

Evolution of Business Interoperability in the Automotive Industry

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Abstract: In recent years, the established roles in the automotive industry have undergone changes: Automakers which have traditionally executed control over the entire value chain are now increasingly focusing on branding and distribution. At the same time, tier-1 suppliers are becoming vehicle integrators. This paper analyses how new forms of cooperation impact the required level of business interoperability. The comparison of two cases, a traditional OEM-supplier relationship and an innovative form of cooperation, reveals that the extensive need for coordination results in higher requirements in terms of business interoperability. The analysis is conducted using a coherent Business Interoperability Framework which covers the dimensions management of external relationships, culture & employee, collaborative business processes and information systems.

1. Introduction

Automakers have traditionally executed control over the entire value chain, including development and production of parts and components, integration of modules and systems as well as assembly of the entire vehicle. Value creation in this industry took place within established supplier hierarchies: Original Equipment Manufacturers (OEMs) developed a concept for a new car along with the major systems and modules. They assigned the production of components, modules and systems to a large extent to suppliers, whereas the OEM assumed responsibility for their integration as well as assembly of the entire vehicle. Suppliers were involved in hierarchical relationships in the automotive supply chain, where OEMs acted as focal players.

In recent years, the established role model has changed [1] [2] [3]:

- OEMs are increasingly focusing on branding and downstream activities.
- Engineering, production and assembly activities are being relocated to automotive suppliers and service providers. Today, their share of total value creation is about 65%, which could increase to 77% over the next decade [2, 89].
- Innovative business models include outsourcing the entire car production to suppliers. As a consequence, so-called tier-0.5 suppliers or “little OEMs” are emerging.
- The supplier industry has consolidated. The supplier base shrank from about 30,000 suppliers in 1988 to 5,600 in 2000 [2, 92].

The resulting new forms of cooperation between OEMs and their suppliers require higher levels of process integration, from product design and engineering to supply chain management and quality management, from marketing and sales to after-sales service. This is associated with the need to realise tighter integration between business partners.

2. Objectives of the Paper

With higher levels of value chain integration, interoperability plays a decisive role. Being “interoperable” refers to the ability to integrate business processes with business partners, understand and process exchanged data, seamlessly integrate it into internal ICT systems and enable its beneficial use. Many authors reduce interoperability to the technical integration across different platforms, network devices and communication protocols as well as the syntactic data formats. They lack interoperability issues from a business perspective such as aligning cross-organisational business processes or consenting to common semantics. In order to address this gap, this paper focuses on business interoperability which is “the organisational and operational ability of an enterprise to cooperate with its business partners and to efficiently establish, conduct and develop IT-supported business relationships with the objective to create value.” [4, 3]. Business interoperability comprises capabilities on the strategic, organisational, cultural and technical levels and builds on the concept of networkability [5, 5] and coordination theory [6, 11].

Based on two case studies from the automotive industry, this paper examines the correlation between cooperation model and the required level of business interoperability. More specifically, it investigates how current trends in the automotive industry affect the interoperability level between OEMs and first-tier suppliers. As a basis for comparison, we use the Business Interoperability Framework (BIF) outlined by [4] which describes the fundamental concepts that constitute business interoperability in a systematic model.

3. Current Situation in the Automotive Industry

3.1 Changing Roles in the Automotive Value Chain

Recent studies (e.g. [7] [8]) assume an extreme decomposition of the automotive supply chain. The traditional roles are about to change, with OEMs focussing on branding and downstream activities and the consolidation in the supplier industries (cf. Table 1, Figure 1). As an example, system integrators are increasingly taking over development, production, and integration of entire vehicles, as Magna Steyr did for the BMW X3 [9].

Table 1. Changing Roles in the Automotive Industry - Core Competencies and Responsibilities

Role / Business Model	Core Competency	Responsibility
Vehicle brand owner (OEMs)	Generation of product ideas and concepts (product innovation), branding, marketing, sales & service	Entire vehicle
Vehicle integrator (OEM, or “little OEMs”/tier-0.5 suppliers)	Series development and production, integration of modules and systems into the vehicle, coordination of supplier network	Entire vehicle
Manufacturing specialist (tier-1 ... n suppliers)	Development and production of standardised components (e.g. windscreen wipers) and parts (e.g. door hinges)	Components or parts
Technology specialist (tier-1 ...n suppliers)	Functional innovation of modules (e.g. wheel suspensions) and systems (e.g. chassis, steering systems), development and production	Functional systems, modules and specialised components
Engineering service provider	Innovation, design and engineering of components, modules and systems	

The automotive industry has a long tradition in value chain integration and is one of the most advanced industries with respect to infrastructures and standards for electronic cooperation [10]. Industry organisations (e.g. VDA in Germany, ODETTE in Europe) have been established for a long time and have created standards for e-business communication, engineering data exchange and logistics management. Besides traditional electronic channels

like EDI, B2B portals are increasingly offered by OEMs to foster electronic integration with suppliers.

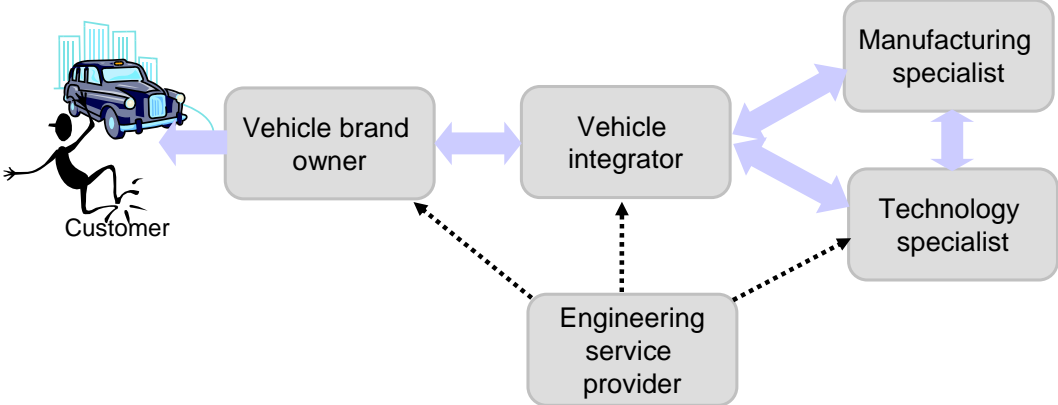


Figure 1. Changing Roles in the Automotive Value Chain

3.2 Business Relationships in the Automotive Value Chain – Two Cases

In this paper we examine two cases representing different cooperation models in the automotive industry. The case of Wafa and BMW represents a traditional OEM-1st-tier-supplier relationship, whereas in the second case, Magna Steyr has become a so-called vehicle integrator or tier-0.5 supplier resulting in a close partnership with BMW. Table 2 summarises and compares the main cooperation characteristics of the two cases.

Table 2. Comparison of Cooperation Models of Case 1 and 2 (own Presentation, based on [9] [11])

Cooperation Model	Case 1 (Wafa/BMW)	Case 2 (BMW/Magna Steyr)
Cooperation scenario	Procurement of automotive exterior	Outsourcing of serial development & production of an entire vehicle
Cooperation partners	Wafa Kunststofftechnik GmbH, based in Augsburg, Germany (1 st -tier supplier) and BMW, based in Munich, Germany (OEM)	BMW, based in Munich, Germany (OEM) and Magna Steyr AG & Co KG, based in Graz, Austria (vehicle integrator)
Cooperation targets	Supply of parts	Entering a new market segment (SUVs), accessing additional know-how and competencies for SUVs
Cooperation dynamics	Stable, one year	Stable, but limited to a certain time period (years)
Network configuration	Hierarchic	Hierarchic, project network
Initiator	BMW	BMW
Interdependence	Sequential	Reciprocal
Complexity of cooperation	Low	High

The business relationship between Wafa and BMW dates back to the 1960s. Wafa is one of the world’s leading suppliers in the fields of plastic injection moulding and surface finishing of decorative components, e.g. automotive exterior like front grilles, wheel covers and hub caps. It is around 100 times smaller than its customer BMW [12]. The cooperation scenario itself, which is common and traditional in the automotive industry, has already described by [13] as “electronic control” relationship in 1995 and has not changed since. Prior to ordering, BMW and Wafa sign master agreements that regulate the basic conditions for orders, products and deliveries for a fixed period (usually one year). On a regular basis, BMW then submits its concrete orders via EDI to Wafa. The orders are automatically entered in Wafa’s PPS system.

Case 2 (cf. [9] [11]) exemplifies the emerging forms of cooperation in the automotive industry. In 2001, BMW decided to outsource the complete serial development and production of its sport utility vehicle (SUV) X3 to Magna Steyr. Magna Steyr, ten times

smaller than BMW, aims to be the leading global, brand-independent engineering and manufacturing partner to OEMs in the engineering and assembly of complete vehicles, the development and manufacture of components and systems [14]. Design, purchasing, testing, sales and service remained with BMW. The main reason for BMW was insufficient resources for developing and producing this new car.

4. Business Interoperability Framework

We base our analysis on the Business Interoperability Framework (BIF) outlined by [4] which describes fundamental dimensions that constitute business interoperability. Important assumptions are (1) that the maximum level of business interoperability does not necessarily represent the optimum level and (2) that business interoperability does not have a direct effect on a company's performance. Similar dependencies have been outlined by the Contingency Theory of Organisational Design: Donaldson [15] states that the relationship between a given characteristic of an organisation (variable X) and its organisational effectiveness (variable Y) is determined by contingency factors (variable W). For example, an organisational structure (e.g. hierarchical, organic, bureaucratic or functional) which “fits” the contingency factors, such as size of the organisation, environment or organisational strategy, is more effective with regard to efficiency, profitability or innovation rate. Applied to business interoperability, we consider the design of relationships with external business partners as a characteristic of the organisation (variable X). The kind of effect on organisation performance (variable Y) depends on certain contingencies which may be the outcome of the organisation’s strategy (e.g. cooperation model, variable W_1) as well as others, which are external or environmental contingencies (e.g. industry dynamics, legislation, collaboration space, variable W_2). Following this concept, the maximum interoperability level is not necessarily the optimum level with regard to organisational effectiveness. In a specific cooperation scenario, which can be characterised by a set of contingency factors, lower levels of interoperability may also be sufficient.

Taking existing maturity and excellence models into account, e.g. the EFQM Excellence Model [16], we structure the BIF as follows:

- A number of categories represent the fundamental concepts of business interoperability.
- Each of these categories is operationalised by a set of criteria (or sub-categories) which outline the key business decisions companies have to solve when establishing interoperable electronic business relationships.
- The life-cycle aspect of the criteria is covered by the dimensions approach, deploy and assess & review (cf. [17]).
- The interoperability levels per criterion serve as a basis for assessment and a guideline towards higher levels of interoperability.

Table 3 depicts the relevant categories for describing business interoperability as well as the related internal and external contingencies. These categories have been identified in a state-of-the-art analysis of existing interoperability frameworks, networked organisations, e-business standards, etc. (cf. [4]).

Table 3. Business Interoperability Framework - Categories and Contingencies [4, 9]

Business Interoperability (= organisational design of the external business relationships)		
Category	Perspective	Description
Management of external relationships	“How do we manage and control external relationships?”	Interoperable organisations manage and monitor their external business relationships.
Collaborative Business Processes	“How do we cooperate with business partners?”	Interoperable organisations can quickly and inexpensively establish and conduct electronic cooperations with business partners.

Employees & Culture	“How do we behave towards our external business partners?”	Interoperable organisations promote relationships with business partners at an individual, team-based and organisational level.
Information Systems	“How do we connect with business partners?”	Interoperable ICT systems can be linked up to other ICT systems quickly and inexpensively, and support the cooperation strategy of the organisation.
Contingencies (= factors which impact the organisational design)		
<i>Category</i>	<i>Perspective</i>	<i>Description</i>
Cooperation Model (internal)	“What is the strategic intent of cooperating with external partners?”	Business strategy and cooperation model impact the required level of business interoperability.
Collaboration Space (external)	“Which baseline exists for cooperating with business partners?”	The collaboration space comprises proven cooperation models, processes and infrastructure which are available in the specific context.
Industry and general environment (external)	“Which environmental factors affect the external business relationships?”	Industry dynamics, legislation and other environmental factors determine requirements to be met by business interoperability.

5. Application of the Business Interoperability Framework

We apply the Business Interoperability Framework to describe the level of business interoperability for the two cooperation scenarios outlined in Section 3.2. This includes identifying the contingencies in a first step. In the second step, the actual assessment of the scenario, the level of business interoperability (from 1 “none” to 5 “fully interoperable”) is defined for every criterion and life-cycle perspective (cf. Figure 2).

Criteria	Life Cycle	Level of Business Interoperability					Description
		5 (fully interoperable)	4 (qualified)	3 (moderate)	2 (minimum)	1 (none)	
Management of External Relationships - "How do we manage and control external relationships?"							
Cooperation (internal process)	Approach	Strategic importance of cooperation is embedded in company strategy, rigorous process	Importance of cooperations is addressed in company strategy, Partner selection process taking into account "factors", expandable and defined	Cooperations are addressed in company strategy, some evaluation criteria for partner choice exist, process covers only parts of the cooperation live-cycle	Cooperations are established with known "best practice"	Cooperations are not part of company strategy, partners are selected ad hoc and	1: cooperation process of no relevance 2: cooperations are of strategic importance but cooperation process is in place
	Deploy	Processes used in most external relationships, cooperations are actively managed	Processes used in most external relationships	Process is used in some (new) partnerships	Processes used in some (new) partnerships	Processes used in some (new) partnerships	Processes used in some (new) partnerships
Cooperation targets	Approach	Cooperation targets are defined and communicated	All partner targets are communicated	Targets are specified by one (dominant) partner	Targets are defined by one (dominant) partner	No target setting	1: Each partner has individual targets, which are not communicated among partners 2: Targets are determined by BMW and communicated to Magna
	Deploy	Cooperation targets are shared among partners ("common purpose")	All their targets are communicated remain	dominant partner communicates targets to other partners, but may pursue other hidden aims	dominant partner communicates targets to other partners, but may pursue other hidden aims	dominant partner communicates targets to other partners, but may pursue other hidden aims	dominant partner communicates targets to other partners, but may pursue other hidden aims

Figure 2. Structure and Application of the BIF

Although similar external contingencies apply to both cases (as described in Section 3), the cooperation models differ with regard to the interdependence of the two partners and the resulting complexity of the relationship. We consider the characteristics of the cooperation model as outlined in Table 2 as being the most important internal contingencies.

Figure 3 depicts the assessment of the level of business interoperability for the two cases. With regard to the management of external relationships, new forms of cooperation prove to be more demanding than traditional OEM-supplier relationships. Wafa purely reacts to cooperation opportunities, but does neither align cooperation targets nor define clear escalation procedures. When entering a strategic partnership with Magna Steyr, BMW actively manages the cooperation, communicates cooperation targets and makes provisions for risk and conflict management.

Criteria	Life Cycle	Level of Business Interoperability					Description
		5 (fully interoperable)	4 (qualified)	3 (moderate)	2 (minimum)	1 (none)	
Management of External Relationships - "How do we manage and control external relationships?"							
Cooperation (management) process	Approach	Strategic importance of cooperations is embedded in company strategy, rigorous partner selection process, advanced process is in place	Importance of cooperations is addressed in company strategy, partner selection process taking into account "hard factors", expandable process is defined	Cooperations are addressed in company strategy, some evaluation criteria for partner choice exist, process covers only parts of the cooperation live-cycle	Cooperations are established with known partners, "best practices" / cooperation knowledge / experience of individuals	Cooperations are not part of company strategy, partners are chosen ad hoc and with no pre-defined evaluation criteria, no guidelines or processes exist	1: Cooperation process of no relevance 2: Cooperations are of strategic importance and cooperation process is in place
	Deploy	Process is rolled out to all external relationships, cooperations are actively managed	Process is used in most partnerships	Process is used in some (new) partnerships	Individual "process" is setup with each partner	No / ad-hoc setup of electronic relationships	
Cooperation targets	Approach	Cooperation targets are co-defined with partner built by consensus	All partners are involved in target setting	Targets are specified by one (dominant) partner	Targets are defined individually	No target setting	1: Each partner has individual targets, which are not communicated among partners 2: Targets are identified by BMW and communicated to Magna
	Deploy	Targets are documented, openly communicated and shared with all partners ("common purpose")	All partners communicate their targets; individual targets that are not communicated remain	Dominant partner communicates targets to partners, but may pursue other hidden aims	Partners pursue individual targets and do not communicate them to partners	Targets are unclear	
Risk & Conflict Management	Approach	Mechanisms for risk and conflict management have been identified and preparations have been made to use them		At least one partner is aware of the relevance of risk and conflict management and identifies some mechanisms		Cooperation is not aware of the relevance of risk & conflict management	1: Conflicts were solved when they arise 2: Some mechanisms for preventing conflicts have been established (e.g. team building events)
	Deploy	Risk management mechanisms are used during the cooperation to avoid conflicts in advance		Pre-defined risk management mechanisms are used when conflicts arise	Ad-hoc conflict solving	No conflict solving	
Collaborative Business processes - "How do we collaborate with business partners?"							
Public Process	Approach	Public processes are co-defined with business partners and built by consensus, documented and reflect industry standards (n:m)	Responsibilities and collaboration processes are defined bilaterally while taking into account previous and future cooperation processes	Responsibilities and collaboration processes are defined bilaterally with some partners (1:1)		No awareness of cross-organisational business processes	1: EDI process for product orders (VDA) used with all partners 2: Defined on a 1:1 basis but taking into account future cooperations
	Deploy	Public process is the "standard" cooperation process		Number of bilateral process agreements is limited		No awareness of cross-organisational business processes	
Process visibility	Approach	Process visibility requirements for external partners are identified	Visibility requirements for collaboration critical information are identified	Some aspects of process visibility are implemented		No awareness for process visibility requirements of external partners	1: No information is shared 2: Information is shared openly with partner
	Deploy	Full accessibility of relevant information for external partners	Accessibility assured for critical and other important information	On-demand visibility		No visibility for external parties	
Semantics of business documents	Approach	Adherence to generally accepted message standards which reflect common practice		Bilateral agreement on document formats	Acceptance of proprietary message format of one partner	No agreement on mutual format	1: EDI VDA messages used 2: Proprietary formats from BMW used
	Deploy	Generally accepted message standards are used in all cooperations		Use of standards in some cooperations, besides bilateral agreement	Usage of proprietary message format of one partner	Mapping between own and partner format	
Information Systems - "How do we connect with business partners?"							
Interaction type	Approach	Plans to use machine-to-machine	Simple file exchange of machine-readable documents	Advanced human-to-machine interaction (e.g. online services on portal)	Minimum human-to-machine interaction (e.g. static website)	None	1: EDI used with all OEMs 2: Necessary IT landscape was closely integrated between two partners
	Deploy	Established machine-to-machine connections	Some machine-to-machine connections	Mainly human-to-machine interaction	Some human-to-machine interaction	Only human-to-human interaction (e.g. phone, fax, e-mail)	
Cooperation architecture	Approach	B2B architecture with m:n-connectivity; using a common set of standards, protocols and interfaces that reflect open or industry standards	Using a common set of standards, protocols and interfaces on a proprietary, bilateral base	B2B architecture with 1:n connections; using a common set of standards, protocols and interfaces on a proprietary, bilateral base from one partner	Close 1:1 integration with proprietary systems, standards and protocols from one partner	No architectural considerations	1: EDI 1:1 connections with all OEMs 2: BMW's systems were rolled out to Magna
	Deploy	Established m:n-connectivity; Existing infrastructure is coupled using standards	m:n connectivity via hubs	1:n-connections are prevailing with "standards" defined by one partner		Only 1:1 connections are established	

Case 1 (Wafa/BMW)
 Case 2 (BMW/Magna Steyr)
 Case 1&2

Figure 3. Level of Business Interoperability for Case 1 and 2

Wafa and BMW base their cooperation on state-of-the-art B2B processes using EDI standards defined by VDA recommendations. This supports the findings of Bensaou and Venkatraman [13] regarding the wide use of ICT functionality when "the technology is more reliable and offers stable standards", as, for example, in supply chain functions. The more extensive cooperation scenario between BMW and Magna Steyr requires the definition of cross-organisational processes, starting as early as in the series development and continuing to

after-sales service. The alignment of business processes and the resulting integration of information systems were time-consuming and costly [10] since both partners were entering this type of cooperation model for the first time. The medium-to-high business interoperability levels for case 2 result from heavy investments made by BMW and Magna Steyr in the cooperation infrastructure (e.g. 50 roll-outs of BMW systems to Magna, more than 280 IT projects [9]). BMW invested additional effort in order to anticipate future requirements of similar cooperation models [9].

The level of business interoperability for the two cooperation models represents the “organisational design” of the relationship with regard to several dimensions (“hard” dimensions such as ICT infrastructure or process design; “soft” dimensions e.g. in cooperation management processes, risk and conflict management). We assume that both companies chose the organisational design that best fits their respective internal and external contingencies in order to maximise value creation. Since similar external contingencies which reflect industry structure and dynamics apply for both cases, the different business interoperability profiles can be explained by the choice of the cooperation models which represent an internal contingency. For the “traditional” OEM-supplier relationship, higher interoperability levels in respect of so-called “public processes”, semantics for business documents and cooperation architecture were derived. This reflects the maturity of B2B cooperation in the automotive sector. The “innovative” cooperation is more demanding in terms of cooperation management and alignment of business processes. As a result, the level of interoperability with regard to process and targets, risk and conflict management, and process visibility are higher in these areas. Similar interoperability levels were derived for the interaction type which is machine-to-machine in both cases.

6. Summary

This paper analyses two different cooperation models within the automotive industry, a traditional OEM-supplier relationship and an innovative cooperation model between OEM and an emerging tier 0.5-supplier. By applying the Business Interoperability Framework, it derives two different interoperability profiles reflecting the cooperation model (internal contingency) as well as the level of standardisation (external contingency). It demonstrates that different cooperation models are associated with different levels of business interoperability between the business partners involved. Besides the purely technical integration of ICT systems (e.g. network infrastructure, data semantics, message standards, system interfaces), interoperability issues on the organisational, business process and cultural levels are taken into account. As seen in the BMW/Magna Steyr case, outsourcing the entire development and production of the X3 series required extensive investments in order to define the cross-organisational business process flow and implement the links between information systems. In addition, these new forms of cooperation need to be actively managed, e.g. through explicit risk and conflict management.[9]

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