Characteristics of project-based alliances: evidence from the automotive industry

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Abstract: As organisational governance has evolved from hierarchical structures to relational networks, project-based alliances are increasingly employed by automakers as part of their innovation strategy. In this study, we explore characteristics of different types of project-based alliances in the automotive industry. Employing dyadic data drawn from 59 new product development project-based alliances undertaken by two firms, we are able to discern the relevant characteristics of product, process, and software development projects. Our results suggest very different characteristics for each project type, with products and software presenting contrary results across almost all characteristics. Characteristics of process-focused projects are unique from either product and software alliance-based projects.

Keywords: project-based alliances; innovation; product development; automotive industry.

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1 Introduction

The automotive industry has proved to be among the most progressive innovators in the global marketplace, introducing new technologies, features, and products at a blistering pace. It has faced tremendous challenges from an ever-evolving and vacillating economic environment, an expanded range and depth of geographic markets, and an increasingly complex and competitive arena. Additionally, governmental regulations that are inconsistently developed and applied around the world have caused tremendous pressures on budgets and systems. None of this, of course, considers that buyers remain demanding. Consumers in the developed world have come to expect stylish design, exceptional safety features, and integration with personal connectivity; consumers in emerging markets expect vehicles that are made to suit their unique needs as well. In the face of all these broad challenges, innovation is necessary to both adapt to environmental advances and to proactively create opportunities for the future; it is among the key reasons the industry has continued to grow through periods of substantial turbulence (Townsend and Calantone, 2014).

While the automotive industry has continued to grow in size and is expected to sell at least 89 million units globally in 2016, it has also undergone intense structural change in order to adapt to the environmental constraints and competitive pressures. Hierarchically controlled systems that had adversarial orientations toward inter-firm relationships in markets are evolving into more dynamic cooperative arrangements (Whitley, 2006). Companies that were once highly vertically integrated have focused more strictly on their core businesses, shedding their internal supply bases in the process (Jullien and Pardi, 2013). This has been largely a function of the need to exploit key capabilities, and to find efficiencies across systems in the face of extreme cost compression. Internalised systems and structures have given way to quasi-market-based approaches to organisational governance. For example, both General Motors and Ford spun off their internal supply bases, which have become major suppliers to many OEMS in the industry. This phenomenon of disentanglement has not been limited to fully internalised structures. Case in point, a quasi-internalised organisational structure was permanently altered when Nissan largely disbanded its keiretsu system in order to raise cash in a time of financial crisis. Suppliers are now more commonly managed through relationships, rather than through a system of inter-ownership. In this relational paradigm, there is also need to safeguard critical assets and knowledge bases. These competing interests provide a quandary for managers who are trying to integrate innovation into extremely complex products like automobiles, where thousands of parts come together to form a final product comprised of components that include products, processes, and, increasingly, software. Key innovation often takes place within vertical and horizontal channel, but a balance must be struck between the need to safeguard and the need to collaborate. Achieving successful outcomes in this dynamic environment requires novel approaches to developing new products.

In addition to the expected efficiencies gained through careful management of value chain activities, inter-firm cooperation is a means to advance competitiveness through new product development (Kasper and Streit, 1998; Dolan and Lindsey, 1988). The mechanisms facilitating innovation in contemporary networks though is fundamentally different than how relationships would have been managed in the past, when firms outside the boundary of the OE would be integrated through contractual governance structures. In the contemporary milieu, traditional forms of relationships have begun to change from contract-based affiliations into more collaborative arrangements such as inter-firm partnering and networking (Dilk et al., 2008). While major events, like equity stakes and large scale relationships between and among automakers and their supply base get a considerable amount of attention, among the most prolific forms of partnerships are those that are project-based. This approach is represents a finite type of relationship, based on a clear design where specific goals are expected to be achieved through the relationship (Schulze et al., 2014). Many automakers and suppliers now consider each product to be a form of project-based alliance, making this an extremely important tool for managers.

Project-based alliances are an inherently progressive organisational form, as each venture creates a new structure to support the needs of each project, and each expected outcome. Much of the research related to project-based organisational forms has been focused on the form itself (Whitley, 2006), learning processes (Prencipe and Tell, 2001) and the effectiveness of this organisational form (Hobday, 2000). The alliance literature is, of course, extensive in breadth and depth, with the basis being that alliance arrangements are agreements between firms to cooperate in some way, but they do not involve the creation of new entities (Glaister and Buckley, 1996; Contractor and Lorange, 1988). What is important to note in this context is that partnership structures have been recognised as alternatives to either pure market exchange or internalisation, with the term quasi-hierarchy applied to joint ventures, or the term quasi-market applied to contractual relationships (Osborn and Baughn, 1990). We explore project-based alliances as a quasi-market form of organisational structure employed to address contexts in the automotive industry.

Project-based alliances are employed by automakers in a myriad of ways. They use them to spread the costs of new technologies and products across multiple partners, to share resources and knowledge, and to develop ecosystems and platforms. Key project types include product-based projects, process-based projects, and software development projects. The fundamental research question we address is in this study: What are characteristics of different types of project-based alliances in the automotive industry? Gaining a greater understanding of the phenomena associated with project-based innovation in the automotive industry provides a foundation for improving managerial decision making when developing and executing an innovation strategy that include project-based alliances among network partners. It also provides scholars a foundation for further understanding of the phenomenon and the development of future research.

The remainder of this article is framed in the following manner. First we explore the conceptual foundations of alliance-based projects, key project types, and alliance-based project characteristics. Next, we present our method to approach our research question, and the results of our exploratory study. We conclude with a discussion and future research directions.

2 Conceptual development and literature review

Transaction cost economics is among the most dominant theoretical perspectives of business that explains an exchange-based paradigm has been viewed via the exchange-based perspective, as most commonly explained by Coase (1937). The basic tenets of this theory encompass the merits of vertical integration – considered to be the link backward into materials, laterally into components, and forward into distribution – relative to market exchanges, with the principal reason for the implementation of a hierarchical structure being the requisite need to economise on transaction costs (Williamson, 1985). Correspondingly, partnership forms have been recognised as alternatives to either pure market exchange or internalisation, with the term quasi-hierarchy applied to joint ventures, and the term quasi-market applied to contractual relationships (Osborn and Baughn, 1990).

Over time, a shift in focus of businesses from vertical integration to a focus on core competencies has given rise to the use of complex quasi-form organisational structures seeking to establish or extend a firm's differentiation, either vertically in its value chain or horizontally through either competitors or complementary companies. This is because internal organisations tend to have distinctive governance instruments, which should have an advantage in situations of high asset specificity. Yet, efficient boundaries establish the point where common ownership and own supply can be shown to be economical. On the other hand, markets have high-powered incentives which favour tighter production cost control, and restrain bureaucratic distortions. They can also achieve advantage through aggregate demands that realise economies of scale and scope (Williamson, 1985). As the cost of design and development increases, firms in industries with high development costs such as those in the manufacturing sector have increasingly employed the use of consortia in order to control these overhead expenses (Terpstra and Simonin, 1993).

Since alliances allow for the pooling of resources without the level of commitment or integration required by equity-based agreements, they create a broader range of resource opportunities. Through alignment and extension, collaboration with a partner provides an opportunity to fulfill the requirements of a sustained competitive advantage, where the deployment of resources and capabilities enable the firm to conceive of or implement strategies that ultimately improve performance, exploit market opportunities, or neutralise impending threats (Barney, 1991). Leveraging a firm's particular skills with the distinctive resources of its partners creates the opportunity for more effective positioning in the marketplace (Bucklin and Sengupta, 1993). Thus, through the efficient use of a partner's existing resources, the boundaries of the firm can be effectively extended in a way that cannot be achieved independently.

Project-based alliance relationships are inherently attractive for a number of reasons. They are a means for firms to maintain independence, while creating synergies that extend the range of its core resources. One key synergy lies in knowledge accessing whereby the alliance partners increase their knowledge specialisation leading to an increase in the value of the partnership (Grant and Baden-Fuller, 2004). Risk sharing in highly volatile environments reflect in the changes of degree and pattern of environmental attributes (such as competition, technology, consumer preferences), industry structures, or even shareholder value (Milliken, 1987). Rapid changes create a situation of relative uncertainly, and it is under these conditions that the advantage of alliances as a vehicle for knowledge accessing is especially apparent (Grant and Baden-Fuller, 2004). Alliances enable firms to gain knowledge to adapt to these environmental changes (Das and Teng, 2000). The automotive industry is in a period of significant transition with the advent of alternative drive trains, and the increased use of technology within the vehicle system itself, as well as the interface with consumers, their personal devices, and even external technologies, such as traffic and weather.

Long product development times, extensive depth of supply chains, and technology-intensive products that are highly varied and differentiated, are key attributes of the automotive industry (Dickinson et al., 1993). In the past, the suppliers in this industry were inextricably linked to specific original equipment manufacturers on the basis of the strength of the dependency of their business; it was due to an oligarchic structure to the industry. Yet, the nature of many manufacturing industries has changed and the number of direct tier one suppliers has been reduced significantly. Modular products and sourcing for final assembly has resulted in relationships with increased parity between suppliers and manufacturers (Marx et al., 1997). Many tier 1 OE suppliers have gained critical mass through mergers and acquisition, and internal growth to become more independent and allowed for more project-based alliances product development.

According to Whitley (2006), there are two differentiating features of project-based structural forms: Singularity and distinctiveness that are orthogonally related and form four distinct types of project forms. Rather than investigating structural forms, we explore the characteristics of one organisational form: project-based alliances. In order to study this effectively in the automotive industry, we consider three key project types: products, processes, and software. Our purpose is to understand better what characteristics are most relevant for the various project types.

3 Method

In this section, we describe the data and present our measures, variables, and estimation strategy. The first part of the section, we show the steps we follow to prepare the data and build the analytic sample. Then, the second and third we present the results of an exploratory factor analysis and dependent and explanatory variables we use for the analysis. In the final part of the section, we offer a detailed overview of the estimation strategy we employ to explore our research question.

3.1 Sample

Our exploratory study employs data drawn from 59 new product development projects jointly undertaken by two firms. The objective of the collaborative development for the partners was to develop innovative and complex technical products, software, or processes. The firms belong to the automotive industry and are located in Switzerland, Germany, and Austria. The study only included projects completed within the last three years, ensuring the respondents could recall information-relevant details. The project is considered as the unit of analysis for all measures.

3.2 Data collection

The project selection was based on an existing database of development projects complemented with secondary data from press releases on development cooperation. R&D managers' names and contact information were added and the relevant projects' details were obtained by phone. Thereafter, one partner was appointed as the *source firm* and the other as the *recipient firm* to include *both* partners in order to obtain unbiased data. Multiple respondents were contacted from each project for the data collection procedure: the project manager, the project leader, and at least four randomly selected recipient firm team members as well as the source firm's project leader. The respondents' participation was strictly voluntary and their anonymity ensured. All the respondents received a link to their personalised and standardised online questionnaire via email. The type of questionnaire to which they were linked depended on the role that they had played in the project. The number of team members answering the questionnaire differed, as this depended on the response rate and project size, although both the partner firms were always represented. In total, the study comprises 252 valid responses, which constitute 59 sets of data. The response rate of the firms requesting a link to their particular questionnaire was 88%, resulting in a final sample of 60 firms. These firms had undertaken a development project with one other firm from this sample. Some firms, however, answered the questionnaires in respect of various projects that they had undertaken with different partners. The questionnaires were administered in German. Whenever possible, this research used construct definitions and measures from the literature to ensure content validity (Churchill, 1979; Nunally and Bernstein, 1994) (see Table 1). To encourage realistic answers, the respondents were asked to describe a specific set of knowledge that had to be transferred. Thereafter, they answered the questions related to this knowledge set's transfer.

3.3 Data preparation

The data, as already mentioned, consists of multiple individuals evaluating the same items. For example, team leaders and team members of both partners evaluated self-reported project success. This procedure is rather common in self-reported questionnaires, and it aims at reducing single source bias (Baugh et al., 2006). Therefore, we first assess the reliability of the individual answers, for each of the evaluated items or characteristic of a given project. Second, if the evaluations turn out to be reliable, we can replace the missing values of those who were not asked to evaluate a certain item with a within-project average consisting of individual's evaluations of those who were asked about such item. This ensures that we do not lose too many observations when creating the final sample.

Table 1 Description of the independent variables

Concept	*Factors and variables*	*Cronb. α*	*Description*
Interdependence	Product architecture (1 item)	---	• The architecture of the item (product, process, software) that was developed in the project was characterised by clearly defined (technical) interfaces with the partner's component.
	Development tasks (2 items)	0.761	• There was a large subject-specific dependence between the development tasks of our company and of the partner's development tasks. • The partner's development contribution was an important component of the developmental work of the common project team.
Resource deficiency	Material and financial resources (4 items)	0.801	• We had enough/sufficient material resources in this project (e.g. test stands, rooms/facilities etc.) (reversed). • In this project we had to get along with less material resources than in previous projects (e.g. test stands, rooms/facilities etc.). • We had enough/sufficient financial resources in this project (e.g. project budget) (reversed). • In this project we had to get along with less financial resources than in previous projects (e.g. project budget).
	Human resources (2 items)	0.835	• We had enough/sufficient human resources in this project (reversed). • In this project we had to get along with less human resources than in previous projects.
Communication	Co-location (1 item)	---	• How long did you work together with the partner on a common location/site? (in relation to the entire project duration.)
	Share of face-to-face (3 items)	---	• Share of formal face-to-face communication during the project 1 with video conferences 2 in group meetings in the own/in the partner company 3 by expert meetings

Table 1 Description of the independent variables (continued)

Concept	*Factors and variables*	*Cronb. α*	*Description*
Organisational processes	Organisational processes (4 items)	0.709	• The project required new production processes or new equipment. • The project changed the organisational culture. • The project required intense collaboration with external partners. • The project required additional financial means.
Market position	Market position (3 items)	0.742	• The project improved partner A's market position. • The project improved partner B's market position. • The project created an entirely new customer benefit.
Knowledge transfer	Learning from project (4 items)	0.867	• Knowledge was successfully transmitted between the partners. • The partner is able to share the received knowledge to third parties. • The partner is satisfied with the received knowledge. • The partner autonomously applies the received knowledge.
	Tacit knowledge (1 item)	---	• Share of tacit knowledge of total knowledge transferred during the project.
Benefit from partnership	Benefit from partnership (3 items)	0.802	• The partnership increased product quality. • The partnership improved problem-solving skills during the project. • The partnership helped to set more realistic project goals.
Control	Team size (1 item)	---	• Total number of individuals that worked for the project.

To assess the validity of individuals' answers, we follow the approach by James et al. (1984). They introduce a procedure for estimating inter-rater reliability for evaluations on Likert scales of a series of targets by one group of 'judges.' The term 'inter-rater' refers to the degree to which the judges are interchangeable, i.e., to which extend these judges agree on a set of judgments. Mathematically, the inter-rater reliability is the proportion of systematic variance in a set of judgments in relation to the total variance in the judgments. In practice, the most direct approach for computing the inter-rater reliability for multiple items is:

$$r_{WG(J)} = \frac{J\left[1-\left(\overline{s_{x_J}^2}/\sigma_{EU}^2\right)\right]}{J\left[1-\left(\overline{s_{x_J}^2}/\sigma_{EU}^2\right)\right]+\left(\overline{s_{x_J}^2}/\sigma_{EU}^2\right)}$$

where $r_{WG(J)}$ is the within-group inter-rater reliability for judges scores based on J items, $\overline{s_{x_J}^2}$ is the mean of the observed variances on all X_j items, and σ_{EU}^2 is the expected error (E) variance based on a uniform (U) distribution, which can be calculated following Mood et al. (1974) as $\sigma_{EU}^2 = (A^2-1)/12$, where A corresponds to the number of alternatives in the response scale (for us, $A = 5$). In our case, the number of judges changes over different items and projects. We thus need to compute each s_x^2 separately and then calculate the overall average variance. We compute the inter-rater reliability for each item evaluated on a Likert scale, which corresponds to 26 variables of the 35 we use for our analysis. Therefore, with $J = 26$, we compute the within-group inter-rater reliability as follows:

$$r_{WG(26)} = \frac{26[1-(0.4777/2)]}{26[1-(0.4777/2)]+(0.4777/2)} = \frac{19.78977242}{20.02862733} = 0.988074325$$

The inter-rater reliability is very high, indicating that, within projects, individuals agree almost perfectly in their assessments. This is not only strengthening the validity of the data but it also allows building the project-level average without great concern of confounding factors. For the other nine variables, it is not possible to compute the inter-rater reliability because the theoretical distribution under random error is not known. However, for those variables that are not on a Likert scale, we can decompose the total variance into within- and between-group components. This should suggest whether the judges' answers are similar within projects. Such variance decomposition reveals that 88.54% of the total variance arises between projects, indicating that within-groups judges are consistent in their evaluations.

3.4 Factor development and analysis

We base the selection of explanatory variables on the existing theoretical and empirical literature. In general, research on strategic alliances and supplier integration categorises the success factors in two broad categories: integration characteristics and outcome characteristics. While the former entails the practices in use during project development, the latter primarily describes the outcomes of the relationship between the partners. In our data, we have enough information on many of the most important integration and outcome characteristics that, according to the literature, contribute to strategic alliance performance. In detail, we classify the information available into seven concepts, three of which entail core integration characteristics and the other four gather the key outcome characteristics. For each of those seven concepts, we then include a sub-category of one or two variables that best represent each concept.

In terms of integration characteristics, in our data we have detailed information about interdependence of project tasks, resource availability (tangible and intangible) and type of communication. Task interdependence is relevant because it determines how the work has to be performed. High integration has the advantage that all parties involved in the project tend to be more committed (Sivadas and Dwyer, 2000). However, high integration could also cause delays and time lags. The net effect is unclear and might depend, among other elements, on project type (Dvir et al., 1998). In our analysis we distinguish between two types of interdependence: product architecture and development tasks. While product architecture entails interdependences among components and interface, development tasks represent resource interdependence.

Resource availability is a key environmental factor, and it comprises both physical and human assets (Ragatz et al., 1997). In our data we have information about financial, material, and personnel resources. Furthermore, we measure these resources in both absolute and relative terms. The absolute measure is an assessment on whether the project had enough of resources, and it was assessed once for each type of resource separately. The relative measure is instead an assessment of the resources that are available for the current project compared to previous projects.

In our data, we have measures of both co-location and share of face-to-face communication relative to total communication during the project. In the data, interviewees assigned percentages to each type of communication, expressed as a share of total communication during the project. The six possible categories are communication via mail, telephone, documents, video conferences, meetings at own location, and meeting at partner's location. The last three categories comprise our variable for face-to-face communication.

In terms of outcome characteristics, we have information about, organisational processes, market position, knowledge transfer, and partnership benefits. The two important elements of the outcome characteristics are the improved market position and the organisational processes enabled during the partnership. Market position matters because the success of a partnership depends on the market position of all partners and whether the project aims at increasing customer benefits (Dvir et al., 1998). In our data, every interviewee assessed the impact of the project on each firm's market position and whether the project brought new customer benefits. Similarly, we have detailed information on the organisational changes that took place during the project. For example, we know whether a certain project brought new processes or equipment, whether the project changed the organisational culture or improved the collaboration with external partners. These factors are important determinants for partnership projects in general (Ottum and Moore, 2003), but they are likely to change according to project type (Dvir et al., 1998).

Knowledge transfer is also a key determinant of partnership success and project type (Ragatz et al., 1997). Knowledge transfer means that all the relevant information and technology, either explicit or implicit, are shared during the partnership. As Kostova (1999) points out, greater insight over the knowledge relates to the degree that an individual invests energy, time, effort, and attention in the knowledge. Since one of the purposes of our questionnaire was to understand how knowledge transfer works in a partnership in the automotive industry, we have several elements that describe whether and how knowledge was conveyed during each project. We classify knowledge transfer in two categories: whether knowledge was successfully transmitted and used and how much tacit knowledge was needed for the project.

Expected (and realised) partnership benefits are a strong determinant for joint projects, because these benefits determine the amount of effort and commitment that each party invests in the project (Dvir et al., 1998). For this reason, we include precise measures of partnership benefit in the analysis. In the data, we can observe three types of benefits exclusively arising from the partnership. The interviewees evaluated whether the partnership increased product quality in general, whether the partnership improved problem-solving skills during the project, whether the partnership helped set more realistic project goals.

Finally, as common in the literature, in our analysis we control for team size. Team size is expected to play an important yet different role in each project type, because we might imagine that for some types of project it is more efficient to work in smaller teams. This could be the case for software development, because – as also suggested by Pendharkar and Rodger (2009) increasing the team size by certain proportion would require more than proportional increase in resources.

Table 1 delineates an overview of the concepts, with the respective variables that measure each factor and a brief description of the actual question/statement. In column (3) we also calculate Cronbach's alpha for those variables we measure with more than one variable. All the alphas are larger than the conventional critical value of 0.70, suggesting that we are able to measure the underlying concepts at a satisfactory level.

3.5 Dependent variables

In this study, we explore the determinants of each type of project. To do so, we look at whether firms collaborate to develop a product, process, or software. These types of projects are mutually exclusive, meaning that each project falls in exactly one of those three categories. We thus build the outcome of interest as a series of three binary variables indicating whether a project aims to develop a project, process, or software. Doing so allows us to separately investigate the determinants of each type of project, relative to the other two. This is important, because the literature suggest that project success factors are not universal for all project types, which means that different types of projects might exhibit different set of success factors (Dvir et al., 1998).

3.6 Model estimation

Given the binary nature of our dependent variables, our empirical strategy has been adapted accordingly. The literature proposes several approaches for binary response models (Wooldridge, 2000), which all have in common the specification of the probability function. Binary response models have a Bernoulli probability function, which can be expressed as follows:

$$f(y \mid x) = P(y = 1 \mid x)^{y}[1 - P(y = 1 \mid x)]^{1-y}$$

where $y = 0, 1$ is the binary dependent variable, x represents the regressors, and $P(y = 1 \mid x)$ is the conditional probability of observing outcome 'one' given the regressors. While binary response models have the same probability function, they differ in the way they parameterise $P(y = 1 \mid x)$ in terms of x. One standard approach is to derive $P(y = 1 \mid x)$ as a monotonic transformation of a linear index function:

$$P(y = 1 \mid x) = G(x'\beta)$$

where $x'\beta = \beta_0 + \beta_1 x_1 + \cdots + \beta_k x_k$ represent the k regressors with the respective β coefficients. The several binary response models differ in the way they parameterise the function G. The three most common parametrisations are the cumulative distribution function of the logistic distribution (the logit model), the cumulative distribution function of the standard normal distribution (the probit model), and the identify function (the linear probability model). Here we focus on the third, because despite some minor disadvantages it does not suffer from a non-existence problem sometimes encountered in the logit and probit models (Winkelmann and Boes, 2009)[1].

The linear probability model (LPM) is essentially a linear regression model to explain a binary dependent variable. The LPM assumes that the response probabilities are determined by the linear index $x'\beta$ and that the transformation function is specified as $G(x'\beta) = x'\beta$. The LPM can thus be estimated by ordinary least squares (Angrist and Pischke, 2009). However, special attention must be dedicated to standard errors. Since the dependent variable y can take only two values, so does the error term e:

$$e = y - x'\beta = \begin{cases} -x'\beta \text{ if } y = 1 \\ 1 - x'\beta \text{ if } y = 0 \end{cases}$$

It follows that the variance of the error is:

$$Var(e \mid x) = x'\beta(1 - x'\beta)$$

This indicates that the error term is heteroskedastic, which we have to account for in our estimation strategy. To do so, we compute robust standard errors throughout the paper (Wooldridge, 2000).

In our empirical application, we estimate a separate LPM for each binary outcome:

1 $$\begin{aligned} product = {} & \beta_0 + \beta_1 \cdot (\text{component interdependence}) \\ & + \beta_2 \cdot (\text{resource interdependence}) + \beta_3 \cdot (\text{learning}) \\ & + \beta_4 \cdot (\text{market innovation}) + \beta_5 \cdot (\text{organisational innovation}) \\ & + \beta_6 \cdot (\text{partnership benefit}) + \beta_7 \cdot (\text{face-to-face communication}) \\ & + \beta_8 \cdot (\text{tangible resources}) + \beta_9 \cdot (\text{intangible resources}) \\ & + \beta_{10} \cdot (\text{work in same building}) + \beta_{11} \cdot (\text{tacit knowledge}) + \beta_{12} \cdot (\text{team size}) \end{aligned}$$

2 $$\begin{aligned} process = {} & \beta_0 + \beta_1 \cdot (\text{component interdependence}) \\ & + \beta_2 \cdot (\text{resource interdependence}) + \beta_3 \cdot (\text{learning}) \\ & + \beta_4 \cdot (\text{market innovation}) + \beta_5 \cdot (\text{organisational innovation}) \\ & + \beta_6 \cdot (\text{partnetship benefit}) + \beta_7 \cdot (\text{face-to-face communication}) \\ & + \beta_8 \cdot (\text{tangible resources}) + \beta_9 \cdot (\text{intangible resources}) \\ & + \beta_{10} \cdot (\text{work in same building}) + \beta_{11} \cdot (\text{tacit knowledge}) + \beta_{12} \cdot (\text{team size}) \end{aligned}$$

3 $$\begin{aligned} software = {} & \beta_0 + \beta_1 \cdot (\text{component interdependence}) \\ & + \beta_2 \cdot (\text{resource interdependence}) + \beta_3 \cdot (\text{learning}) \\ & + \beta_4 \cdot (\text{market innovation}) + \beta_5 \cdot (\text{organisational innovation}) \\ & + \beta_6 \cdot (\text{partnetship benefit}) + \beta_7 \cdot (\text{face-to-face communication}) \\ & + \beta_8 \cdot (\text{tangible resources}) + \beta_9 \cdot (\text{intangible resources}) \\ & + \beta_{10} \cdot (\text{work in same building}) + \beta_{11} \cdot (\text{tacit knowledge}) + \beta_{12} \cdot (\text{team size}) \end{aligned}$$

Table 2 Regression results

Concept – factors	*Product projects*	*Process projects*	*Software project*
	[1]	*[2]*	*[3]*
Interdependence – product architecture	–0.087***	0.047	0.040**
	[0.03]	[0.031]	[0.017]
Interdependence – development tasks	0.039	–0.061*	0.021
	[0.034]	[0.032]	[0.017]
Resource deficiency – material and financial	0.083*	–0.037	–0.047
	[0.044]	[0.041]	[0.028]
Resource deficiency – human resources	–0.027	–0.046	0.073***
	[0.049]	[0.050]	[0.023]
Communications – co-location	–0.004***	0.001	0.003***
	[0.001]	[0.001]	[0.001]
Communications – share of formal face to face	0.949***	–0.161	–0.787***
	[0.254]	[0.239]	[0.176]
Organisational processes	–0.159***	0.129***	0.030
	[0.045]	[0.041]	[0.022]
Market position	0.091***	–0.091***	0.001
	[0.034]	[0.027]	[0.017]
Knowledge transfer – learning from project	–0.133***	–0.002	0.135***
	[0.040]	[0.042]	[0.026]
Knowledge transfer – tacit knowledge transferred	–0.010***	0.013***	–0.003**
	[0.002]	[0.002]	[0.001]
Benefit from partnership	–0.171***	0.241***	–0.070***
	[0.045]	[0.045]	[0.023]
Team size	0.001*	–0.001	–0.001*
	[0.001]	[0.001]	[0.000]
Constant	0.687***	–0.042	0.355***
	[0.085]	[0.071]	[0.076]
Adjusted R-squared	0.626	0.581	0.487
N	158	158	158

Notes: ***p < 0.01, **p < 0.05, *p < 0.10.
Robust standard errors are in parentheses below the coefficients.

We estimate each equation separately using the entire sample, which allows understanding the determinants – or 'success factors' in the sense of Dvir et al. (1998) of each project type, relative to the other two. The coefficients can be interpreted directly as marginal effects, and they indicate whether each factor is positively or negatively associated with the development of a given project type. Complete reporting of the regression results are presented in Table 2.

4 Conclusions

Our study contributes to the literature by exploring the relationship between project development characteristics and project type in automotive industry alliances. While alliance-based projects of all sorts have been considered independently in the literature, understanding how projects types are related to different project characteristics can aid in future research.

The factors developed provide a strong and logical overview of the characteristics of project-based alliances in the automotive industry. Our model supports the stratification of these characteristics by project type; the findings indicate that products, processes and software development projects each have distinct characteristics and degrees. Table 3 presents an overview of the results. The cells with a + (plus) indicates that the respective project characteristic is relatively greater when compared to the other project types; a – (minus) indicates the relatively lower of that project characteristic. For example, product focused projects indicate a larger team size compared with process and software focused projects, while software projects are characterised by a team size that is smaller compared to product and process focused projects.

Table 3 Automotive industry project characteristics

Concept	*Factors*	*Product projects*	*Process projects*	*Software projects*
Interdependence	Product architecture	–		+
	Development tasks		–	
Resource deficiency	Material and financial resources	+		– (p = .103)
	Human resources			+
Communications	Co-location	–		+
	Share of formal face to face	+		–
Organisational processes		–	+	
Market position		+	–	
Knowledge transfer	Learning from project	–		+
	Tacit knowledge transferred	–	+	–
Benefit from partnership		–	+	–
Control	*Team size*	+		–

4.1 Integration characteristics

Key project-based alliance characteristics that are related to integration between partners are shown to be distinctive for the different project types. Interdependence, based on product architecture and development tasks, has clearly defined interfaces in software focused projects relative to product or process projects. This suggests a more modular structure for software projects. On the other hand, the architecture of the products being developed was of more integral nature, showing less clearly defined technical interfaces. Rather surprising is that process focused projects showed a relatively low interdependence of development tasks. This may be because the relative interdependence is not as important for process-based projects as it is likely partners may implement the processes developed independently.

Product focused projects had comparatively less tangible resources available while software projects were equipped with more tangible resources. At the same time, software projects faced a relative scarcity of human resources. This might reflect the pressure to safe cost in a world that faces fierce competition caused by a consolidation of automotive firms in the western hemisphere on the one hand, and by a number of new entrants populating the market coming from developing countries such as China or India. At the same time, there is a relative abundance of financial resources that software projects experience coupled with the scarcity of human resources. The auto industry is affected by today's digital economy, as there are more electronic chips in an automobile than there are mechanical parts. Themes that have been forecast, such as telematics, connected cars, up to a point, autonomous driving are becoming a reality. Firms appear to be employing their resources to support their software needs to support this changing landscape. While strategic decisions in favour of the digital route lead to the allocation of financial resources to joint software projects, the relative scarcity of human resources indicates a deficit of skilled employees (we can speculate: software engineers).

The results for the communication characteristics studied are interesting. Partnering firms of software projects co-located their employees more, but team members of product projects were relatively less co-located. We speculate that as a result thereof, formal communication was conducted relatively more in product-based projects and relatively less in software-based projects. Most likely, team members of software-based projects communicated face to face in an informal way. To compensate for the need for face to face communication that could not happen informally for the significantly less collocated team members of product-based projects, formal face to face communication was implemented through personal meetings or video conferences. Overall, it is surprising that software teams indicated the highest co-location compared to process and product development teams. Often we assume that the software affinity leads to a higher tendency of dispersed work. It is software that allows us to work in teams dispersed across the globe, and software engineers are those familiar most with the respective communication tools. Yet, it appears that co-location is more frequent than would have been expected.

In addition, we expected the organisational structure would mirror the product structure (Brusoni and Prencipe, 2011). Since software development is relatively more modular, less co-location would be necessary whereas the products to be developed (which are relatively more integral) would show a higher co-location of team members. Instead, we find the opposite.

4.2 Outcome characteristics

Not surprisingly, organisational processes and with these, organisational culture had to change more in process-based projects and less in product-based projects. A little more debatable is the result that product-based projects improve the allies' market position relatively more and process-based projects improve the allies' market position relatively less. At first sight, it seems apparent that a newly developed product that built on the competence of two firms (instead of one) excels others offered in the market. However, considering the prevailing importance of cost in the automotive industry, particularly when it comes to hardware-based components, it is a bit surprising that newly developed, innovative processes do not contribute in a similar manner but significantly less to the improvement of the partnering firms' market position.

Learning and knowledge transfer are important benefits that firms look for when they engage in a project-based alliance. Analysing learning and knowledge transfer, we find that partners of software projects learn the most while partners of product projects learn the least. Further, or results show that process projects have the highest transfer of tacit knowledge while product and software projects transfer tacit knowledge the least. Processes are often inherently tacit and need great effort to be explicated (Nonaka and Von Krogh, 2009). Hence, it is not surprising that the knowledge transferred in the course of joint process-based projects is rather tacit as well. Interesting and perhaps counterintuitive is our result related to benefits that partners derived from a project-based alliance. It is the process-based projects that benefitted most. This is particularly striking as these projects showed the least improvement of the allies' market position due to the joint development project.

Project-based alliances are an inherently progressive organisational form. As an intrinsically dynamic organisational system, project-based alliances are being used by automakers to achieve a wide variety of organisational goals, especially for their innovation initiatives. Project types include product projects, process projects, and software development projects and each venture creates a new structure to support the needs of each project, and each expected outcome. Our study illustrates the different characteristics of each of the project types in alliance-based product development programs in the automotive industry? Gaining a greater understanding of the phenomena associated with project-based innovation in the automotive industry provides a foundation for improving managerial decision making when developing and executing an innovation strategy that includes project-based alliances among network partners. It also provides scholars a foundation for further understanding of the phenomenon and the development of future research.

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Notes

1 This problem, extensively discussed in Winkelmann and Boes (2009), is present in our analysis when we analyse software projects. Using logit or probit models for the other two outcomes brings similar results to the ones presented in the main analysis.