

THE PORTUGUESE RAILWAY ROLLING STOCK ASSEMBLY INDUSTRY: BETWEEN ADAPTATION AND ADAPTABILITY

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Competitive paper

In this paper the Portuguese railway manufacturing industry is addressed, in particular how the firms involved create value over time in their relationships. The paper deals with an empirical research carried out to analyze the way firms interact strategically and manage constraints and opportunities within their relationships, from the industrial networks perspective.

The purpose of this paper is to analyze how companies, in four dyadic customer-supplier relationships interact strategically and value the relationship outcomes and how they became constraints and opportunities affecting the industrial network. To that purpose, we empirically analyze the process through which customer and supplier manage adaptation and adaptability in order to create value, and how the focal customer organizes its relationships with those four different suppliers.

The actions and reactions identified within the dyadic relationship are analysed according to five dimensional determinants representing different visions of interaction structure defined in the literature, namely, the actor, resource and activity (Håkansson et al., 2009), the integration/adaptation (Brennan et al., 2003), the adaptability/flexibility (Ford et al., 2002; Sharifi et al., 2005), the relational structure (Turnbull et al., 1996, Ford et al., 2002) and the value dimensions (Gadde and Håkansson, 2001).

The results presented contribute to the understanding about each dyadic relationship in the industry and the possible interrelated influence between them. These results emphasize some aspects related to the way firms manage adaptation and adaptability between partners; the economy of resources needed; and the activities in the industrial processes chosen for cooperation.

Keywords: Adaptation, Adaptability, Interaction, Relationship, Strategy

THE EUROPEAN RAILWAY ASSEMBLY INDUSTRY

The railway manufacturing industry has undergone, during the last decades, a globalization and concentration process and most of the traditional local country railway manufacturers have been bought and integrated into the worldwide OEM's networks of facilities. The integration of those firms in the OEM network has shifted the scope of local regional activities from a high specialized engineering and component production industry to a more general high performance assembly industry based on the OEMs global supply chains. Procurement activities, stock costs and final product transportation costs became central to each local country assembly unit and most of them failed to obtain competitive manufacturing conditions and profitability ratios when compared with their counterparts in central Europe.

Historically, the supply of rolling stock was heavily related with infra-structure specific conditions that constrained train dimensions, energy and signaling systems. Rolling stock supply relied on the local operator expertise to develop trains for each line and service type. Local investment policies and government control of railway business made difficult any attempt to create common specifications and a standardized train offer. The rolling stock industry developed slowly and until the 1980's the main strategic changes occurred within a process of industry concentration. This process generated less than five European players (OEM), specialized on the integration of systems and subsystems to their own rolling stock. Such systems could be supplied by internal or external capabilities. Later during the 1990s, the OEM integrators concentrated again their operations in central European wide production centers closing most of their local industrial operations. Most of the local country based manufacturers were bought and integrated in the OEM supply chain and continued to supply the local railway operations and the industry adopted an integration supply chain model (Figure 1) based on the outsourcing of component supply. Business position evolved from local product customization to a broad product development approach based on a European specific platform for each service (LRV, Suburban, Regional, Intercity and High Speed).

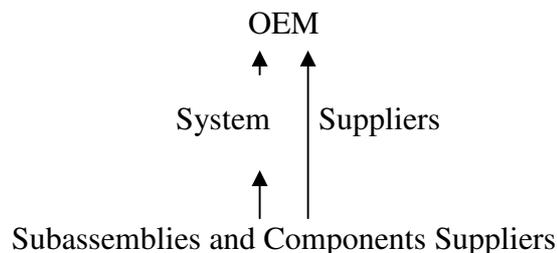


Figure 1 - OEM industry supply chain organization after outsourcing

THE PORTUGUESE MARKET

The Portuguese manufacturing industry has followed similar trend, developing different strategies according to each rolling stock market (locomotive, tram-train, passenger trains and wagons). Two local firms were central in this business context (Metalsines - supplier and EMEF - customer) each driving the industry in different time frames and market conditions. During these time periods the main OEM (Alstom, Bombardier, Siemens - suppliers) tried to secure their local customers with different collaborative strategies between those more oriented to customized business agreements with industry partners and those related to direct control through local industry acquisition.

In the 1990's the main Portuguese railway operator developed a company (EMEF) whose mission was to maintain and refurbish the rolling stock in the Portuguese market, based on its own long established industrial infra-structure. In an attempt to improve profitability, this company tried to gain new assembly competences based on the refurbishing business. Demand for locomotives, tram-trains, passenger trains and wagons has significantly increased in recent years across Europe with the development of public and private transport to anticipate railway liberalization requirements. EMEF replaced the historical Portuguese railway manufacturing company - Sorefame. During four decades until the 90s, Sorefame had been the main industrial facility in Portugal for train and carriage production. This company developed competence starting from an agreement made between the US and Portugal for technology transfer after the war. By 1994 Sorefame was bought by the Swedish ABB that later joined Daimler Benz (Adtranz group) in the process of industry consolidation.

In 2001 Bombardier acquired the Adtranz group (including the Sorefame production and assembly unit) and joined the other two big industrial players (Alstom and Siemens) in a world competition. Market conditions changed in 2002 with market for trains becoming too short for the existing capacity. In 2004 the Bombardier Portuguese assembly unit was closed, after a last attempt to achieve an agreement with the Portuguese Government in order to envision a strategic plan for rolling stock investments in future years.

On the other hand, the Portuguese wagon manufacturing industry also included several metalworking (metallomechanics) companies and foundries working with the private railway operators until the 1950's and after that period with the public railway operator that resulted from their nationalization. After 1976 the wagon manufacturing industry started being developed at the scope of state investment plans. Metalsines was created in 1986 as a state owned start-up and later became a private company. This company was initially created to manufacture three thousand wagons for the local Portuguese public railway operator. This aim was later trimmed to become compatible with Metalsines industrial capacity that has never exceeded some 100 wagons per year.

After 2005, the positive development of passenger and cargo railway services and the need of new rolling stock seem to be too demanding for the supply side. This lack of global supply created an opportunity window to establish a relationship through the creation of a collaborative platform between the suppliers (Alstom, Bombardier, Siemens, Metalsines) and the main Portuguese customer (EMEF). The new competencies and shared resources generated were intended to allow a common answer to diversified tenders (train and wagon production/maintenance/repairing and rehabilitation) from south Europe, South America and Maghreb.

RESEARCH QUESTIONS

In the industrial network approach the heterogeneous actors (e.g. a company, a department, a dyadic relationship) are considered to be linked by specific interdependences that can explain basic questions as for example "Why do producers and users hold on to each other over years and even decades, instead of jumping around between different counterparts, playing with the price mechanism?" (Håkansson et al., 2009: 14).

These actors own specific identities and characteristics according to the resources and activities they develop (Håkansson and Snehota, 1995) and have limited opportunities to act independently of their partners decisions (Håkansson et al., 2009), due to the degree of interconnection and dependence in their relationships. The possibility of attaining their objectives also depends on how the other actors plan, act and react to its performance (Wilkinson and Young, 2002).

Thus, the achievement of internal resource efficiency and the effectiveness in external negotiations are mutually dependent and potentially conflicting aspects that require interaction, because one partner may need to increase a specific cost in order to attain a lower overall cost in the relationship (Gadde et al., 2002: 5). The strategy is conceived as a bilateral and interactive process, where the action is defined over time by the relationships between actors in the various dyads (Wilkinson and Young, 2002).

According to Ford et al., (2002) companies in a network are continuously producing network outcomes for each single participant in the network both individually and collectively. Those outcomes have a positive or negative impact in revenue or profit and each company and each company will observe, assess and respond to only a subset of networking outcomes in particular. A company can change or reinforce activities depending on negative or positive outcomes.

The company action within the dyadic relationship depends, on one hand, on how the actors assess outcomes concerning effectiveness of what is accomplished in the relationship viewed as dyadic adaptability to new market conditions. On the other hand, it also depends on how well the processes work within that relationship (efficiency), viewed as dyadic adaptation.

These allow the actors to evaluate the value of the relationship (Ford et al., 2002) knowing that the result of outcome assessment constrains the level of future interaction and resource allocation. In this context, knowing the network more relevant outcomes for those involved in this industry over the past two decades and how these have led to the abandonment / reinforcement of certain activities in the network leading to relationship adaptation and adaptability form the research questions for this study.

CONCEPTUAL BACKGROUND AND RESEARCH METODOLOGY

This study has both inductive and deductive characteristics although the first characteristic prevails. An inductive study is one where results are derived from the empirical findings, whereas the deductive study concerns research when theory is tested with regard empirical findings. The theoretical frame and the empirical findings have emerged gradually and theoretical interests and the specific issues have changed in an iterative manner over time because the accumulation of knowledge involves a continual cycling between theory and data (Eisenhardt, 1989). Although we used semi-structured interviews as the main source of information about the dyadic relationships analyzed in this study, consolidated tables with quantified dimensions were later prepared and validated, taking into account the various responses.

Empirical material was selected since the beginning of the study before defining and clarifying the research topic in detail and before selection of the relevant problem areas in the

literature. Data was gathered based on an overall research topic and issues that would later be confronted and re-defined several times during the research process. After focusing on a specific conceptual background the study was conducted through theoretical models, shaping the research process structure and data collection.

The research topics and issues were derived, from both practical and social reasons (Silverman, 2004). Understanding strategic action in the railway manufacturing industry is of major importance due to political and economic impact. Local industries are defied by global players with a growing pressure on decision makers, consultants and researchers to better define the grounded rules that support feasible economic approaches shaping the industry structure.

The industrial network perspective on strategy includes elements of context, process and content. The paper develops on the dyadic relationships as the contextual domains where strategic actions and reactions occur (Brennan et al., 2003). The analysis of those strategic actions and reactions, and ensuing results, relies on a number of characteristics/factors developed accordingly to the systemic approaches oriented to adaptation/integration involving adaptation (Canning and Brennan, 2004) and to systemic approaches oriented to adaptability/flexibility in industrial networks (Wilkinson and Young, 2002)

The adaptation concept refers to the changes made by the companies to fit the characteristics of supply chains in dynamic environments and requires internal and external fit. Adaptations may imply considerable investments by one or both parties to a relationship, often non-transferable investments (Brennan, et al., 2003: 1636). Strategy in the industrial network approach is conceived as an adaptation process that requires the adjustment between the activities performed by an actor and its environment to achieve coherence between the internal resources and capabilities and the network conditions (Hakansson & Snehota, 1995).

Adaptations in inter-firm buyer-supplier relationships can take place at the level of the product or in terms of management processes, information exchange (Brennan et al., 2003, 1652) and organizational restructuring. The dyad partners seem to adopt a strategic intention of developing a regional industrial platform based on a business model that combines internal integration/adaptation in the supply chain with external integration/adaptation to the business environment.

The adaptability concept refers to the willingness to reshape supply chains whenever necessary, without ties to legacy issues. An adaptable supply chain is able to adjust its design to meet structural shifts in markets, new supply network strategies, changes in products and technologies. Adaptability objectives are related to the capacity to adjust chain design to accommodate market changes (Lee, 2004: 1). Strategy, as envisioned in the adaptability concept, can be described as a process to achieve a flexible and agile industrial network associated with the way how resources are interrelated.

An adaptable industrial network has the ability to develop supply chains that respond quickly to market opportunities. The design / change of a supply chain depends on a number of key internal and external factors (eg. related to the market, to the business environment, to the product) relevant to the industry (Sharifi et al., 2005: 1082). Changes in the supply chain, viewed as collections of different network outcomes, can be studied along three dimensions: actors, activities and resources, and a company must consider how networking within a

number of relationships affects the individual, the relationship and the network outcomes from each (Ford et al., 2002).

DYAD RELATIONSHIPS APPROACH – THE CASE STUDY

The analysis is exploratory and qualitative (Silverman, 2004) based on a case study (Yin, 2003) of four dyadic relationships (Figure 2) between the main Portuguese industry customer and its main suppliers.

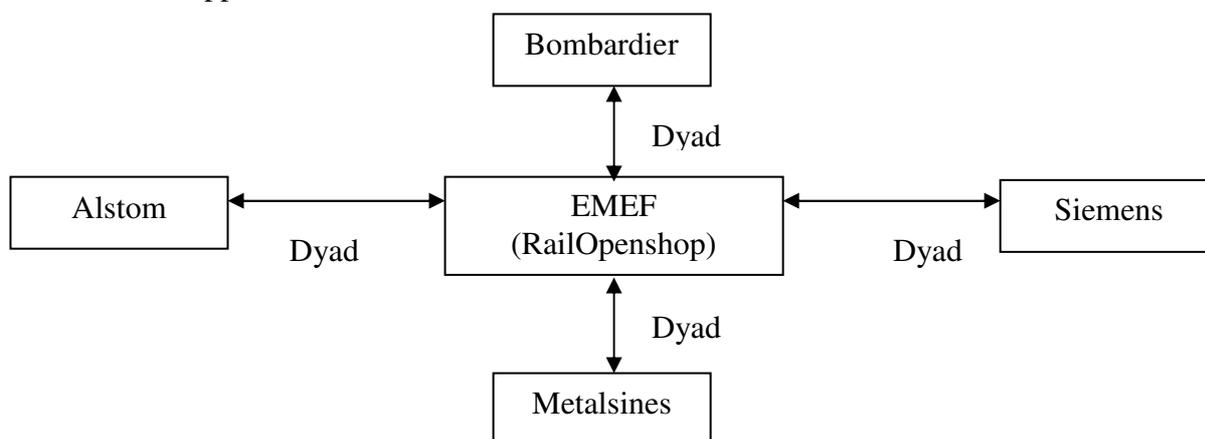


Figure 2 – Dyads in the focal Portuguese industrial network

Case selection was based on a relevant sample of dyad relationships that represent all the categories of product development effort for the Portuguese railway manufacturing industry. The relationships are long-term and project-oriented and focused in critical projects/events that provide the empirical boundaries in the study. These contextual elements provided a distinctive frame in which the theoretical interests are studied.

It is our purpose to empirically describe the key events in the relationships established over time, using multiple primary and secondary sources, in order to increase knowledge on the problem under study.

The unit of analysis is the dyadic relationship. According to Håkansson et al., (2009), the analysis of the dyad interaction requires the distinction between the temporal contexts (typification of relationship) that have occurred over time in the relationship. For each time interval the context is addressed through a particular episode of interaction. These episodes are driven by past interactions and expectations of future interaction (Håkansson et al., 2009).

The sequence of contexts is guaranteed by the connection between past and future episodes. The interaction model (Halinen et al., 1999; Håkansson, et al., 2009, 35) proposed by the relational approach supports the concepts of individuality for each episode in what concerns network logic, actors specificity and their subjective views, as well as in the ability to interpret a situation (time and situation dependence).

The paper appeals to this model, considering each episode as a supply order/contract for rolling stock. A contract for supply railway rolling stock is a very complex event, limited in time with typical duration of 3-4 years, generating a number of interdependencies throughout the product life cycle. The data was collected on three contracts (events) for each dyad, involving the customer and the suppliers, from the 1990's until the present.

- EMEF-Alstom relationship focusing on the LE2620 supply contract (built by Sorefame in Portugal in 1985/1987), the CP3150 (Train Electric Triple Unit, refurbished by EMEF in Portugal in 1998/1999) and the CP3500 (Train Electric Quadruple Unit, built by CAF in Spain in 1999/2000)
- EMEF-Bombardier relationship focusing on the UME3400 supply contract (Train Electric Multiple Unit, built by Siemens/Bombardier in Portugal in 2001/2), the Eurotram tram-train supply contract (built by Bombardier in Portugal) and the Flexity Swift tram-train supply contract (built and assembled by Bombardier and EMEF in Portugal in 2008/2009),
- EMEF-Metalsines relationship focusing on the Uaoos wagon supply contract (built by Metalsines in Portugal in 1992/5), the Tadns/Habis/EAS-z wagon supply contract (built by EMEF and Metalsines in Portugal in 2006/8) and the Lgnss wagon supply contract (built by EMEF in Portugal in 2009/11);
- EMEF-Siemens relationship focusing on the CP5600 supply contract (Electric Locomotive Siemens-Kauss Maffei, built in Germany and Portugal in 1991/3), the UME3400 supply contract (Train Electric Multiple Unit, built by Siemens/Bombardier in Portugal in 2001/2) and the CP4700 supply contract (Electric Locomotive Siemens, built and assembled by Siemens and EMEF in Germany and Portugal in 2007/9);

Empirical data on the contextual nature of the relationship needed to understand the process of interaction in the dyad were obtained through workshops, interviews, observation and participation in business meetings, active participation in feedback meetings and other sources of data. Given the need to achieve focus and a high degree of involvement between researchers and the interviewed, an interview guide was developed.

SEMI-STRUCTURED INTERVIEWS

The interviews guide was designed after listening to the industry experts and analyzing reports and other available technical documents. The industry participation and the selection of events were initiated through a workshop, held in January 2008, followed by a second workshop, held in April 2008, for respondent selection. The respondents were selected based on the role they had in relation to the episodes.

The interviews guide was tested before starting the interviews by listening to industry experts. The guide for each episode included a number of questions related to a particular theme to be addressed in the interviews. These themes reflect five dimensional determinants representing different visions of interaction structure defined in the literature, namely, the actor, resource and activity (Håkansson et al., 2009), the integration/adaptation (Brennan et al., 2003), the adaptability/flexibility (Ford et al., 2002; Sharifi et al., 2005), the relational structure (Turnbull et al., 1996, Ford et al., 2002) and the value dimensions (Gadde and Håkansson, 2001).

During the second semester of 2009 a total of 28 interviews were conducted to study the dyadic relationships. The respondents were introduced to the themes in the study and to the semi-structured questionnaire, phasing the interviews and confirming and complementing

earlier versions after being translated to written text and defining the linguistic codes and concept used within the industry. The respondents had the possibility to shift from the initial focus questions of the researcher, influencing the research process. The answers were coded to allow some confidentiality and later aggregated in resuming tables that represent different dimensions of dyadic relationship.

In the research we used respondent validation, by going back to the subjects with tentative results and refine them to check and test whether the empirical material have been correctly understood and interpreted. Since the respondents have sometimes different perceptions about the same events, we tried to capture their distinctive position and examine these explanations in greater detail to investigate the factors underlying the specific position.

The results of the interviews were recorded as written text (Patton, 2002). An *ad hoc* approach was used (Kvale, 1996) to analyze the results of the interviews, by applying elements of condensation, categorization, narrative and interpretation to the expert's testimony. Indicative tables were prepared from the textual records (with a scale of 1 to 6; 6 as maximum value) of how the degree of importance attributed by respondents to the questions formulated was perceived by the interviewers. Consolidated tables were later prepared taking into account the various responses. After that these tables were presented to the respondents for validation and consensus (Delphi method approach).

FINDINGS AND DISCUSSION

ACTORS, RESOURCES AND ACTIVITIES

Table 1 presents the structural characterization of the dyad. The development of the relationship is influenced by two types of stakeholders: - product certifying companies and financing partners. Product certification was a former customer competency that has been lost due to new industry regulation. Subassembly or component suppliers have only a direct relationship with the customer in the wagon (hauled stock) manufacturing activities. For automotive vehicles the supplier intermediates the relationship with the customer and organizes component delivery to the assembly line (batch production). The customer is responsible for the assembly operations of the small number of vehicles considered in each contract (typically between twenty and thirty).

Financial resources are considered important, in particular the project predictability aspects, since these influence the capacity to establish a sequence of project and capital needs. Vehicle components are very expensive and must be specified and ordered for batch production long before assembly (risk of stock holding).

Most of the engineering effort in the dyadic relationship concentrates at the beginning with an extensive period of requirement specification and at the end of the relationship in support of product certification and homologation. Component outsourcing production is outsourced and the automotive vehicle has a modular design. Thus production resources are limited and not specific to a single product, and the production line can be used to various activities (ex. vehicle maintenance and repair). The complex automotive components cannot be produced with resources possessed within the dyad. With the exception of specific high performance

components produced by the supplier, all the remaining components are produced by global and highly specialized companies.

Wagon production follows a different approach, since the dyad seems to concentrate on an increasing differentiation on activities based on improved production technology (welding supported on computerized material inspection, positioning and environmental condition control) to obtain assembly efficiency for contracts of several hundreds of wagons. In Europe the wagon manufacturing companies produce a significant number of wagon components in order to achieve a lower vehicle cost structure and to control delivery times.

There is an extreme shortage on wagon components in the international market. In the first two events, EMEF and Metalsines used external suppliers due to limited industrial capacity. Yet, they took advantage of those contracts to develop internal competences. In the third contract they changed procurement policy and started internal component production to achieve the desired competitive prices and faster delivery times.

The wagon production process differs from those of the locomotive, passenger trains and tram-trains where the number of vehicles manufactured under a single contract is generally limited (e.g. less than 50 or 100 units) with very low production volumes of different products. Large scale production of wagons is increasingly important due to product standardization and due to the need to manufacture hundreds of vehicles under a single contract. Proximity between production and place of usage is important since the final product cannot displace without being tested and approved for a specific infrastructure.

Topics on Actors, Resources and Activities	E-A			E-B			E-M			E-S		
	1	2	3	1	2	3	1	2	3	1	2	3
Stakeholders												
- Subassembly suppliers	6	3	1	6	6	3	6	6	6	6	6	3
- Product certifying companies	2	3	4	4	4	4	2	6	6	2	4	6
- Financing	6	6	6	6	6	6	6	6	6	6	6	6
- I&D	3	3	2	2	2	2	1	1	1	2	2	2
- State and regulatory	6	6	6	6	6	6	6	6	6	6	6	6
Financial Resources												
- Financial autonomy	6	6	6	6	6	6	6	6	6	3	4	5
- Contract value	6	3	1	6	6	2	6	5	2	4	6	3
- Project predictability	6	6	6	6	6	6	6	6	6	6	6	6
Engineering resources												
- Requirement specification	6	6	6	6	6	6	6	6	6	6	6	6
- Product standardization	2	2	2	2	2	2	3	5	5	2	2	2
- Production technology	6	3	2	6	6	2	2	2	4	6	6	3
- Product certification and homologation	6	6	6	6	6	6	2	6	6	6	6	6
Human Resources												
- Qualified workmanship availability	6	6	6	6	6	6	6	6	6	6	6	6
- Product engineering competence	6	6	6	6	6	6	6	6	6	6	6	6
Production activities												
- Product specification	6	6	6	6	6	6	6	6	6	6	6	6
- Component production	3	2	1	3	3	1	3	4	5	3	3	1
- Component procurement	4	4	2	4	4	1	3	6	4	2	2	1
- Product production/assembly	6	6	3	6	6	6	6	6	6	6	6	6
- Product test and trial	6	6	6	6	6	6	6	6	6	6	6	6
- Product certification and homologation	6	6	6	6	6	6	6	6	6	6	6	6
- Commercial activity	2	2	2	2	2	2	2	2	2	2	2	2
Characteristics of the production Process												
- Process standardization	1	1	2	2	2	2	3	5	5	2	2	2
- Production scale	1	1	1	1	1	2	2	5	5	1	1	1
- Proximity between production and place of usage	6	6	4	6	4	4	6	4	4	6	6	4
- Proximity to suppliers	6	6	3	6	6	6	6	6	6	6	6	6
- Coordination between production activities	1	3	1	1	1	1	2	3	4	1	1	2
- Coordination speed with external suppliers	1	1	1	1	1	1	1	1	3	1	1	1
- Specificity of process	1	1	1	2	2	1	1	1	1	1	2	1
- Availability of manufacturing resources	2	4	1	5	5	2	1	3	4	5	5	3
- Direct control of manufacturing resources	2	6	1	5	5	2	3	5	6	5	5	3

Topic consolidated importance rating on a six-point scale, 1 (minimum) to 6 (maximum), attributed to episodes 1 to 3 (rolling stock orders /contracts analyzed in each relationship).

EMEF-Alstom relationship (E-A), episodes 1-LE2620, 2-CP3150 and 3-CP3500

EMEF-Bombardier relationship (E-B), episodes 1-UME3400, 2-Eurotram , 3-Flexity Swift

EMEF-Metalsines relationship (E-M), episodes Uaooos (1), 2-Tadns/Habis/EAS-z, 3-Lgnss

EMEF-Siemens relationship (E-S), episodes 1-CP5600, 2-UME3400, 3-CP4700

Table 1 – Actors, Resources and Activities in the customer-supplier focal dyads

The relationships have different priorities related to the production process. Wagon manufacturing has an active investment policy on new manufacturing resources, specific to the production process, in order to increase their control and availability. Automotive rolling stock manufacturing focuses on less specific and complex tasks (e.g. final assembly) with fewer requirements on resource control and availability.

OUTCOMES AFFECTING ADAPTATION IN THE DYAD

Table 2 shows the dyad adaptation dimensions. In motorized vehicle manufacturing, the success of customer-supplier relationship depends on the adaptation of the product to the customer operating conditions. Adaptation of information exchange is needed to detail every functional aspect and performance expectation that the product must perform. However those aspects are not related to specific production activities but only with the product initial configuration (component functionality and performance) as well as with after sales service (significant product complexity) activities. Process and production planning adaptation are related with inbound logistics related with stocking all the components needed for assembly without a very restrictive stock window.

Product adaptation to the customer operating conditions and production process adaptation to reliability, speed and quality requirements became both important in wagon manufacturing. In the first and second events EMEF and Metallsines rely on their own supply chain to build the wagons independently from each other at a high cost. In the third event EMEF defines a strategy of vertical integration of external partners, including Metallsines with a specific role in the supply chain.

Topics on Adaptation	E-A			E-B			E-M			E-S		
	1	2	3	1	2	3	1	2	3	1	2	3
- Adaptation of product	6	5	6	6	6	6	6	6	6	6	6	6
- Adaptation of process	3	4	2	3	3	2	2	3	4	3	3	2
- Adaptation of production planning or scheduling	3	4	2	3	3	3	2	3	4	3	3	3
- Adaptation of financial or contractual terms or conditions	6	6	6	6	6	6	6	6	6	6	6	6
- Adaptation of stockholding and delivery	3	3	3	3	3	3	3	2	4	3	3	3
- Adaptation of organizational structure	6	6	6	6	6	6	2	2	4	6	6	6
- Adaptation of information exchange	5	5	5	6	6	4	6	2	4	5	5	5

Topic consolidated importance rating on a six-point scale, 1 (minimum) to 6 (maximum), attributed to episodes 1 to 3 (rolling stock orders /contracts analyzed in each relationship).

EMEF-Alstom relationship (E-A), episodes 1-LE2620, 2-CP3150 and 3-CP3500

EMEF-Bombardier relationship (E-B), episodes 1-UME3400, 2-Eurotram , 3-Flexity Swift

EMEF-Metallsines relationship (E-M), episodes Uaoo (1), 2-Tadns/Habis/EAS-z, 3-Lgnss

EMEF-Siemens relationship (E-S), episodes 1-CP5600, 2-UME3400, 3-CP4700

Table 2 – Topics on adaptation in the customer-supplier focal dyads

In this strategy Metallsines does not produce complete wagons and starts making components for EMEF production/assembly line. The customer coordinates component delivery windows and component quality control for its own assembly line. Wagons component production has

relatively low complexity when compared with locomotive and train component production. Adaptation of financial or contractual terms is common to all the dyads and vehicle types since the cost structure due to materials, article and component acquisition is very high.

In wagon manufacturing the actors defined their industrial intervention scope allowing them to consider improvement on most of the adaptation topics. In motorized vehicle manufacturing the actors maintain or decrease adaptation on some topics since all the specific activities related to component production (e.g. engineering activities needed to build stainless steel train bodies) are replaced by direct external component delivery to the customer assembly line.

OUTCOMES AFFECTING ADAPTABILITY IN THE DYAD

Table 3 shows the dyad adaptability dimensions. The relationship seems to be centered on the management of product life cycle cost. The railway vehicles can last for more than thirty years so each contract generates interdependencies (due to maintenance, repair and refurbishing activities) that far exceed the period related to manufacturing and delivery analyzed each event. Product requirements and all the work around production and testing activities are focused on product performance.

The decisions about technology and design formalized in the functional and technical requirement phases impact the whole product life cycle and the customer capability to participate in future activities that allow him to retain value in the relationship (eg. vehicle maintenance, repair, and refurbishment).

Those capabilities are obtained during the assembly operations using knowledge transfer mechanisms, partially defined in the contract and partially dependent on supplier policy on technical customer support.

Modular design creates an opportunity for the customer to assemble his own motorized vehicles, as well as motorized vehicles to other regional railway operators (using the same infrastructure characteristics), giving the dyad a number of adaptability capabilities to gain new markets. In the last events the customer is able to use its new industrial capacity to develop a shared industrial platform that can be accessed by all the suppliers in equal terms.

This is similar with the situation occurring in the 1980s when Sorefame did not belong to a specific OEM company (Adtrans and later Bombardier), but has the advantage to support the development of other activities complementary to assembly.

Flexibility, conceived as the possibility to change product features during production, is totally avoided in this industry due to extreme cost (project changes, new components with long delivery times). After production, changes are minor and only related with software to fine-tune train dynamic characteristics. Innovation is secondary in the Portuguese industry context since the main concern is to avoid risk associated with availability and maintenance.

The wagon manufacturing relationship is not concerned with modularity and with constant knowledge transfer since the wagon functional requirements are universal (technical projects are available in an international railway association) and all the gains are concentrated on process efficiency, on material and component cost and on product certification needs to

attain a lower wagon cost structure. The wagon factory also depends on the proximity of the supplier to achieve lower transportation costs of heavy equipment.

Topics on Adaptability	E-A			E-B			E-M			E-S		
	1	2	3	1	2	3	1	2	3	1	2	3
Product Characteristics												
Life cycle cost	3	5	6	6	6	6	6	6	6	4	6	6
Delivery	3	3	3	3	3	3	4	4	4	3	3	3
Quality	4	4	4	4	4	4	4	4	4	4	4	4
Performance	6	6	6	6	6	6	6	6	6	6	6	6
Modularity	2	5	6	6	6	6	3	3	3	3	6	6
Flexibility	1	1	1	1	1	1	1	1	1	1	1	1
Innovation	2	2	2	1	1	1	1	1	1	1	1	1
Pre sales service	3	3	3	3	3	3	3	6	6	3	3	3
After sales service	6	6	6	6	6	6	3	3	3	6	6	6
Environmental Factor Evaluation												
- Industry regulation	2	4	6	4	4	4	2	4	6	1	4	6
- Compatibility between new and already existing products (locomotives)	1	1	1	1	1	1	6	6	6	1	1	1
- Compatibility between the product and the infra-structure (train and railway line)	6	6	6	6	6	6	6	6	6	6	6	6

Topic consolidated importance rating on a six-point scale, 1 (minimum) to 6 (maximum), attributed to episodes 1 to 3 (rolling stock orders /contracts analyzed in each relationship).
 EMEF-Alstom relationship (E-A), episodes 1-LE2620, 2-CP3150 and 3-CP3500
 EMEF-Bombardier relationship (E-B), episodes 1-UME3400, 2-Eurotram , 3-Flexity Swift
 EMEF-Metalsines relationship (E-M), episodes Uaoos (1), 2-Tadns/Habis/EAS-z, 3-Lgnss
 EMEF-Siemens relationship (E-S), episodes 1-CP5600, 2-UME3400, 3-CP4700

Table 3 – Topics on adaptability in the customer-supplier focal dyads

All the four dyads suffer a negative impact from to the new industry regulation due to cost and time spent with other partners in activities that were traditionally performed inside the dyad. Those activities are related to the extensive work developed to test and check vehicle compatibility with environmental factors, with special focus on the compatibility with the rail infrastructure. Wagon manufacturing is less focused on adaptability since the

OUTCOMES ON PRIORITIES AND CONSTRAINTS ON RELATIONAL STRUCTURE

Table 4 shows the dyad relational structure dimensions. Priorities in the relationship are centered on market share and relational strengthening since the customer controls almost all the local rolling stock contracts. Knowledge transfer seems to be the mechanism of compensation that allows the customer to maintain industrial activities for each new railway technology. Problems in the relationship arise from knowledge availability and knowledge transfer capacity constraints. Time between investment and industrial policy decisions affects strategic action within the dyad.

The complexity in interaction structure seems to be dependent on the product complexity an on the pace of change. In the four customer-supplier industrial relationships actor positioning

seem to evolve to a more flexible posture and both the customer and the supplier seem to agree in sharing or switching activities that traditionally were related to a specific industry role to their counterparts.

Topics on relational structure	E-A			E-B			E-M			E-S		
	1	2	3	1	2	3	1	2	3	1	2	3
Objectives												
- Market share	3	6	6	6	6	6	6	6	6	6	6	6
- Relational strengthening	4	6	6	6	6	6	3	2	4	6	6	6
- Knowledge transfer	5	5	3	4	4	3	4	5	4	4	4	4
Problems												
- Time between decisions	6	6	6	6	6	6	6	6	6	6	6	6
- Knowledge availability in the relationship	6	5	3	4	4	4	5	6	5	5	4	4
- Knowledge transfer capacity (proficiency)	6	5	3	4	4	4	4	4	4	3	4	4
- Component procurement	6	5	1	3	3	2	6	6	5	4	3	2
- Customer engineering and workmanship competence	3	4	4	4	3	4	6	6	6	3	4	4
Factors influencing the interaction												
- Structure (simple/complex)	6	6	6	6	6	6	2	3	3	6	6	6
- Change pace (low/high)	3	6	6	6	6	6	1	3	4	6	6	6
- Actor positioning (rigid/flexible)	1	6	2	1	1	4	1	3	3	1	1	4
- Formalization Characteristics (contracts e procedures)	2	3	4	2	2	4	2	3	4	2	2	4
- Informal Characteristics (values, commitment)	6	5	6	5	5	6	5	4	4	5	5	6
- Trust												
- Influence of power	6	6	6	6	6	6	6	5	6	6	6	6
- Influence of political and institutional facilitators (context)	3	4	6	6	6	6	4	6	6	3	3	6
- Relationship age	6	6	6	6	6	6	6	6	6	6	6	6
- Relationship closeness	6	6	6	6	6	6	6	6	6	6	6	6
	6	6	6	6	6	6	4	4	4	6	6	6

Topic consolidated importance rating on a six-point scale, 1 (minimum) to 6 (maximum), attributed to episodes 1 to 3 (rolling stock orders /contracts analyzed in each relationship).

EMEF-Alstom relationship (E-A), episodes 1-LE2620, 2-CP3150 and 3-CP3500

EMEF-Bombardier relationship (E-B), episodes 1-UME3400, 2-Eurotram , 3-Flexity Swift

EMEF-Metalsines relationship (E-M), episodes Uaoos (1), 2-Tadns/Habis/EAS-z, 3-Lgnss

EMEF-Siemens relationship (E-S), episodes 1-CP5600, 2-UME3400, 3-CP4700

Table 4 – Topics on interaction structure in the customer-supplier focal dyads

Formalization of benefit transfer and responsibility in the project tasks is becoming more important since the industry is expanding the number of actors, activities and certifications needs due to new industry regulation. Informal agreements based on trust and mutual interest are common to the dyads, but their importance seems to be growing as a mean to develop common strategies to overcome the increasing limitations on cooperation and on common action imposed by fierce competition in the liberalized market. The influence of actor power and of political and institutional facilitators is considered as very important.

OUTCOMES ON VALUE WITHIN THE DYAD

Table 5 shows the dyad value dimensions. Financial returns in the relationship, long term supplier stability and after sales service are considered as generating the main value in the relationship. Financial profitability in recent contracts is considered less important, since the partners in the dyad count on the benefit transfer during the entire vehicle life cycle.

Major wagon manufacturing must have an output above three hundred wagons per year to reach scale economies. Metalsines had not such capacity and after the second event decided to be only a parts supplier, focusing on component production to serve the partnership with EMEF. With this agreement, EMEF decided to increase production to such a level that now can benefit from scale economies and justify investments, with suppliers like Metalsines, on new component development.

Topics on Value	E-A			E-B			E-M			E-S		
	1	2	3	1	2	3	1	2	3	1	2	3
- Financial profitability in the contract	3	2	4	6	6	3	4	3	3	3	3	3
- Financial profitability in the relationship	6	6	6	6	6	6	4	3	3	6	6	6
- Long term supplier stability	6	6	6	6	6	6	5	5	5	6	6	6
- After sales service	6	6	6	6	6	6	4	4	4	6	6	6
- Economies of integration/focus	1	1	1	1	1	1	2	4	4	1	1	1
- Economies of scale (number of wagons/contract)	1	1	1	1	1	2	1	4	6	1	1	1
- Innovation Economies	1	1	1	1	1	1	1	1	1	1	1	2
- Interdependence Economies	5	5	3	4	4	4	1	2	3	4	4	4
- Conformance with specific customer requirements	3	3	3	4	4	3	6	3	2	3	3	3
- Anticipated test in supplier premises before contract	4	4	4	4	4	5	6	6	6	5	5	5
- Benchmarking on product usage in various operating contexts	5	4	6	4	4	5	4	4	4	6	5	6

Topic consolidated importance rating on a six-point scale, 1 (minimum) to 6 (maximum), attributed to episodes 1 to 3 (rolling stock orders /contracts analyzed in each relationship).

EMEF-Alstom relationship (E-A), episodes 1-LE2620, 2-CP3150 and 3-CP3500

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EMEF-Siemens relationship (E-S), episodes 1-CP5600, 2-UME3400, 3-CP4700

Table 5 – Topics on value in the customer-supplier focal dyads

Investment decisions on new locomotive, passenger train and tram-train contracts (motorized vehicle production) depend on the capacity to choose among the supplier (OEM) competitive offers (focused on price), assuming that quality is acceptable.

Orders for new wagons differ from that approach since they depend on a prior evaluation of the supplier quality control system and manufacturing competence, especially in the welding processes. Welding quality can not be tested during a visit. Specific welding activities can be certified but this is an expensive practice. They are usually evaluated according to the

behavior of already existing products used by the other customers. Transparency in the form of customer access to supplier testing premises or to other customers experience on vehicle behaviour under different operational conditions (benchmarking) is considered a valued sign of trust and commitment.

CONCLUSIONS

The results provide some insight on the network outcomes that constrained the level of interaction in the customer-supplier relationship within the Portuguese Railway Rolling Stock Assembly Industry. Some relevant network outcomes were found in the industry relationships dedicated to automotive vehicle manufacturing (locomotives, passenger trains, tram-trains). Those network outcomes include aspects as – a growing product and component complexity, - contracts for a small number of vehicles; - different product and component technologies between contracts, - growing interdependence and collaboration in after-sales services during product life cycle, - influence of political and institutional facilitators.

Those outcomes lead to the abandonment, by the customer, of activities related with definition of technical project and component production and procurement. The supplier reinforced component production/procurement activities using European wide industrial assets, not dependent on the relationship. On the other hand, the customer reinforced local activities related to functional definition and final product assembly and product testing, organizing all the necessary industrial assets. The success of those activities depends on component modularity and on the knowledge transferred by the supplier. The supplier shares activities related to product assembly, maintenance and certification with the customer, using the customer local industrial assets. The customer and the supplier believe they can use this approach to quickly install new industrial facilities, optimized for assembly, test and after sales service in new railway infrastructures, focusing on relationship adaptability.

The relevant network outcomes developed from the industry relationship dedicated to wagon manufacturing were – stable product and component technologies, - contracts for a higher number of vehicles, - greater production process specialization. Those network outcomes lead to an increase in specialization in wagon production and assembly focusing on the supply side with more investment on component production. The customer reinforced all the production activities reaching higher industrial activity and supporting relationship adaptation.

We can conclude that in both automotive vehicle manufacturing and wagons manufacturing network outcomes significantly changed the activity scope in the relationships with different relationship impact. Relationship adaptability allowed the dyads that work for motorized vehicle manufacturing to prosper, based on external component supply chain to change already existing products/platforms and serve different customer requirements. Emerging price competition for new contracts and services will also require a combination of flexibility and integration/adaptation. Modular design allows them to maintain a flexible project-based supply chain. The partners in the dyad avoid duplication in their resource collection leading to a lean local manufacturing structure adapted to market demand. Industry regulation demands increasing product standardization. This would require the reinforcement of specific integration/adaptation characteristics within the dyad, not yet visible in the analysed episodes.

Relationship adaptation allowed the dyad dedicated to wagon manufacturing to develop new products that respond to standardized product requirements with the reinforcement of manufacturing competence and internal specific component production. The partners

gradually focused on different tasks within the supply chain avoiding duplication and making it possible to integrate those activities.

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