backward

integrate regarding this aspect. As discussed previously, an OEM that does not pursue a technology leadership strategy should be careful to vertically integrate when an industry is immature and competition is volatile, due to that it entails substantial risks (see Afuah & Utterback, 1997; Harrigan 1985b). Regarding the aspects of corporate strategy and economics, the results of this research study cannot be used to draw any conclusions. Hence, this study does not leave any suggestions on how the OEMs that are pursuing a cost leadership strategy need to change its positioning in their value chains for the PE systems studied.

Moving upstream in value chains, as we think is beneficial for premium OEMs in general to do, is not unproblematic and such decisions need to be carefully evaluated (see Blois, 1972). For instance, a backward integration creates exit and mobility barriers (see Porter, 1980a) and prevent the OEMs to change their strategy even in situations where they do not receive an optimal return on its investments (see Harrigan, 1984, 1985a). The current circumstances are characterized by technologies and designs that are changing rapidly, and during such circumstances it is important to have low exit and mobility barriers. Hence, the OEMs need to carefully balance vertical integration and strategic outsourcing (see Rothaermel et al., 2006).

We argue that the general premium OEM would benefit from backward integration and starting to perform the development activities for PE systems in-house. This approach to backward integration can take several different forms (see Harrigan, 1984). In theory, a nonintegration or a quasi-integration approach are the most attractive alternatives, since the OEMs will through these gain the benefits of vertical integration without fully owning (or perhaps not owning at all) the upstream business (see Blois, 1972; Mahoney, 1994). However, benefiting from vertical contracting and quasi-integration requires the OEMs to have strong bargaining power relative its suppliers (see Harrigan, 1984) which currently is not the case. Thus, we conclude that the OEMs' approach to vertical integration will involve a high degree of financial ownership.

6. Conclusion

We conclude that the studied OEM is in a weak bargaining position in relation to its tier 1 suppliers for PE systems. By vertically integrating and performing the development activities in-house, the OEM would attain a more favorable bargaining position. Other premium OEMs that are larger than the OEM studied are considered to have a better bargaining position, making vertical integration less attractive.

This study identifies several drives for vertical integration in the value chains for PE systems which should be considered as generalizable for other OEMs. Therefore, this gives the general premium OEM many drivers for vertically integrating in the value chains for PE systems. We have seen that the characteristics of the systems studied are important to consider when conducting vertical integration strategies. By developing the systems in-house, the systems' complexity can be better handled, and OEMs can develop systems with more effective integration which leads to higher performance. In addition, the OEMs can perform more profitable value added activities in-house, better control the systems' quality, achieve a shorter time to market, and reduce costs. Furthermore, our analysis shows that in-house development of the system studied is important for OEMs that are aiming to become technology leaders. Hence, it would be favorable for the studied OEM to reorganize its value chains for PE systems and internalize the development activities.

This study does not conclude whether or not OEMs that are pursuing a cost leadership strategy would benefit from backward integration. A higher bargaining power, the early industry phase of the studied systems, and the volatility of competition are all pointing toward not backward integrating. However, this study cannot conclude how the cost leadership OEMs' corporate strategies and potential economic effects from a backward integration would affect the OEMs' integration strategies, and therefore this study does not leave any conclusions on if it is beneficial for cost leadership OEMs to change their positioning in the value chains for PE systems.

7. Suggestions for Future Research

To fully understand how the bargaining power is distributed between the OEMs and their suppliers for PE systems, further stages of the value chains need to be investigated. In addition, the breadth and degree of integration (see Harrigan, 1985b, 1986) need to be investigated. Thus, these factors need to be analyzed in order to fully understand which activities in the value chains which the different actors are expected to perform in the future. Moreover, how the development activities can be moved in-house in practice needs to be investigated.

The systems studied is a subset of all PE systems which go into the powertrain of BEVs, hence studying all systems which differentiates an ICEV from a BEV would provide a more holistic view. In addition, this study was conducted from a single OEM's perspective, and therefore a more thorough investigation (e.g., other actors' perspectives) is needed.

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DIVISION OF INNOVATION AND R&D MANAGEMENT
CHALMERS UNIVERSITY OF TECHNOLOGY
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