

THE ONTOLOGY OF THE BRAZILIAN TRUCK INDUSTRY: A PRODUCT PERSPECTIVE

Sergio Evangelista Silva (UFOP)

sergio@decea.ufop.br

Claudia Pinheiro dos Santos Francisco (UFOP)

claudiapinheiro.engenharia@gmail.com

Thiago Augusto de Oliveira Silva (UFOP)

thiagoep@gmail.com

Wagner Ragi Curi Filho (UFOP)

wagner@deenp.ufop.br



This paper portrays the Brazilian truck industry from the perspective of the products (trucks) offered by the main truck assembler of this market. For this purpose it is used the concept of product ontology, where all products of this industry are grouped in a single hierarchical structure, where it is outlined their common aspects, as well as, their singularities. For attain this goal it was used the archival method, whereas it was identified all product lines of trucks offered for the six main manufactures, where together are responsible for more than 95% of sales in this market. The use of the ontology concept to map all trucks offered in this industry, allowed to present a comprehensive and deep view, where it was possible to identify the dynamic of this industry, as well as, the strategic positioning of each assembler, according to this product portfolio.

Palavras-chave: product ontology; product portfolio; product strategy; market segmentation.

1. Introduction

From the product perspective a market is formed by all products offered by the firms which actuate in a given economic segment. It is important to note that even though at first sight all firms which compete in a given industry may be regarded as rivals, a detailed exam may reveal that in practice this will not necessarily occur. Indeed, a market can be composed by many segments (Barroso and Giarratana, 2013; Boverland, 2005; Greve, 2008; Porac and Thomas, 2011), whereas the products of different segments, may not be capable of mutual substitution, and thus do not act as effective competitors.

Accordingly, to obtain a deep understanding of a given market one important construct is the product (Giachetti and Dagnino, 2014) which is the mean used by the firm to attain competitive advantage over its rivals, through the process of value generation (Ito 2012; Mello; Leão, 2008; Moraes and Mattar, 2014). In other words, it is necessary a detailed exam of all products offered in given market, in the sense of obtain a general landscape of the market, as well as a deep view of its many ramifications.

Despite the necessity of exam the products offered within a given market, the classification process of whole products in a unique framework is not a trivial task. This is due to the fact that in a real market can be offered a huge variation of products, whereas it is not always clear the classification process. The existence of the several different products within a market can be better related to the market segmentation literature (Barroso and Giarratana, 2013; Boverland, 2005; Greve, 2008; Porac and Thomas, 2011). Despite of the considerable development of this concept, which can be manifested through many books and papers, the majority of the works dealt with the concept of market segmentation in a high level sphere, not properly considering the effects of product variation in the constituency of the several segments of a market. Thus, for a better understanding of how the products variation will influence the formation of a particular market, the concept of ontology may be useful.

The ontology concept has its origins at the philosophical field and refers to the understanding of the essence of being (Sartre, 2009). Recently this concept has received practical application in the field of systems modeling, whereas it is useful to map and understand the elements and their relations in a given domain (Beydoun *et al.* 2011; Nadoveza; Kiritsis, 2014). In fact, the use of the ontology concept at the modeling of a market will be positive wherein it allows its detailed mapping.

Drawing upon the concepts of multimarket competition and ontology this paper presents the concept of market ontology which is applied to map the current configuration of the Brazilian truck industry from the perspective of the products offered by the main truck assemblers. As a result, the application of the ontology concept seems to be feasible to map the market relationships among the trucks. In this sense, it can be noted that the competition takes place at different levels, from the basic characteristics of the products to specific performance attributes. Additionally, the application of the ontology concept to map this industry allowed a deep understanding of the competitive relationships among the trucks, showing different strategies, as in terms of product offered to the markets, as well as the segmented focused by different firms.

2. Conceptual Background

2.1. Market segmentation and competition

It is common in several industries the existence of a wide diversity of products and operation fields. This phenomenon is known as market segmentation (Barroso and Giarratana, 2013; Boverland, 2005; Greve, 2008; Porac and Thomas, 2011). In a literature analysis the market segmentation is the result of both, the perception by the firms of gaps in the market, whereas the necessities of some group of clients are not satisfactorily meet (Greve, 2008; Porto and Torres, 2012), and the continuous seeking to attain competitive advantage, or strength its competitive situation in face of competitors (Barroso and Giarratana 2013; Desarbo and Grewal, 2006). Thus, the continuous market segmentation is a result of the congruence of competitive forces in one hand and the opportunities available in the market in other hand.

Aside the client, that is, from an objective perspective, two are the main constructs that the markets can be segmented, namely the product (Greve, 2008; Leask and Parker, 2007; Pinho and Silva, 2001) and the geography (Fuentelsaz; Gomes, 2006; Mas-Ruiz and Ruiz-Moreno, 2011; Mas-Ruiz et al. 2014). Starting from the product, to be considered as participants of a given industry, firms have to offer products that in a general form serve to the same basic purpose (e.g. a cloth, an automobile, and so forth). However, despite all product within a class perform the same basic function, the segmentation process involve to offer products that permit to perform specific tasks, that is, they provide specific functionalities within the general class (Barroso and Giarratana 2013; Lounsbury and Leblebici, 2004; Porto Torres,

2012). For instance, at the footwear industry the footwear serves to different clients (men, woman, children) in varied situations (work, special occasions, sports, casual use, and so forth). In addition, the products in a same market segment can be configured according to different performance attributes (Kachani and Shaatov, 2011; Karlsson and Skold, 2007) such as brand, flexibility, brand image, quality and so on (Chambers et al. 2006; Guedri McGuire 2011; Pereira et al. 2010; Porto and Silva, 2014; Reis and Pena, 2000). For instance, while a focal firm can offer shoes for the men segment focusing in design and comfort, its incumbents can focus in more simple footwear offered at a low price.

The geographic segmentation is another relevant dimension of the segmentation process (e.g. Mas-Ruiz and Ruiz-Moreno, 2011; Mas-Ruiz et al. 2014). The geographic scope of the segmentation can be appraised in four different levels, local, which refers to specific places of a city where a firm will operate, micro-regional, which refers to a group of cities where a firm will operate, regional referring to the states of a country, and global which refers to the regions of the earth where the firms will offers its products.

It is important to consider that the majority of firms are not mono product firms (Karlsson; Shold, 2007; Kachani and Shaatov, 2011). That is, they normally offer to the market more than one product, which increase the likeness to operate in multiple markets (Guedri and McGuire, 2011; Fuentelsaz and Gomes, 2007). From the firm perspective the operation in multiple markets, from the product and/or geographic perspective can have the purpose of reduce the risks and/or taking the chances of increase their profits.

At the multimarket competition an important concept is the market contact, that happens when two firms which operate at the same geographic regions and/or offer products with characteristics (Fuentelsaz and Gomes, 2006; Greve 2008). In addition, due to the heterogeneity of firms and their practices the competitive mutual pressures can be asymmetric between two firms, where the pressure undergone by a firm from a rival can be different from the pressure that its cause over this same rival (Desarbo et al 2006; Mas-Ruiz et al. 2014; Molnar et al. 2013).

Lastly, the plurality of firms and markets in a same industry allows the grouping of firms within different groups, labeled strategic groups, according to their common characteristics (Guedri and McGuire, 2011; Leask and Parker, 2007; Mas-Ruiz and Ruiz-Moreno, 2011).

2.2. Ontologies

Currently the ontology concept is widely applied at the computer science, with the purpose of modeling of different contexts (Beydoun *et al.* 2011; Nadoveza; Kiritsis, 2014). The main issue in an ontology deployment is the modeling of the main constructs of a domain, in order to permit their categorization in a whole, where there are elucidated common and particular aspects, until reach the particular or individual object level.

To address the ontology modeling, the hierarchical reasoning can be used, where the elements of a domain are depicted in an inverted tree shape, whereas the more general level is presented at the top, while the specific elements of the domain are presented at the bottom (Zhang; Cheng, 2016). In this kind of representation there is the relation of the type *is one* between elements of lower level and the element of the higher level. For instance, the upper element of a footwear ontology is the class *footwear*. In other hand, its immediate lower elements could be adult and child footwear. In the both situation, the footwear have the same function, that is, to protect the feet, but they are specialization of the concept of footwear, applied to specific scenarios.

3. Method

This research used as main approach the qualitative method (Suddaby and Bruton, 2015) where it was also used some basic quantitative techniques (Shah and Corley, 2006). It was mapped almost the whole Brazilian truck industry, regarding to the lines and models of trucks offered by the six main manufactures. This research is classified as qualitative whereas it was made a comprehensive mapping of the Brazilian truck industry, whereupon there were identified all segments, product lines and models offered within this industry. Additionally there were used basic quantitative methods in the order to provide a basic portrayal of the competitive relationships between the manufactures and the different strategic groups existents in this industry.

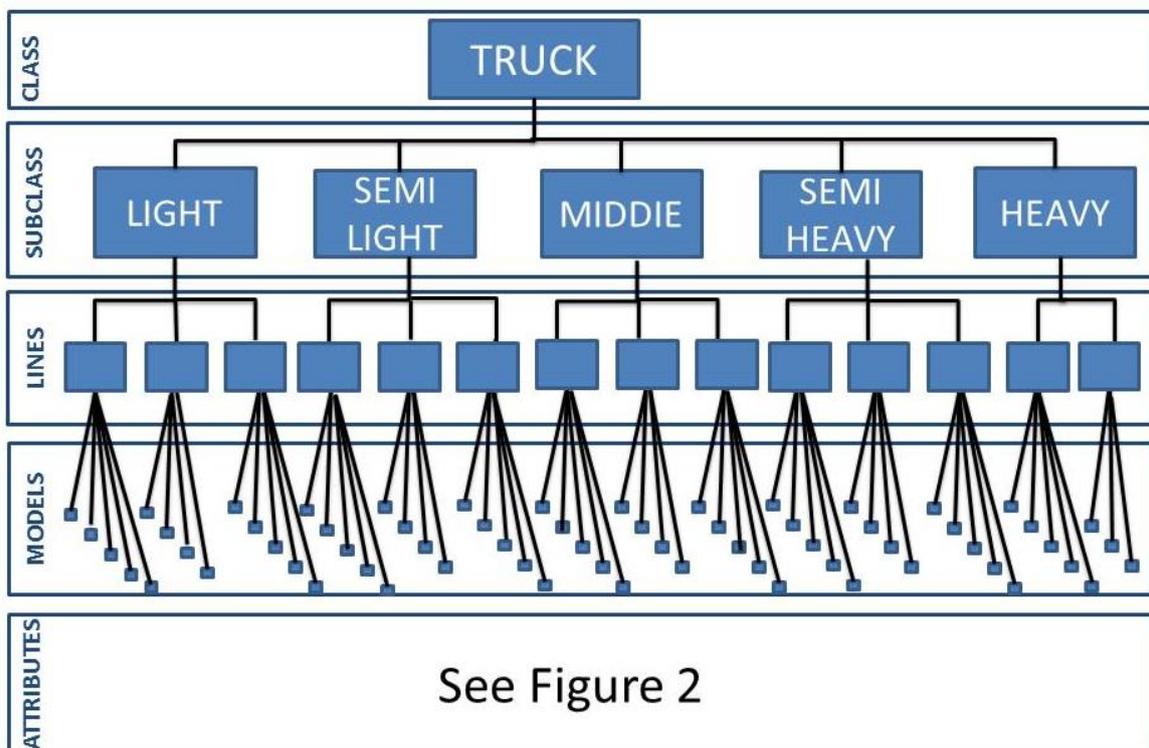
It was addressed the archival analysis where it was accessed the web sites of the six main assemblers, which in sum possess more the 95% percent of market share, in order to obtain the data about all lines and models of trucks offered by these firms, as well as the classification of these products in the markets segments. As a complementary strategy it was

required to the ANFAVEA (Associação Nacional de Veículos Automotores) complementary data about the truck industry in the sense to better characterize this industry.

4. Data presentation

In this section it is presented the basic data of the Brazilian truck industry. For a better understanding of this industry it is outlined an approach of the truck industry based in five layers, represented at Figure 1, which manifest the ontology of the trucks offered in this industry. The first layer is formed by the truck, which the main function is to transport heavy objects. According to the variables MTC (maximum traction capacity) and MLTL (maximum legal truck loadings) a truck can be classified in five subcategories (light; semi-light; medium; semi-heavy and heavy). Within these subcategories, each assembler can offer various product lines (third layer). A truck line is formed by a set of trucks with the same basic characteristics (gearbox, cabin, etc.).

Figure 1 - A five level scheme about the ontology of truck industry



Source: Authors

Accordingly, at the fourth layer, within a same truck line can exit variations in issues as engine power, MTC, quantity of axles, and so on, where each variation consists in a different truck model. This situation can be better understood in Figure 2, where it was detailed the models of the medium sub-category of trucks, wherein M1, M2, M3 and M4 represent the assemblers which operates in this market segment.

Lastly, the fifth layer, presented at Figure 2, refers to small variations in the truck models, at the middle segment, which do not comprise neither core, nor specific functionalities. The issues which define this layer are often optional truck configurations, such as quantity of axles, motor power, and so on. Some assemblers can standardize packages of additional configurations, while others may allow the consumer to make a custom choice.

Figure 2 - Attributes performances to medium subclass

MIDDIE	<i>Subclass</i>	<i>Lines</i>	TGW: 13000 MTC: 13700 AXIS: 3 ENGINE: Cummins / ISF 160 TRACTION: 6X2 POWER RATING: 162 hp (119 kw) 2.600 rpm MARCH: 6 forward, 1 reverse CYLINDER: 4	<i>Performance and attributes</i>	
			M1-LINE 1		TGW: 13200 MTC: 13700 AXIS: 3 ENGINE: Cummins / ISF 160 TRACTION: 6X2 POWER RATING: 160 hp (119 kw) 2.600 rpm MARCH: 6 forward, 1 reverse CYLINDER: 4
			M1-LINE 2		TGW: 13200 MTC: 23000 AXIS: 2 +3 ^a ENGINE: MAN D08 34 190 TRACTION: 4X2 POWER RATING: 186 hp (137 kw) 2500 rpm MARCH: 6 forward, 1 reverse CYLINDER: 4
			M 1-LINE 3		TGW: 15000 MTC: 27000 AXIS: 2 +3 ^a ENGINE: MAN D08 34 190 TRACTION: 4X2 POWER RATING: 186 hp (137 kw) 2500 rpm MARCH: 6 forward, 1 reverse CYLINDER: 4
			M 2-LINE 1		TGW: 13200 MTC: 23000 AXIS: 2 ENGINE: MAN D08 34 190 TRACTION: 4X2 POWER RATING: 186 hp (137 kw) 2500 rpm MARCH: 6 forward, 1 reverse CYLINDER: 4
			M 2-LINE 2		TGW: 13000 MTC: - AXIS: 3 ENGINE: MB OM 924 LA TRACTION: 6X2 POWER RATING: 156 hp (115 kw) 2.200 rpm MARCH: 6 forward CYLINDER: 4
			M 2-LINE 3		TGW: 14300 MTC: - AXIS: 3 ENGINE: MB OM 924 LA TRACTION: 4X2 POWER RATING: 185 hp (136 kw) 2200 rpm MARCH: 6 forward CYLINDER: 4
			M 3-LINE 1		TGW: 13900 MTC: 8900 AXIS: 3 ENGINE: MB OM 924 LA TRACTION: 4X2 POWER RATING: 185 hp (136 kw) 2200 rpm MARCH: 6 forward CYLINDER: 4
			M 3-LINE 2		TGW: 13300 MTC: - AXIS: 2 ENGINE: Iveco FPT NEF4 TRACTION: - POWER RATING: 182 hp (134 kw) 2700 rpm MARCH: 5 forward, 1 reverse CYLINDER: 4
			M 4-LINE 1		TGW: 15000 MTC: 27000 AXIS: 2 ENGINE: Iveco FPT NEF4 ID TRACTION: 4x2 POWER RATING: 206 hp 2500 rpm MARCH: 6 forward, 1 reverse CYLINDER: 4
					TGW: 10510 MTC: 12000 AXIS: 2 ENGINE: Cummins ISB4.5 186 P7-1 TRACTION: - POWER RATING: 189 hp (139 kw) 2.300 rpm MARCH: 5 forward, 1 reverse CYLINDER: 4
					TGW: 14500 MTC: 27000 AXIS: 2 ENGINE: Cummins ISB4.5 186 P7-1 TRACTION: - POWER RATING: 189 hp (139 kw) 2.300 rpm MARCH: 6 forward, 1 reverse CYLINDER: 4
					TGW: 15000 MTC: 27000 AXIS: 2 ENGINE: Cummins ISB4.5 186 P7-1 TRACTION: - POWER RATING: 189 hp (139 kw) 2.300 rpm MARCH: 6 forward, 1 reverse CYLINDER: 4

LEGEND
M: Model
TGW: Total gross weight
MTC: Maximum drawability
AXIS: Number of axis
ENGINE: Engine brand
TRACTION: Wheel Drive System
POWER RATING: Maximum power rating (hp, kw, rpm)
MARCK: Quantity of march
CYLINDER: Quantity of cylinder

Source: Authors

4.1. A portrayal of the Brazilian truck industry from the product perspective

The current portrayal of the Brazilian truck industry is outlined at Table 1. In this table there are presented the main firms which actuate in this market, the categories where each one offer products, the lines and models of trucks offered to the market.

Only four of the six firms actuate in all segments of the truck industry. M5 and M6 are focused in assemble big trucks, which are within the semi-heavy and heavy segments.

Table 1 - The subcategories of the Brazilian truck industry and the lines and models offered by the truck manufacturers.

Subcategories	Company	Lines	Models
Semi light	M1	1	1
	M2	1	3
	M3	1	3
	M4	1	1
Light	M1	1	3
	M2	1	2
	M3	2	2
	M4	2	2
Middle	M1	3	6
	M2	3	3
	M3	1	1
	M4	1	3
Semi Heavy	M1	3	6
	M2	3	3
	M3	1	1
	M4	1	3
	M5	1	3
	M6	2	3
Heavy	M1	2	8
	M2	4	18
	M3	3	6
	M4	1	5
	M5	3	14
	M6	3	5

Source: Authors

Thus, it can be noticed from these data different competitive relations wherein three companies (M1, M2, M3 and M4) compete with each other in all markets, and consequently they can be considered direct rivals. Contrarily M5 and M6 compete with the remaining four firms within the segments which they operate. These two distinct situations allow classification of the six firms in two strategic groups. The first, named as Strategic Group A is formed by the firms which compete in all segments (M1, M2, M3, M4) and the second is formed by the group of firms (M5 and M6) which compete only in the semi-heavy and heavy segment, named as Strategic Group B.

Contrary to the basic assumption of the literature that firms in different strategic groups have little mutual competitive pressures, in this study it can be noticed that even the firms will be grouped in two different strategic groups, they exert mutual pressures, however the level of these pressures are asymmetric, where the first group actuate within the same segments where the second group of firms actuate, but the inverse situation does not occur.

4.2. A synthesis of the lines and products' strategies of the truck manufacturers

Based on the data presented initially about the practices of the truck manufacturers Table 2 presents a synthesis whereby it would be possible to recognize additional strategic behavior of the truck manufacturers. Indeed, it can be noted different practices of the firms regarding the product lines and the models offered to the market that in sum, reflects their competitive strategies from the product perspective.

Referring to the lines offered it can be observed two strategies, the situation where some firms offer few lines to the market, and the opposite situation where the firms offer many product lines to the market. The first situation is accomplished by the two firms which actuate at the Strategic Group B and the M4, while the second situation is accomplished by the three remaining firms.

Table 2 - A synthesis of the lines and products of the firms

	Categories	Total lines	Total of models	Average lines by categories	Average models by categories	Average models by lines
M1	5	10	24	2	4.8	2.4
M2	5	12	29	2,4	5.8	2.41
M3	5	8	13	1.6	2.6	1.62
M4	5	5	14	1	2,8	2.8
M5	2	4	17	2	8.5	4.25
M6	2	5	8	2.5	4	1.6

Source: Authors

From the perspective of the quantity of models offered, it was detected three strategies. First, the situation where the manufacturer offers a lot of models, in this case more than twenty one (M1 (with 24) and M2 (with 29)), the intermediary situation where the firm offer between ten and twenty truck models ((M3 (with 13), M4 (with 14) and M5 (with 17)) and the situation where the firm offer few models, less than ten (M6 (with 8)).

For a better understanding it is convenient to account these three strategic types within each strategic group. In the Strategic Group A while M4 and M3, besides actuate in all segments, seek to offer a narrow amount of truck models, while M1 and M2 offer a wide quantity of models. Thus, within this strategic group it can be considered two strategic subgroups (M4, M3 and M1 and M2 respectively). Similarly within the B Strategic Group while the M6 carry out a strategy of offering few models, M5 offer many models to the market. These two opposite strategies can be interpreted at the following way. The offering of a narrow quantity of models can be considered as a strategy to lowering the development and production costs. From a marketing perspective it is expected that these firms will target their products to focal points within each market segment, where they operate. Thus this strategy will be labeled as production focused strategy.

In other hand, the strategy of offering many models of products can be labeled as a market focused strategy, whereby the firms seek to enhance its capacity of meeting different customer needs, focusing its products not only in the focal points of each market segment, but also seeking to give support to segment fringes, in an attempt of improve the value generated to the market.

5. Analysis and Conclusion

This paper use the ontology concept to map the Brazilian truck industry, referring to the characteristics of the truck offered by the six main manufacturers. Accordingly, the product of this industry was modeled in an ontology, based in five layers. This approach showed to be feasible as a tool to map and understand the competitive behavior of firms in a market referring to their product portfolio strategy.

It is important to note that albeit in this article the truck industry was modeled in an ontology with five layers, the application of this concept in other industry can produce a framework with a different number of layers, according to the profile of products, as well as the level of development of such industry.

With regard to the Brazilian truck industry specifically, the modeling of this industry using the ontology concept displayed two different strategic groups where there are asymmetrical mutual competitive pressures between the firms of these different groups, as well as, different competitive strategies of the firms from a same group. From the perspective of product lines,

there are companies that offer few product lines to the market and those that offer many product lines. For a strategy characterization, referring to the number of models offered, three different ways were identified: companies that offer great number of models (with more than twenty one models); companies in an intermediary position that offer between ten and twenty models; and companies which offer few models, which offer less than ten models.

As practical implication, marketing and strategy practitioners can easily employ the concept of market ontology presented in this paper, to better understand the industries and their competitive practices, concerning the product portfolio strategy. As suggestion for future study, it could be developed market indexes in the sense of better explain the configuration of a given industry, as well as their firms.

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