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Systems for Logistics Services e-Procurement: Design and Performance

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Abstract

The paper addresses the topic of e-procurement of logistics services and examines how the system that companies adopt to support this task affects the process performance, evaluated in terms of objective outcomes (e.g., logistics providers' profits) and other performances related to behavioral issues. Specifically, the considered system is characterized by the exchange mechanism that rules the transaction (multi-attribute auction vs. negotiation) and the level of complexity by which the service is described. The analysis, conducted via a laboratory experiment, shows that both the exchange mechanism and the complexity of representation affect performance. Practical implications are derived, which could help companies design effective e-procurement systems.

Keywords: auctions, negotiations, logistics services, e-procurement, laboratory experiments.

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1. Introduction

Most of the peculiarities of logistics services procurement arise from the different nature of a service than that of a physical good. Lovelock (1983) explains the nature of the service concept by means of several features: services are intangible, heterogeneous (i.e. they cannot be standardized), they need simultaneous production and consumption, and are perishable (i.e. cannot be stored). These characteristics may be behind the firms' belief that defining, measuring, and controlling performances is more difficult for services than for goods. This may lead to inefficiencies and lack of control – the issue raised in the case of procurement (Fitzsimmons *et al.*, 1998; Smeltzer and Ogden, 2002). Often, a major quota expense of a firm's expenditures for services is for logistics.

In addition to the above characteristics, it should also be mentioned that services are also highly complex and affected by uncertainty. Complexity increases when buyers demand advanced services, including bundles of multiple services or value-adding logistics solutions (e.g. integrated transportation and warehouse management, supply chain inventory management, and reverse logistics), thus requiring a high degree of customization (Andersson and Norrman, 2002).

Innovation in logistics services and the growing impact of logistics on competitive advantage is one of the reasons for the ongoing changes in the relationship between buyers and suppliers, which are moving from competitive to collaborative approaches. In the former, which are typically limited to the purchase of basic services, the focus of the relationship is transaction efficiency, thus price is considered the main leverage. Conversely, the procurement of logistics solutions involves collaboration, information and data sharing, risks and rewards sharing, and joint investments in facilities and equipment, namely third-party logistics relationships (Berglund *et al.*, 1999; Skjoett-Larsen, 2000).

The above changes have impact on the design of the system for the logistics services procurement (Bellantuono *et al.*, 2008), in particular when such a process is supported via information and communication technology (e-procurement). This paper focuses on the choice of specific key features of such systems: the exchange mechanism (e.g. auction vs. negotiation) and the level of complexity adopted to describe the service itself. Both features have impact on the outcome achieved by the e-procurement process.

Exchange mechanisms are sets of rules, which specify the functioning of the market and permissible behavior of its participants. The three standard mechanisms are: (i) catalogues, where requests and offers are posted; (ii) auctions, where one side automates the process during which participants from the other side compete against each other; and (iii) negotiations, where the participants bargain over the conditions of an exchange. One or more of these mechanisms are implemented in every e-marketplace. This research focuses on auctions and negotiations.

Auctions are well-structured and can be described completely and unequivocally using a set of rules and formulae. Negotiations belong to a rich and ill-defined family of processes used for exchanging goods or services among buyers and sellers, and for resolving inter-personal and inter-organizational conflicts. Negotiations involve an exchange of information comprised of offers, counter-offers, and arguments with the purpose of reaching a consensus (Bichler *et al.*, 2003).

In addition to the mechanism selection, a key issue concerns the criterion or criteria according

to which the e-procurement decision is made. A survey by Ferrin and Plank (2002) found that over 90% of purchasing managers based their decisions on both price and non-price variables (e.g. durability, service, lead-time, and trust). As most e-procurement decision problems are multi-attribute, companies need guidelines to properly identify e-procurement systems able to handle several decision criteria. In particular the performance offered by multi-attribute auctions as well as multi-attribute negotiations, when applied to e-procurement of logistics services should be investigated. However, the most recent survey on experimental auction research (Kagel and Levin, 2012) does not include any multi-attribute auction experiment. Furthermore, some scholars (Chen-Ritzo *et al.*, 2005) found that the higher complexity of a multi-attribute auction mechanism consumes some of the efficiency gains over price-only auctions. Similar considerations could apply to multi-attribute negotiation. As a result, there is a need for investigating the trade-off between the description accuracy of the procured service (number of utilized criteria and associated complexity of the multi-attribute mechanism) and the e-procurement process performance.

This paper investigates how the process performance in logistics service e-procurement is affected by the features of the system adopted to support this task. In particular, the considered system handles multiple decision criteria to select the logistics provider and is characterized by the exchange mechanism (multi-attribute auction vs. negotiation) and the level of complexity adopted to describe the logistics service (i.e. number of attributes). The process performance is analyzed in terms of objective and substantive outcome, trust, satisfaction with dealing, and perception of opportunism.

The remaining of the paper is organized as follows: Section 2 provides a short literature review to illustrate the constructs that define process performance, and states research hypotheses. Section 3 presents research methodology, in particular the protocol adopted to conduct the laboratory experiment as well as the measurement of constructs and their validation. Results are summarized in Section 4 and discussed in Section 5.

2. Literature review and research hypotheses

2.1 Constructs

The constructs taken into account in this study are introduced and described below.

Objective and substantive outcomes. Following Oliver *et al.* (1994), we define negotiation outcomes as the products of a given bargaining episode and make a distinction between economic and social-psychological outcomes.

Economic outcomes refer to the objective allocations of the negotiated resources that result from the bargain and are typically thought of in terms of revenue or profit claimed by individuals as well as in terms of the joint payoff for both parties. Social-psychological outcomes are the subjective social perceptions held by negotiating parties following the encounter. Apparently, both kinds of outcomes directly affect satisfaction, albeit in a measure that depends on the specific bargain context (Oliver, 1993).

In this study, both objective and substantive outcomes are treated as dependent variables (DVs), whereas the exchange mechanism and number of attributes are the independent variables (IVs). Objective outcomes are directly measured in terms of supplier's profit and

revenue, whereas substantive outcomes are obtained from the following questionnaire:

- I am satisfied with the results that I achieved.
- I achieved more than what I had expected.
- The outcome is better for the buyer than it is for the provider.
- The results I obtained are not favorable for my company.

Trust. Literature on procurement and supply chain management, while stressing the importance of trust in building effective buyer–supplier relationships (Kumar, 1996; Zaheer *et al.*, 1998), states that developing the intended partner's trust is an important concern in partnership management (Johnston *et al.*, 2004). However, the concept of trust is not univocally defined (Gattiker *et al.*, 2007). For instance, according to Doney and Cannon (1997), trust is a combination of perceived credibility and perceived benevolence. Cummings and Bromiley (1996) provide a more complex definition, which invokes the expectation that another group or individual (i) be honest, (ii) behaves according to explicit or implicit commitments, and (iii) renounces to take gain when there is a chance to do it at the counterpart's expense. It has been also stressed that the level of trust between two persons or organizations is affected by the experience they had in past mutual relationships (Kim *et al.*, 2008).

The above definitions help us to investigate trust by means of items, each focusing on it from a different perspective. In particular, we considered the following items adapted from Doney and Cannon (1997) to test the construct:

- I think that the buyer will keep the promises he/she makes to my company in the future.
- When making important decisions, the buyer considers my company's welfare as well as his/her own.
- My company trusts the buyer to keep our best interests in mind.

Satisfaction with dealing. Relationship management and the actors' satisfaction with relationship are important components of the relational outcomes. Relational success of an exchange can be measured by the actor's satisfaction with their relationship (Wong, 2000). Such a satisfaction requires that in buyer-supplier relationships the so-called arm's length arrangements are forsaken and replaced with strategies able to build strong relationships among partners (Gadde and Snehoda, 2000; Liu et al., 2010). Research on antecedents of satisfaction has shown that this may be affected by specific actions and behaviors that parties repeatedly adopt in dealing with their counterparts. This result holds for both buyer's (Humphreys et al., 2004) and supplier's satisfaction (Goffin et al., 2006; Ghijsen et al., 2010).

From the suppliers' perspective, satisfaction has been defined by Benton and Maloni (2005) as "the feeling of equity with the relationship no matter what power imbalances exists". The survey conducted by Ghijsen *et al.* (2010) within the automotive industry provides examples of variables – such as recommendations, information exchanges, threats or legalistic pleas. The authors adapt measures proposed by Benton and Maloni (2005) and Ping (1997) in order to discuss the roles these variables play in building supplier's satisfaction). In this research, we adopt the following items, based on (Ghijsen *et al.*, 2010):

- Dealing with this buyer benefits my company.

- This buyer is a good company to do business with.

Perception of opportunism. Williamson (1975) defines opportunism as "self-interest seeking with guile", i.e. with "lying, stealing, cheating, and calculated efforts to mislead, distort, disguise, obfuscate, or otherwise confuse" (Williamson, 1985). Somewhat similarly, Macneil (1981) defines guile as "taking advantage of opportunities with little regard for principles or consequences".

Following Jap (2003), we claim that "opportunism is not merely a form of distrust. Trust is a broad meta-construct with many facets and levels (Rousseau *et al.*, 1998). Opportunism is more circumvented and behavioral in nature; it is observable by the supplier and grounded in specific actions and should create reduced attributions of trust".

The concept of opportunism has been widely discussed in the field of buyer-supplier relationships (Brown *et al.*, 2000). Indeed, although both parties would make a profit, in fact they pursue different conflicting objectives: buyers aim at reducing price, increasing quality and charging their counterpart for risks due, for instance, to units unsold or late deliveries. In contrast, suppliers wish to maximize sales, irrespective of buyers' actual requirements, obtain assurances on minimum purchases, transfer increases in labor or row materials costs, and so on. These conditions breed discord and suspicion, and make parties agree on complex coordination schemes so as to reduce their vulnerability toward counterpart's opportunistic behavior. Unfortunately, contracts cannot include rules to manage all possible cases, thus parties have to cope with opportunism and hold-up problems (Kim and Mahoney, 2010).

In this paper we focus on the supplier's perception of opportunism, namely the suspicion that the buyer behaves opportunistically at his expense. The items used to test this construct are the same as in Carter and Stevens (2007):

- In future interactions, I believe that the buyer would be unwilling to accept responsibility for his/her mistakes.
- In future interactions, I believe that the buyer would try to "nickel and dime" my company.

2.2 Research hypotheses

Our research goal is to identify guidelines for companies that need to select or design systems for logistics services e-procurement. We then propose several research hypotheses, which concern the impact that specific design parameters (the exchange mechanism chosen for the logistics service procurement and the level of complexity adopted to describe the service) have on certain performance (objective and substantive outcome, trust, satisfaction with dealing, and perception of opportunism). The possible impacts of two independent (design parameters) on five dependent (performance) variables result in ten hypotheses.

Hypotheses H1 to H5 assume the exchange mechanism to be an independent variable. Ivanova-Stenzel and Kroger (2005) found that bidders' satisfaction is higher in auctions than in negotiations, due to a higher transparency of their set of rules. On the other hand, Gattiker *et al.* (2005) show that, at different levels of procurement complexity, if the buyer adopts e-auctions instead of e - negotiations, the seller's trust may decrease. Similar results have been obtained by Beall *et al.* (2003). Also the relationship between the adoption of a specific exchange mechanism and the perceived opportunism has been widely discussed in literature,

however, results are to some extent controversial. For instance, Beall *et al.* (2003) give empirical evidence that the bidders' suspicions of opportunism is lowered in e-auctions, due to the intrinsic transparency of this mechanism, Other scholars affirm that suppliers believe that the buyers' opportunism leads them to: (i) adopt reverse auctions instead of other mechanisms (Carter *et al.*, 2004; Jap, 2003; Smeltzer and Carr, 2003), (ii) select specific kinds of auctions (Jap, 2003), or (iii) admit a higher number of participants (Carter and Stevens, 2007).

In hypotheses H6 to H10 we assume the complexity of service description to be an independent variable, and operationalize it in terms of the number of service attributes to be dealt with during transactions. We assume that a transaction based on three attributes, compared with one based on two attributes, is less easy to manage and requires more attention and carefulness.

Below are ten hypotheses:

H1. Auctions will generate lower objective outcome than negotiations.

H2. Auctions will generate a higher substantive outcome than negotiations.

H3. Auctions will generate a lower level of trust than negotiations.

H4. Auctions will generate lower satisfaction with dealing than negotiations.

H5. Auctions will generate lower perception of opportunism than negotiations.

H6. Transactions with high complexity of representation will generate lower revenue for providers than transactions with low complexity of representation.

H7. Transactions with high complexity of representation will generate a lower substantive outcome than transactions with low complexity of representation.

H8. Transactions with high complexity of representation will generate a lower level of trust than transactions with low complexity of representation.

H9. Transactions with high complexity of representation will generate lower satisfaction with dealing than transactions with low complexity of representation.

H10. Transactions with high complexity of representation will generate higher perception of opportunism than transactions with low complexity of representation.

The conceptual model is depicted in Figure 1.

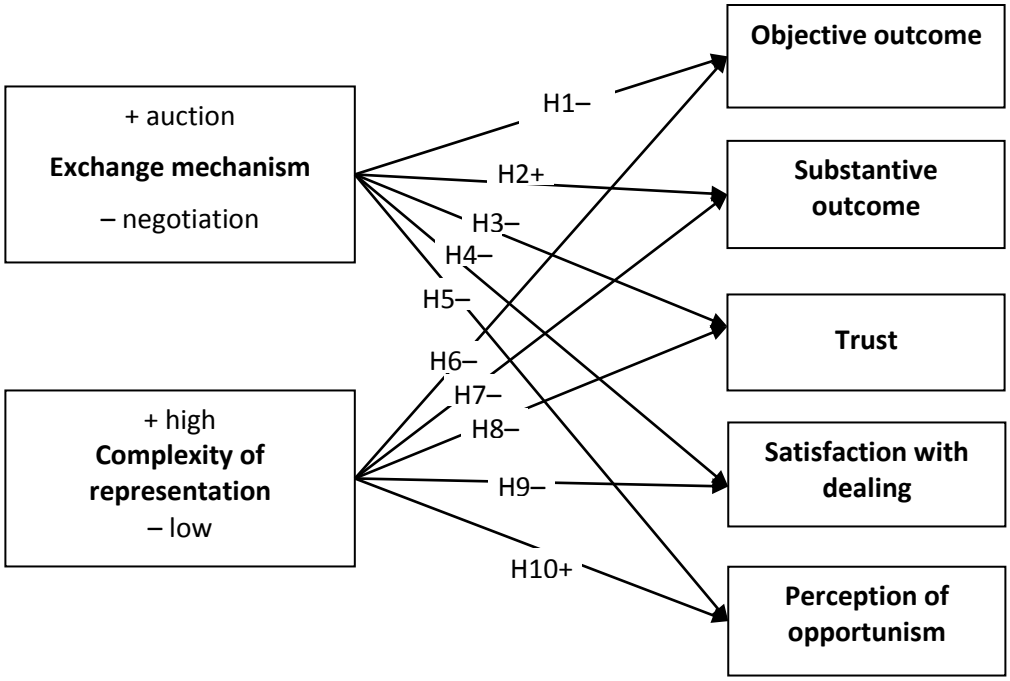

Fig. 1. Conceptual model.

3. Methodology

Our research utilized laboratory experiments, which are a specialized form of field experiment that usually involves students acting in an environment created for research purposes (Colquitt, 2008). Thanks to (small) grants(monetary rewards, participants are induced to adopt "smart" decisions, namely to maximize their own payoff, thus optimizing behavior. This increases their compliance with the experiment's aim, and reduces the risk of bias. The use of students instead of experienced suppliers is common in experimental design (Naquin and Paulson, 2003; Gattiker *et al.*, 2007) and assures that results cannot be explained through participants' work experience with e-procurement (Carter and Stevens, 2007).

3.1 Participants

The sample consisted of students enrolled in courses at an Italian University. In both auctions and negotiations, the role of bidders was played by second and third-year undergraduate students in Management Engineering. There were 200 participants. Two participants were not taken into consideration because their records were incomplete. Of the 198 remaining participants, 51% were female and 98.5% Italian citizens. 83.3% participants were between 21 and 25 years old, while 14.6% participants were under 21 years old. Students' participation was voluntary, but they were awarded extra credit. To motivate conscientious behavior during the experiment, participants were also informed that the best 25% of performers would double their extra credit.

Buyers for negotiations were selected from graduate students and junior researchers in Management Engineering. They received detailed instructions regarding their behavior, so as to make their tactics similar during the experiment. Auctions did not require buyers?

3.2 Design

Our hypotheses were tested by adopting a 2×2 research design, whose experimental factors were the exchange mechanism and the level of complexity in describing the service. For both factors – considered as independent variables – we took into account two values, namely auction and negotiation for the former, and two and three service attributes for the latter. All variables were completely crossed, thus resulting in four experimental conditions.

Differently from auctions where the system works automatically, in negotiations buyers play active roles. To assure a tight control on the resulting possible confounding factors, every experimental condition that recurs in negotiations includes 14 transactions (equally divided into two groups, based on the buyer's strategy – competitive vs. cooperative). On the other hand, every experimental condition that recurs in auctions includes 11 transactions. On the whole, 50 independent transactions were considered.

3.3 Procedure

Transactions were performed entirely on a web-based platform named *InterNeg Virtual Integrated Transaction Environment* (INVITE), hosting a system for conducting auctions (*InterNeg Multi-Attribute Reverse Auction System* - IMARAS) and another for conducting negotiations (*InterNeg Multi-Bilateral Negotiation System* – IMBINS). The above transaction environment and the two systems are detailed in Strecker *et al.* (2006) and Kersten *et al.* (2012).

Transactions were conducted in a computer laboratory, in consecutive sessions, and they lasted two hours each, including the preparation time. Participants at the bidder-side were randomly matched up in groups of four and their identities were unknown to each other. At the beginning of every session, the facilitator seated participants at the computer terminals far from each other to prevent them from communicating or peeping, and briefly explained the goal of the experiment and its rules. Then, he gave the participants a folder containing their log-in credentials for the platform, the system guide, some general notes on auctions or negotiations, and the description of the case, including both public and private information (see Section 3.4 for details). Participants were asked to read the material. After 25 minutes, participants were administered a quiz to ascertain their comprehension of the case: if they gave a wrong answer, the system did not allow them to proceed. Then, their expectations on the task, behavior, and outcomes, and a subjective assessment of the case understanding were checked through a pre-questionnaire.

The interaction in itself lasted 50 minutes at most: during this phase, the participants submitted bids on behalf of their hypothetical companies, each having different features and priorities. If an agreement was reached, the corresponding transaction ended in advance. At the end, all the participants were asked to complete the final feedback to capture their reactions concerning some items, and leave comments. A short debriefing closed each session.

3.4 Business case

We used the same procurement case in both auctions and negotiations. Milika, a producer of perishable goods (the buyer) is seeking a logistics service provider who would provide transportation from a single depot to a large number of customers. The buyer wants to sign a contract with a single provider for one year with a possibility of renewal. Milika assures the minimum quantity of goods to be transported. The contract consists in defining some

attributes. In two-attribute transactions they are: (i) the standard rate of transportation, i.e. the amount per unit that the buyer pays to the provider; and (ii) the penalty for delay in providing customers with the requested goods on time. In three-attribute transactions, there is also (iii) the rush rate for unexpected delivery, i.e. the amount per unit that the buyer pays to the provider for rush orders, requested by customers, to transport the good on an ad-hoc basis. The possible ranges for each attribute are known to every participant.

The producer uses either an auction or a negotiation to select one service provider. He invites four different providers with a proven record to participate. Therefore, four sales managers participate in the transaction on behalf of their own logistics service company. Participants are told that the company they represent estimated a revenue function based on the problem attributes. For each configuration of attribute values, the revenue value can easily be calculated using a simple calculator which is embedded in the case description. In order to simplify comparison of different offers or bids, the revenue is represented as ratings between 0 and 100 interval. Ratings are secret and the higher the rating, the better the contract for the participant.

Every participant knows that if he accepted a contract below a given break-even rating, the firm he represents would incur losses. Every participant is also given reservation values for the attributes. The revenue formulae, as well as reservation and breakeven values, may be different among providers.

3.5 Measures

As discussed in Section 2.1, five constructs (objective outcome, substantive outcome, trust, satisfaction with dealing, and perception of opportunism) have been taken into account (Table 1). The first of them can be directly measured and has been operationalized in terms of providers' profit, defined as the difference between the rating that the provider reaching the agreement actually achieves by the contract and his break-even rating. Based on such a definition, we can compare results, which come from sellers who have different break-even ratings.

The other four constructs, which cannot be directly measured, are assessed by items adapted from the existing literature. These items have been put into questions and included in the questionnaire, which has been administered at the end of the transaction. Answers were expressed in terms of scores along a seven-point Likert scale (from "strongly disagree" to "strongly agree").

Table 1. List of constructs and related items.

Substantive outcome	OUT1	I am satisfied with the results that I achieved.
	OUT2	I achieved more than what I had expected.
	OUT3	The outcome is better for the buyer than it is for the provider.
	OUT4	The results I obtained are not favorable for my company.
Trust	TRU1	I think that the buyer will keep the promises he/she makes to my company in the future.

	TRU2	When making important decisions, the buyer considers my company's welfare as well as his/her own.
	TRU3	My company trusts the buyer to keep our best interests in mind.
Satisfaction with dealing	DEA1	Dealing with this buyer benefits my company.
	DEA2	This buyer is a good company to do business with.
Perception of opportunism	OPP1	In future interactions, I believe that the buyer would be unwilling to accept responsibility for his/her mistakes.
	OPP2	In future interactions, I believe that the buyer would try to "nickel and dime" my company.

3.6 Validity and reliability

To examine the existence of underlying constructs correlated to the items, we used the exploratory factor analysis, extracting factors through weighted least-squares method and Kaiser's rule, and using direct oblimin rotation method. The research hypotheses can be referred to the entire sample as well as to specific subsets of it (obtained through selecting data according to the desired values of the independent variables), thus distinct analyses have been conducted, each taking into account different sets of data: the whole sample of respondents (ALL), only the ones participating in auctions (AUC) or negotiations (NEG), as well as in transactions with three (HIGH) or two (LOW) attributes.

This study is part of a wider research, which analyzed constructs (and related items) that have not been described above, as they are outside the scope of this paper. However, all the factor analyses refer to the entire set of items (dependent variables).

Results show that in all factor analyses the items related to the four constructs of interest in this study load on only three factors. None of the factors is correlated with any of the items associated with the other constructs that are not investigated here. Furthermore, the constructs *substantive outcome* and *perception of opportunism* correspond to factors independent from each other, whereas the constructs *trust* and *satisfaction with dealing* collapse into one factor, which we then treat as a unique construct, named *positive attitude toward the buyer*.

Table 2. Results of explorative factor analyses and reliability analyses on the five sets of data.

ALL				
	Loading	Mean	St. dev.	α
Positive attitude toward the buyer		*2.58*	*0.89*	*0.832*
TRU2	0.711			
TRU3	0.693			
DEA1	0.838			
DEA2	0.725			
Perception of opportunism		*2.73*	*0.73*	*0.583*
OPP1	0.643			
OPP2	0.652			

AUC				
	Loading	Mean	St. dev.	α
Substantive outcome		*-2.38*	*1.42*	*0.827*
OUT1	- 1.028			
OUT2	- 0.721			
Positive attitude toward the buyer		*2.48*	*0.89*	*0.789*
TRU2	0.614			
TRU3	0.670			
DEA1	0.754			
DEA2	0.614			

NEG				
	Loading	Mean	St. dev.	α
Positive attitude toward the buyer		*2.65*	*1.01*	*0.878*
TRU1	0.614			
TRU2	0.797			
TRU3	0.699			
DEA1	0.850			
DEA2	0.739			
Perception of opportunism		*3.20*	*0.94*	*0.743*
OPP1	0.829			
OPP2	0.798			

LOW				
	Loading	Mean	St. dev.	α
Substantive outcome		*-2.11*	*1.27*	*0.831*
OUT1	-0.873			
OUT2	-0.733			
Positive attitude toward the buyer		*2.16*	*0.96*	*0.817*
TRU1	0.651			
DEA1	0.674			
DEA2	0.710			
Perception of opportunism		*3.30*	*0.93*	*0.702*
OPP1	1.008			
OPP2	0.550			

HIGH				
	Loading	Mean	St. dev.	α
Substantive outcome		*-2.64*	*1.41*	*0.842*
OUT1	-0.999			
OUT2	-0.693			
Positive attitude toward the buyer		*2.71*	*0.88*	*0.842*
TRU1	0.647			
TRU2	0.757			
TRU3	0.691			
DEA1	0.801			
DEA2	0.669			

For each set of data, Table 2 shows results for all the factor,. The table includes the list of items corresponding to every factor, their loadings, mean and standard deviation of the factor scores, and the Cronbach's alpha. The latter has been adopted to test the reliability of factors: since all the coefficients but one – i.e. the one associated with the perception of opportunism in the analysis related to the entire set of data – are larger than 0.70, which is assumed as cut-off value (Nunnaly, 1978), the existence of an adequate internal consistency is proven (Hair *et al.*, 2010).

4. Results

As a consequence of the explorative factor analysis, hypotheses H3 and H4, as well as H8 and H9, collapsed into the following hypotheses, respectively:

H3*.Auctions will produce lower positive attitude toward the buyer than negotiations.

H8*. Transactions with high complexity of representation will generate lower positive

attitude toward the buyer than transactions with low complexity of representation.

These hypotheses, together with the hypotheses H1-H2, H5-H7, and H10, were tested via ANOVA considering the entire set of data and within each subset (i.e. AUC, NEG, LOW, HIGH). Since certain hypotheses do not make sense in given subsets (e.g. H3* does not make sense in both AUC and NEG), we have 26 hypotheses. However, a few of them could not be tested as the factor or reliability analyses prevented us from using the related dependent variables. Table 3 summarizes the ANOVA results for the 17 remaining hypotheses. Hypotheses for which $p < 0.10$ (in bold) are assumed statistically significant, i.e. the corresponding null hypothesis (H_0: $\mu_1 = \mu_2$) is rejected. For these, Table 4 reports mean and standard deviation of the two groups, defined by varying value of the independent variable.

Table 3. Results of ANOVA. Significant results are in bold.

Set	Hypothesis	Total variance		Within-group variance			Between-group variance			F	p
		Sum of squares	d.f.	Sum of squares	d.f.	Mean squares	Sum of squares	d.f.	Mean squares		
ALL	**H1**	**13017.92**	**49**	**9831.92**	**48**	**204.83**	**3186.00**	**1**	**3186.00**	**15.55**	**0.00**
ALL	H3*	192.73	197	191.05	196	0.98	1.68	1	1.68	1.72	0.19
ALL	H6	13017.92	49	12614.64	48	262.81	403.28	1	403.28	1.54	0.22
ALL	**H8***	**192.73**	**197**	**185.86**	**196**	**0.95**	**6.86**	**1**	**6.86**	**7.24**	**0.01**
AUC	H6	3810.96	21	3710.55	20	185.53	100.41	1	100.41	0.54	0.47
AUC	H7	175.16	87	174.04	86	2.02	1.12	1	1.12	0.55	0.46
AUC	**H8***	**68.80**	**87**	**64.39**	**86**	**0.75**	**4.41**	**1**	**4.41**	**5.88**	**0.00**
NEG	H6	6020.96	27	5698.64	26	219.18	322.32	1	322.32	1.47	0.24
NEG	H8*	110.36	109	109.15	108	1.01	1.21	1	1.21	1.20	0.28
NEG	H10	96.57	109	96.13	108	0.89	0.44	1	0.44	0.50	0.48
LOW	**H1**	**8384.00**	**24**	**6532.34**	**23**	**284.02**	**1851.66**	**1**	**1851.66**	**6.52**	**0.02**
LOW	H2	159.39	99	159.32	98	1.63	0.08	1	0.08	0.05	0.83
LOW	H3*	91.54	99	91.49	98	0.93	0.05	1	0.05	0.05	0.82
LOW	H5	85.67	99	83.73	98	0.85	1.94	1	1.94	2.27	0.14
HIGH	**H1**	**4230.64**	**24**	**2876.85**	**23**	**125.08**	**1353.79**	**1**	**1353.79**	**10.82**	**0.00**
HIGH	H2	193.23	97	189.87	96	1.98	3.37	1	3.37	1.70	0.20
HIGH	**H3***	**74.47**	**97**	**72.39**	**96**	**0.75**	**2.08**	**1**	**2.08**	**2.76**	**0.10**

Table 4. Mean and standard deviation of dependent variables for statistically significant hypotheses.

Set	hypothesis	dependent variable	independent variable			
			name	value	mean	st. dev.
ALL	H1	objective outcome	exchange mechanism	auction	-7.05	13.47
				negotiation	9.04	14.93
ALL	H8*	positive attitude	complexity of representation	2 attributes	2.39	1.02
				3 attributes	0.14	0.65
AUC	H8*	positive attitude	complexity of representation	2 attributes	2.26	0.53

				3 attributes	0.13	0.67
LOW	H1	objective outcome	exchange mechanism	auction	-4.91	12.90
				negotiation	12.43	19.35
HIGH	H1	objective outcome	exchange mechanism	auction	-9.18	14.31
				negotiation	5.64	7.99
HIGH	H3*	positive attitude	exchange mechanism	auction	0.14	0.54
				negotiation	2.58	0.65

Results show that the exchange mechanism affects the providers' objective outcome. Specifically, in the whole set of data (ALL) the objective outcome, which is measured in terms of profit, is lower for auctions than for negotiations. This result has been obtained by limiting the analysis to the subsets of transactions with both three and two attributes (HIGH and LOW), i.e. representing the logistics service in a more and, respectively, less complex way. Furthermore, for transactions with high complexity in representing the service (HIGH), the exchange mechanism reveals significance as to the providers' positive attitude toward the buyer: the latter, indeed, is higher in negotiations than in auctions.

As to the complexity of representation for the service to be procured, results show that a higher number of attributes reduces the providers' positive attitude toward the buyer. This is statistically proven for the entire set (ALL) and for auctions only (AUC), however, there is no statistical evidence of this upshot if we consider negotiations only (NEG).

5. Discussion and implications

The aim of this study was to examine how the design of the system that companies adopt in procurement of logistics services affects the process performance. The topic has been widely investigated by scholars, especially in the last decade, when the pervasiveness of information and communication technologies put emphasis on the nexus between the choice of a specific market mechanism and the effects on actors' behavior. This study, however, is innovative in that it considers multi-attribute mechanisms (both negotiation and auction), and utilizes the same business case and technological platform to compare different mechanisms (which avoids biases due to features other than the mechanisms themselves).

We focused on two key dimensions to describe the system, i.e. (i) the exchange mechanism that rules the transaction and (ii) the level of complexity by which the service itself is described. On the other hand, we measured as dependent variables the objective outcome (i.e. the profit that logistics providers gain) and other performances related to behavioral issues, i.e. substantive outcome, positive attitude toward the buyer, and perception of opportunism.

The analysis, based on the results of laboratory experiments, gave us evidence that the logistics providers' objective outcome is affected by the exchange mechanism, and decreases if auctions are adopted, regardless of the level of complexity. Also, the positive attitude of providers toward the buying company diminishes with the complexity of the service description, and this is especially true in auctions.

Both results have practical managerial implications. In particular, when companies need to buy logistics services requiring a complex description and, at the same time, are interested in

enhancing the positive attitude of their counterpart, they should adopt negotiations rather than auctions.

Possible limitations of our study concern the existence of several auction and negotiation types, each of them could be implemented through diverse transaction environments. We had to consider a specific auction and negotiation type and to make a choice of the transaction environment. Furthermore, we could analyze performance under the supplier's point of view. It would be useful to complement the analysis under the buyer's perspective as well.

Further research should address the above limitations as well as consider an additional issue In fact, the number of potential suppliers (in our case assumed to be equal to four) could affect performance and such impact is likely to be different in auctions than in negotiations.

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