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# Game theory and Purchasing Management: an empirical study of auctioning in the automotive sector

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**Abstract.** The purchasing function is assuming an increasingly relevant role within companies in the last decades, taking over the main responsibility for the costs of goods purchased as well as for supplier management. Its relevancy is due to the fact that purchasing can contribute to develop competitive advantages by aligning its strategy to the business strategy. Purchasing strategy is usually deployed per (purchasing) category and operationally executed in the so called tactical purchasing process. One key step is the negotiation/bidding where there is a lack of empirical research regarding the application of game theory. This paper contributes by discussing how game theory can be systematically utilised for designing negotiations (i.e. games) and getting more efficient results –by presenting an empirical study on automotive sector company, specifically on a bidding process for constructing a new production facility in Mexico.

**Keywords:** Purchasing strategy, Category Management, negotiations, game theory, auction, automotive, construction

## 1　Introduction

In the past few years purchasing (PU) has become a strategic business function due to the increased importance of supply chain management. Furthermore the PU function has the main responsibility for the costs of goods purchased (e.g. materials, products or services), as well as for supplier management [1, 2]. The purchasing capabilities (i.e. among others to foster close working relationships with a limited number of suppliers) can allow the companies to create sustainable competitive advantage by enabling to build and leverage beneficial inter-organizational relationships [3, 4].

It often appears that PU can contribute not only to the net income, but also to revenues. Since most companies spend more than half of their sales turnover on purchased parts and services, efficient and constructive relationships with suppliers are key to the company's short-term financial results and long-term competitive

position. Additionally, PU policies can significantly improve sales margins through realizing substantial cost savings [5].

Strategic PU is defined as "the process of planning, implementing, evaluating, and controlling strategic and operating PU decisions for directing all activities of the PU function toward opportunities consistent with the firm's capabilities to achieve its long-term goals" [6]. PU objectives are based upon the company's objectives and could be related to e.g. cost reduction, reduction of supplier base or improving product quality. The PU objectives are later deployed into PU strategies and operative policies, in order to contribute to business success [5]. Therefore, one key element is to make sure the alignment of business and PU strategy, which are later deployed into categories [7]. As the results from both PU and supply management might have a direct impact on financial results of the company [8, 9], PU (operations) strategy must be designed to match and thereby support the business strategy [7, 10-12]. Moreover, different PU strategies are needed for different types of purchased items [7, 13].

Therefore, the research question is: how can –within Purchasing Management- the negotiation framework design profit from game theory in order to achieve more efficient results and therefore increase the firm's competitiveness?

This paper will firstly present a brief literature review and research methodology. The later part of the paper will introduce the case study and main contributions.

## 2 Literature review

**Category management**

Category Management (CM) is defined as "a process that involves managing product categories as business units and customizing them on a store-by-store basis to satisfy customer needs" [7]. CM shifted the traditional focus from brand management approach to a category management approach [14] and it was also adapted to categorize purchased items [4]. A category is defined as "a group of products which can be substituted for one another by a consumer" [5], as e.g. cereals or bakery. CM can be used as the basic unit of strategic analysis, which measures the competitive improvement on PU management [5, 16].

In order to define the strategies for each category, it's recommended to have systematic classifications [15]. One common approach used for it was developed by Kraljic [7] -so called "Kraljic's purchasing portfolio matrix"-. This matrix has become the standard in the field of purchasing portfolio models [17, 18].

**Kraljic purchasing portfolio**

The objective of (Kraljic's) purchasing portfolio matrix is to categorize every purchase into one out of four quadrants, according to their profit impact and supply risk [5, 7, 18, 19]: routine commodity, bottleneck, leverage and strategic. Each of these quadrants requires a differentiated purchasing strategy [5], i.e. a firm's supply strategy depends on the two classifying factors mentioned above.

One of the main critics to the Kraljic matrix is that it does not provide comprehensive strategies for all quadrants, as well as that only proposes options based on power/dependence for items in the strategic quadrant [19]. Although some authors expanded the original matrix and filled in strategies for other quadrants [20-22], there have been concerns that even one strategy per quadrant is not sufficient [19]. Other authors addressed some gaps related to developing the Bottleneck, Non-Critical and Leverage quadrants [19]. Gelderman and van Weele [23] have made valuable contributions by surveying a large number of cases regarding which strategies should be used for each Kraljic's quadrant, as well as by providing a more comprehensive version of Kraljic's initial matrix.

Caniels and Gelderman [19] have demonstrated that there can be a number of strategies for each quadrant, each of which serves a different purpose – to stay put or to move quadrants. It leads to another critic of the original Kraljic matrix— its simplicity regarding complex strategic decisions by basing them on 2 axes alone [23].

## The purchasing process

The above defined (PU) CM is the basis for the strategic PU management and is operationally deployed as a sequence of tasks which are outlined on the (so called) tactical process [5]. This tactical (PU) process has been defined by Van Weele [5] as the sum of PU specification determination, selection of the best supplier and the preparation and conduction of any negotiation with the supplier in order to establish and sign legal contract. The key issue of effective PU decision-making is to guide the efforts of the various organizational parties involved so that an optimal result is achieved for the organization [5].

The selection of a supplier starts with a market research and a list of potential suppliers for a needed item [5, 18]. The next task is to reduce this list to a manageable short list considering suppliers' expertise, past performance, product designs, and quality, among others [18]. In order to select the best supplier, there are two ways: competitive bidding and negotiation. [5, 18] Competitive bidding means situation where a buyer asks for bids from different suppliers, creating a level playing field. One supplier will be selected with whom the delivery of the product will be negotiated [5].

## Game Theory contribution to PU management

Dixit et al. [23] define a (strategic) game as "interactions between mutually aware players and decisions for action situations where each player can choose without concern for reaction or response from others". Moreover game theory (GT) can be explained as a compilation of analytical tools designed to help us understanding the phenomena that we observe when decision-makers interact [24]. The games can be classified depending on three dimensions [24]: (1) Noncooperative and Cooperative Games, (2) Strategic Games and Extensive Games and (3) Perfect and Imperfect Information.

Within GT, Nash equilibrium can be defined as a "list of strategies such that no player can get a better situation by switching to other available strategy, while all other players adhere to the strategies specified for them in the list" [23, 25].

One standard way of applying GT within PU processes is to allow qualified suppliers to bid in auctions [26]. A wide variety of companies applies auctions to the regular negotiations in order to keep best supply-market pricing [26].

In order to conduct a proper auction, each supplier has to be qualified and approved as a suitable provider in case of winning the awarding. Once a proper supply base has been defined, the auction gives the chance to the buyer to conduct the awarding in a fast way to achieve the optimum prices [27]. There are different kinds of auctions: in a forward auction the bidders are buyers and the auction manager is a seller. In a reverse auction the suppliers are who do the bidding and the auction manager is a buyer. A further categorisation depends on if it is ascending or descending, and if the bid is made by the auction manager or bidders (English, Dutch or Japanese) [27].

Even when it is known that reverse auctions in fact "work" to save organizations time and money in their purchasing negotiation, there is few literature in the academics regarding to the specific "whys" and "hows" of this success [28]. As Tassabehji [29] had observed "the study of e-auctions is still in the early stages and there remains a dearth of substantial empirical research and much more to uncover". Mithas et al. [30] discussed that there has indeed been lack of academic research in the area of reverse auctions. The limited availability of data and the proprietary in nature of them [31] could be reason for the limited research in the use of reverse auctions in the B2B (business to business). Additionally, since only few purchasing professionals have actually used reverse auctions, the empirical research is complicate [32]. The studies that have been conducted have largely been either simply descriptive or prescriptive in nature [33]. Thus, studies that provide more details on the actual workings or reverse auctions will be of great interest to both practitioners and academicians in field of purchasing management.

## 3 Research methodology

The research is based on a literature review and a case study following the constructive research (CR) methodology. CR is an approach that aims to produce solutions to explicit problems and is closely related to the concept of innovative constructivism [34]. This approach develops an innovative solution, which is theoretically grounded, to a relevant practical problem. An essential component of CR is the generation of new learning and knowledge in the process of constructing the solution [35]. The case study as such is exploratory in nature. Two of the main researchers have been actively involved in the project transition of the case company. Thus, facets of action research (AR) have also been deployed. In AR both researchers and practitioners are actively engaged in solving a client-initiated project dealing with a certain business problem [36-38]. The company selected for the case faced the challenge of increasing the competition in a given negotiation, which counted for

being the second highest invest of the company ever. The company wanted an innovative approach for assuring a highly performing negotiation, providing the company the highest possible competition to its awarding process –an interesting case for academics in order to develop, structure and test new knowledge.

The studied case implied the design, construction and execution of a GT based awarding process for the construction of a new industrial facility in Mexico for the client company (Spanish company in the automotive sector). The main data collection and observation period lasted for 4 months during end of 2014 and beginning 2015: it consisted of meetings, semi-structured interviews and company internal documentation, as well as direct participation in the case. The researchers attended several preparatory meetings with the CEO, Purchasing Manager, Chief Engineer with the Project Manager of the new production site in Mexico. The first phase of the case research included meetings and interviews that focused on understanding the challenges for the company within the global footprint of the automotive industry and the strategic reasons for implementing a new facility in Mexico, as well the factory role within the company's network. The second phase coped with the game design: it started with joint workshops of researchers and practitioners to develop standard technical project definition which will be the standard base for the later awarding process. Additionally researchers together with Purchasing Manager and Chief Engineer developed a common understanding of the general awarding process and expected outcome from the design and execution. The final outcome of this second phase was the detailed design of the "game" (i.e. awarding process), which included the identification of players, set the rules of the game –especially regarding know/unknown information and awarding decisions- and the operative plan for executing the game. The third (and last) phase included the real supplier market research, which had two main qualification waves, and the final execution of the designed game, i.e. awarding process.


## 4      Case research

The case company is a Spanish Tier-1 and Tier-2 automotive company which supplies to important OEM companies (e.g. PSA Group, Mercedes-Benz, Volvo, etc.) and Tier-1 corporations (e.g. Robert Bosch, TRW, Continental, etc.) and is specialized in metal forging for safety parts.   The case company is increasing its global footprint by opening a new facility in Mexico, which is aimed to satisfy regional demand from already established OEM and Tier-1 customer in Mexico and USA. The researchers were involved for supporting the company in the design and execution of the negotiation for constructing the new factory facility in Mexico during 2015. The construction of the new facility was clustered within the category "Facility Construction".

The whole negotiation design and execution followed a construct which assured a systematic approach:

(1) In order to have a first proper negotiation design, the initial step was to assess the purchasing strategy for the category and to analyse the profit impact and supply

risk by utilizing Kraljic's purchasing portfolio matrix. Semi-structured interviews with the management team as well as group discussion were carried out. Specifically for the positioning of items (the measurement), i.e. for the process of reviewing the positions in the matrix and a process of reflection on the consequences, the consensus method as described by Gelderman and van Weele [10] was utilized. The managed category (i.e. construction of the new facility) was the second highest invest ever for the company and the supply risk was defined as low. Therefore the category was position in the "Leverage" quadrant (Figure 1):
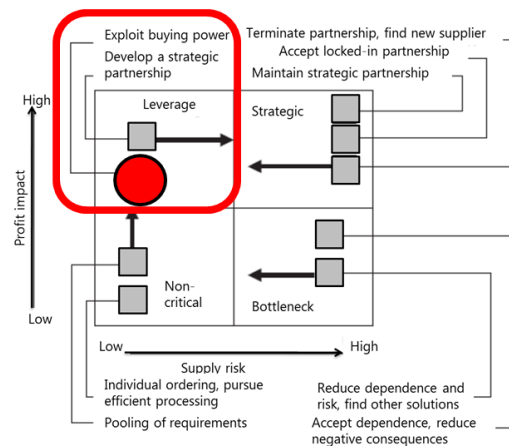


**Fig. 1.** Purchasing strategies for all portfolio quadrants, based on Kraljic's matrix [7; 20-22]

(2) Taking into account the quadrant and the possible strategies [19-23], the researchers and case company agreed that the suitable strategy should be "Exploit buying power". Individual semi-structured interviews were carried out, mixed with group discussions.

(3) The initial negotiation design demanded that the highest number of suppliers should take part in the negotiation process. In order to make bidding comparable, a standard technical specification (including drawings, technical requirements, etc.) was developed by an independent architect – what created the basis for making all bids comparable. After contacting 16 companies from Spain, Mexico and USA, 9 companies sent an initial project offer. A first filter was executed by the company utilizing a priorisation matrix developed by the researchers (including criteria as: cost, offer quality, technical discussions, financial statements, etc.).

From these 9 companies, only 4 companies were selected and invited to participate in the (final) negotiation/awarding process (i.e. game).

(3) The negotiation (i.e. game) design defined the following game rules components, specifically: (a) Non-cooperative game, only one supplier will be awarded; (b) the whole process will have imperfect information; (c) two-phase game: the first one will be a (no electronically managed but manually) reverse Japanese

auction. The best supplier in the first phase will be the first supplier starting the second phase (and subsequently). The second phase has been designed as an extensive game, where the supplier is offered the awarding under certain conditions and should either accept or reject it. If these conditions are accepted, the supplier is awarded, if not the subsequent supplier has the same chance to win the awarding.

The 4 suppliers were contacted for confirming their participation in the final awarding (on 2015, March 11th) and for being available the day before in order to explain the game rules extensively. Finally one out of these 4 suppliers did not accept the invitation for participating in the final awarding. The final negotiation started with 3 suppliers playing a reverse Japanese auction, which lasted for 4 hours and had 20 bidding rounds. After the first phase, 2 suppliers were selected for the second phase of extensive game. The supplier with the lowest bid in the first phase had the first chance to meet the case company and received a binding proposal for winning the award. In fact, the first supplier accepted the conditions and the process finished. Interestingly, the supplier qualified third in the first phase (Japanese reverse auction) gave an (economically) improved offer to its bid in the auction, but the case company did not accept it since it was out of the game rules.

(4) The awarded supplier was immediately offered a legally binding contract, which was signed by the supplier and the case company, finishing the awarding process.

The economical result of the awarding process showed a cost reduction of 24% (the saving counted for approx. 20% of the yearly EBIT of the case company) comparing the construction cost agreed in the contract vs. lowest bid provided among the 9 suppliers which sent project offers in the initial phase.

## 5    Contribution

This case research shows that GT could help PU practitioners to conduct more efficient negotiations, by increasing competition among suppliers. Specifically, this research showed that a proper game design is a crucial element for the latter execution, especially for giving players clear information regarding the game rules. Additionally our case illustrates how business strategy is deployed into PU strategy by means of CM. The presented CM tools are the later basis for a proper awarding process, i.e. negotiation process is fully aligned to the company's strategy, directly contributing to its competitiveness. We call for further empirical research of GT applied to PU management, enriching the understanding of GT influence in real life games. Additionally more research in the CM and its deployment in negotiation techniques could provide interesting insights for the PU strategy field.

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