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Tools without skills: Exploring the moderating effect of absorptive capacity on the relationship between e-purchasing tools and category performance

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Abstract

Purpose: This paper examines the moderating role of a purchasing function's absorptive capacity on the relationship between the use of electronic purchasing tools and category level purchasing performance. We argue that an e-purchasing tool may not in itself positively influence performance unless combined with absorptive capacity as a human interface to maximise its information and transactional improvement potential.

Design/methodology/approach: Survey data collected from 297 procurement executives of large companies in ten countries is analysed using confirmatory factor analysis and hierarchical moderated regression.

Findings: The results demonstrate few significant direct effects of e-purchasing tools on category performance. All performance measures studied are enhanced when dimensions of absorptive capacity and their interactions with the e-purchasing tools are added. Specifically, buyer competence, manager competence and communications climate have performance-enhancing effects. In some cases, absorptive capacity on its own appears to increase performance more than e-tools.

Research limitations/implications: This paper investigates relationships at the category level but does not consider specific category features. In future research, adding value/profit impact and demand/supply characteristics, for example, could provide insights into the most efficient contexts for various e-tools in improving performance.

Practical implications: Absorptive capacity appears critical to the successful implementation of e-purchasing tools. Organisations should look to invest in human capabilities as well as technology to drive performance improvement.

Originality/value: This paper is the first to study the moderating effects of absorptive capacity on the relationship between e-purchasing tool usage and category performance. Its findings support the view that simply implementing technology does not lead to performance improvements, but that a human interface is required to maximise the information and transactional improvement potential of e-purchasing tools.

Keywords: E-purchasing tools, absorptive capacity, purchase category performance

Paper type: Research paper

1. Introduction

Over the past two decades, e-business technologies have transformed supply networks, with potential benefits including reduced purchasing prices, lower transaction costs, and better customer service (Johnson *et al.*, 2007; Rosenzweig, 2009; Slack *et al.*, 2011). However, empirical evidence suggests significant variation in realised benefits of e-purchasing tools (Gonzalez-Benito, 2007). One possible problem may be that studies to date have generally examined the linkages between technologies and performance at the level of the entire organisation or the entire purchasing function (Gonzalez-Benito, 2007). However, often such technologies are not implemented across an entire firm and significant differences can exist in their use for different purchase categories (Pohl and Förstl, 2011). In addition, aggregate measures of firm performance, such as sales and profit margins, have been found to be too remote to be significantly associated with e-commerce capabilities (Zhu and Kraemer, 2002). Sriram and Stump (2004) have suggested that more emphasis needs to be placed on studying the effect of e-tools on a functional level and using more intermediate performance measures such as purchasing costs, and process improvements. Additionally, we need not only to determine whether IT investments produce a positive effect, but by studying best practice, to investigate the contextual factors that influence this relationship (Gonzalez-Benito, 2007; Sousa and Voss, 2008; Rosenzweig, 2009).

Some context-specific studies examining the effects of IT investments have been conducted mainly focusing on customer-facing supply chain processes (Devaraj *et al.*, 2007; Rosenzweig, 2009). At a firm level, Johnson *et al.* (2007) study how industry context, firm characteristics and strategic resources impact on the exploitation of e-business technologies and the relationship between their use and firm performance. They suggest that simply investing in e-business technologies does not provide competitive advantage and that the capabilities for effective implementation are more important. Recent e-purchasing literature appears to be evolving from whether benefits associated with investments actually exist to studying *how* benefits can be obtained. As such, it is assumed that it is not the technology itself that provides competitive advantage, but how it is used in conjunction with complementary capabilities (Zahay and Handfield, 2004; Ordanini and Rubera, 2008). Building on this perspective, our study examines how

different e-purchasing tools can help improve purchase category performance, given certain purchasing organisation characteristics.

The approach of the study is grounded in OM practice contingency research, with a focus on understanding the contextual conditions under which implemented practices are effective (Sousa and Voss, 2008). The contingency model comprises three sets of variables: use of practices, contingency factors and performance. In our research, the practices under investigation are the use of three different groups of e-purchasing tools: e-sourcing tools, e-process tools, and e-transaction tools. The contingency factor examined is the absorptive capacity (AC) of the purchasing function – the human interface needed to enable the best possible use of e-tools and the new capabilities and information provided by them in purchasing. Five different aspects of absorptive capacity are included as moderators: buyer competence, manager competence, communications climate, communications network and knowledge scanning (Tu *et al.*, 2006). Category performance variables include purchasing price, internal process costs, user satisfaction and end user contract compliance. The selection of the contingency factors is influenced by studies typically examining firm level performance and/or organisational IT capabilities (Powell and Dent-Micallef 1997; Bharadwaj, 2000), which have concluded that human elements are key complementary resources needed to drive performance improvement. Accordingly, within the purchasing context, we include absorptive capacity of the purchasing function as the contingency factor in our study and test its moderating effect on category performance.

The paper is structured as follows. Firstly, we examine the effects of e-purchasing tools on various category performance outcomes, and discuss the possible moderating role of absorptive capacity. Within the literature review, we present hypotheses concerning direct and moderated impacts of e-tools on performance. Secondly, we present our data collection and analysis based on survey data from 297 large firms in ten European and North American countries. Thirdly, we discuss our findings and outline contributions to managers and practice, and to academics and theory. Finally, we draw conclusions and suggest opportunities for future research.

2. E-purchasing tools, performance, and absorptive capacity

E-purchasing is a term used to describe the various integrated database systems and a wide area of (typically web-based) network communication technologies employed across all or part of an organisation's purchasing process (Croom and Brandon-Jones,

2007). This process includes the initial identification of needs, specification, supplier search, sourcing, tendering, negotiation, order placement, authorisation, and the mechanisms that register receipt, trigger payment and support post-supply evaluation (Caniato *et al.*, 2010; Slack *et al.*, 2011). These e-purchasing technologies can be clustered into three main groups – *e-sourcing tools*, *e-process tools*, and *e-transaction tools*. E-sourcing tools support the sourcing process, from product/service specification to final negotiation and supplier selection. The most common e-sourcing tools are the use of electronic supplier database, e-tendering and reverse e-auctions (Presutti, 2003; Hartley *et al.*, 2004; Bartezzaghi and Ronchi, 2005). E-process tools support an organisation's order cycle by allowing users to place orders digitally, leverage an automatic authorisation workflow, and track order status (Croom, 2000; Barnes and Vidgen, 2002; Yen and Ng, 2003). E-transaction tools support external communication between organisations and their suppliers. The most common e-transaction tools are electronic data exchange, electronic invoicing, and automated payment (Lancioni *et al.*, 2000; Sriram and Stump, 2004; Croom and Brandon-Jones, 2007).

The use of e-purchasing tools to integrate systems within and between organisations is a potentially powerful source of supply chain improvement (Neef, 2001; Power and Singh, 2007; Sanders, 2007). Such e-tools have the potential to reduce purchasing prices, lower the cost of managing the purchasing process, increase contract compliance, and improve user satisfaction (De Boer *et al.*, 2002; Brandon-Jones and Carey, 2011). As firms weigh opportunities to invest in these different technologies and make the ensuing changes to their organisations, supply base and business processes, an increased understanding of how to maximise potential benefits is needed (Johnson *et al.*, 2007). Given the large expenditures that many e-purchasing tool investments require, it is important to consider the impact of different types of information technologies on performance (Sanders, 2007; Ronchi *et al.*, 2010).

While some studies examine the relationship between e-procurement and performance (De Boer *et al*, 2002; Bartezzaghi and Ronchi, 2004; Croom and Brandon-Jones, 2007), others have taken the viewpoint that IT cannot in itself bring sustained competitive advantage without being combined with other firm capabilities (Mata *et al.*, 1995; Jeffers, 2010). Researchers have argued that because of industry sector isomorphism, competitors often look to duplicate investments in IT (Bharadwaj, 2000). Mata *et al.* (1995) argue that the resource-based view suggests the search for IT-based competitive

advantage must therefore focus less on IT per se and more on the process of organising and managing IT within a firm. IT creates advantage by leveraging and exploiting pre-existing, complementary human and business resources (Powell and Dent-Micallef, 1997; Caniato et al., 2005). That is, a human interface is required to maximise the information and transactional improvement potential of e-tools.

Prior studies (For example, Lewis *et al.*, 2010) suggest that competitive advantage is derived and sustained from capabilities based on socially complex organisational routines that are often developed over a long period of time and are not easily observed. Rosenzweig and Roth (2007) call for future supply chain research to incorporate a more sociotechnical systems approach, where success depends upon the alignment of the people using the appropriate tools and techniques. Therefore, in this study we examine both possible direct effects of e-tools on category performance, as well as how human elements within the purchasing function – its absorptive capacity (AC) – moderate these effects.

In the following, we will first formulate hypotheses for the direct effects of the three groups of e-purchasing tools (e-sourcing, e-process, and e-transaction) on four types of category performance, and then discuss which of these are expected to be moderated by the five AC constructs. The four performance measures used in this study are purchasing price, purchasing process costs, contract compliance, and user satisfaction. Price can be defined as expenditure on direct or indirect products and services (De Boer *et al.*, 2002). Purchasing process costs reflect the work involved in processing orders. This includes the cost of searching for and selecting a supplier, order processing, authorisation, receipting, invoicing and payment (De Boer *et al.*, 2002). Contract compliance is defined as the extent to which users comply with mandated contracts (Karjalainen *et al.*, 2009). User satisfaction is defined as the internal user's perception of the quality of the services provided by purchasing, including both the e-procurement systems and the support provided to use them (Brandon-Jones and Carey, 2011).

2.1. Direct performance effects of e-purchasing tools

E-sourcing tools include applications supporting the sourcing process, from specifications definition to final negotiation and supplier selection. Most common applications are requests for information, proposal, and quotation (e-tendering), as well as reverse e-auctions (Hartley *et al.*, 2004; Bartezzaghi and Ronchi, 2005). E-sourcing tools increase visibility of potential suppliers, giving buyers greater choice, and often

enabling them to pay lower prices for their products and services (Evans and Wurster, 2001;). For example, the increased leverage created by General Electric's use of e-sourcing is reported to have delivered price cuts of up to 20% (Presutti, 2003). One type of e-sourcing tool to receive particular attention for its potential to reduce price is reverse e-auctions (De Boer *et al.*, 2002; Wagner and Schwab, 2004; Puschmann and Alt, 2005; Caniëls and Van Raaij, 2009). Based on data from 200 reverse e-auctions, De Boer *et al.* (2002) find price reductions for direct and indirect procurement of 10% and 15%, whilst Croom and Brandon-Jones (2005) report an average price reduction of 16%. Much of the price savings from e-sourcing tools come from aggregating requirements and economies of scale (Turban *et al.*, 2000).

E-sourcing tools also have the potential to reduce the costs of managing purchasing processes increasing economies of supplier search (Evans and Wurster, 2001; De Boer *et al.* 2002). In addition, e-tendering can drive process cost reduction through the simplification of the tendering process (De Boer *et al.* 2002; Caniëls and Van Raaij, 2009) and the reduction of total cycle time (Emiliani, 2000; Wagner and Schwab, 2004). Based on previous literature, the following hypotheses are presented.

Hypothesis 1: Increased use of e-sourcing tools leads to improved
> *a) purchase price performance*
> *b) process cost performance*

E-process tools, our second set of e-purchasing tools studied, support the complete order cycle within the buyer's organisation (Croom, 2000), and are sometimes referred to as e-MRO or web-based ERP (De Boer *et al.*, 2002). In particular, users might manage orders electronically and leverage an automatic authorisation workflow; once the order is placed they can track and trace its status. Another application widely adopted is document and contract management to fully leverage contract terms. As these tools and applications primarily support the operational procurement process, a key effect is likely to be the reduction in the cost of managing the purchasing process. Process cost reductions can be realised through lower levels of work in progress (Zsidisin and Ellram, 2001); increased process automation (Croom, 2000; Barnes and Vidgen, 2002); more accuracy (Lancioni *et al.* 2000; Neef, 2001; Slack *et al.*, 2011); and the re-design of processes (Puschmann and Alt, 2005).

Increased attention has been paid to how control over the procurement process may be increased through the implementation of e-process tools (Neef, 2001). Contract compliance may be increased as it becomes more difficult for users to circumvent standard procedures for order placement (Karjalainen *et al.*, 2009). Increased transparency enabled by e-process tools has been argued to lead to improvements in contract compliance (Michaelidis *et al.*, 2003; Cuganesan and Lee, 2006). Additionally, efficient contract management may lead to price reductions by ensuring that correct volume discounts are received as agreed with the supplier. In addition, aggregation of requirements is partly obtained by the use of e-process tools (Croom, 2000; Turban *et al.*, 2000). Based on the above, we formulate the following hypotheses:

Hypothesis 2: Increased use of e-process tools leads to improved
> *a) purchase price performance*
> *b) process cost performance*
> *c) end-user contract compliance*

E-transaction tools deal with external communications between the customer and the supplier. Most adopted tools are electronic data exchange, electronic invoicing, and automated payment (Sriram and Stump, 2004). A clear benefit of e-transaction tools is that, once authorised, orders can be sent instantaneously to suppliers, rather than via post or fax. Using IT-based tools speeds up the execution/processing of individual tasks and transactions (Yassine *et al.*, 2004). In addition, the accuracy of orders is likely to increase given the reduction in data re-entry across the different purchasing stages (Lancioni *et al.*, 2000). Therefore, by streamlining the connection with suppliers, the buyer can reduce the costs of managing the purchasing process.

In turn, user satisfaction may increase due to improved access to accurate information, simplification of administrative operations for authorisation, receipting, payment, and maximisation of transmission accuracy (Chopra *et al.*, 2001; Voss, 2003). We therefore formulate the following hypotheses:

Hypothesis 3: Increased use of e-transaction tools leads to improved
> *a) process cost performance*
> *b) user satisfaction*

2.2. Absorptive capacity as a moderating factor

The concept of absorptive capacity (AC) was adapted from macroeconomics by Cohen and Levinthal (1990), who defined AC as the ability of an organisation to recognise the value of new external knowledge, assimilate it, and apply it to commercial ends (Tu *et al.* 2006). In the context of supply chain management, Malhotra *et al.* (2005) refer to AC as the ability of enterprises to acquire and assimilate information from their partners to achieve superior operational and strategic outcomes. As such, an organisation's AC will depend on the absorptive capacities of its individual members and tends to develop cumulatively (Cohen and Levinthal, 1990). Importantly, AC depends on the individuals who stand at the interface of the firm and the external environment or between subunits within the firm – a suitable description of purchasing professionals. In our arguments, the key is not just the notion of buyers at the interface between their own and supplier's organisation, but also of buyers at the interface between the e-tools and the overall purchasing processes they relate to. There are studies in the manufacturing field suggesting software without effective operator and supervisor training, and/or without an effective human/system interface is unlikely to be successful (Guimares *et al.*, 1999). Theories of absorptive capacity propose that knowledge gained from prior experience facilitates the identification, selection, and implementation of related profitable practices (Lenox *et al.*, 2004). The absorptive capacity is a logical and necessary moderating factor as without it, the purchasing function may not be able to fully utilise the increased information and coordination potential of e-tools (the profitable practice in this case). Schiele (2007) supports this logic, suggesting that AC can offer a theoretical explanation for why more developed purchasing organisations profit most from newly introduced knowledge. When the same technology is available to all firms and applications are easily duplicated, sustaining technology advantage does not come from having the technology, but from its efficient use (Clemons and Row, 1991).

Simonin (2004) suggests that research on absorptive capacity has evolved with a strong focus on the characteristics of the particular combination of partners. Dyer and Singh (1998) refer to it as 'partner-specific absorptive capacity', which emphasises partner similarities and the breadth and depth of overlap between them rather than firm-level singularities (Simonin, 2004). In this study, we return the focus of absorptive capacity into firm-level, and go further by examining the construct at a functional – purchasing – level. Tu *et al.* (2006) propose that a firm's AC contains three components: prior relevant knowledge, communications network, and communications climate. The

original definition by Cohen and Levinthal (1990) indicates a fourth component related to knowledge scanning. According to Zahra and George (2002), prior related-knowledge and effective organisational routines and communication processes are major constituents of absorptive capacity. They propose four dimensions of AC: acquisition, assimilation, transformation, and exploitation; a process view of AC (Tu *et al.*, 2006). Malhotra *et al.* (2005) on the other hand have primarily a systems viewpoint. In our study, we follow the approach of Tu *et al.* (2006) and focus on the organisational mechanisms. Building on their work, we examine five sub-constructs of AC, specifically transferred into the purchasing function context: *buyer competence*, *manager competence* (these two forming the prior relevant knowledge part), *communications climate*, *communications network* and *knowledge scanning*. Each of these elements is discussed below and hypotheses are presented.

Buyer competence and manager competence

Prior relevant knowledge is a major determinant of AC, as it confers an ability to recognise the value of new information, assimilate it, and apply it to commercial ends (Cohen and Levinthal, 1990). Buyer competence includes the knowledge of buyers in relation to different aspects of the business, levels of job competence, and education. According to Rosenzweig and Roth (2007), skills are important to the success of e-business implementation efforts. The more knowledgeable buyers are, the more they are expected to be able to use the electronic tools effectively to drive reductions in purchasing price and process costs.

Manager competence considers the knowledge in negotiating and making business decisions, dealing with new technologies, and dealing with human resources (Tu *et al.*, 2006). Mata *et al.* (1995) have shown that out of several attributes applied to IT, only managerial IT-skills can provide sustainable competitive advantage, and without them the full potential of IT for a firm will rarely be realised. While their research focused on managers within the IT function, similarly it can be expected that purchasing manager's skills are crucial in getting the most out of e-procurement tools. Managers play a crucial role in deploying purchasing policies and techniques within the organisation. This not only involves the selection/design of an e-tool, but importantly leading the implementation process. Training and support provision will be critical in enabling more efficient purchasing processes, especially in more value adding processes (sourcing and supply) compared to lower value adding administrative ones (transaction). Moreover,

managers might be involved in the negotiation with suppliers and be able to obtain price reductions due to the streamlined transaction process, which would also benefit suppliers. Specifically, we expect buyer and manager competence to moderate the following relationships.

Hypothesis 4: As buyer competence increases, the positive impact of

　　a) e-sourcing tools on price performance increases

　　b) e-sourcing tools on process cost performance increases

　　c) e-process tools on process cost performance increases

　　d) e-transaction tools on process cost performance increases

Hypothesis 5: As manager competence increases, the positive impact of

　　a) e-sourcing tools on price performance increases

　　b) e-sourcing tools on process cost performance increases

　　c) e-process tools on process cost performance increases

　　d) e-transaction tools on price performance increases

Communications climate

Absorptive capacity not only refers to the acquisition or assimilation of information by an organisation but also to the ability to exploit it (Cohen and Levinthal, 1990). Therefore, an organisation's absorptive capacity does not simply depend on its direct interface with the external environment but also on transfers of knowledge across the organisation and within subunits. Tu *et al.* (2006) define communications climate as the atmosphere within the organisation that defines accepted communication behaviour. They refer to a significant body of literature confirming that an open, supportive climate can greatly improve employees' ability to learn, which in turn leads to effective implementation of new ideas driving higher performance into business processes. Cumulative evidence from literature in Operations Management suggests that effective communication and knowledge management are critical elements of successful process integration (Fugate *et al.*, 2009). Specifically, we expect communications climate to moderate the following relationships.

Hypothesis 6: As communications climate improves, the positive impact of

　　a) e-sourcing tools on process cost performance increases

b) e-process tools on process cost performance increases

c) e-transaction tools on process cost performance increases

Communications network

Tu *et al.* (2006) describe communications network as the scope and strength of structural connections that join flows of information and knowledge between different organisational units. This is seen as essential in integrating functional units (Cohen and Levinthal, 1990) and is required in implementations of complex technologies as it creates an environment where all the units work together to achieve organisational goals (Aletan, 1991). Giunipero *et al.* (2005) suggest that a good purchasing department acts as an information centre that is constantly in communication with its stakeholders. Shared knowledge is a firm-specific asset essential in determining the performance and success of IT investments (Jeffers, 2010). Drawing from this, it would seem likely that communications within the purchasing unit and with other units would act as a competence, specifically in terms of shared values and objectives, and ultimately common behaviours. Therefore communications network is expected to positively moderate the relationship between the use of e-purchasing tools and process performance, especially in those processes going beyond the purchasing function (supply and administrative tasks). Common behaviours among end users and effective communication are also likely to help improve both contract compliance and satisfaction with e-tools. As such, we expect communications network to moderate the following relationships.

Hypothesis 7: As communications network improves, the positive impact of

a) e-process tools on process cost performance increases

b) e-process tools on contract compliance increases

c) e-transaction tools on process cost performance increases

d) e-transaction tools on user satisfaction increases

Knowledge scanning

Competition is increasingly knowledge-based as firms strive to learn and develop capabilities faster than their rivals (Lane and Lubatkin, 1998). According to Malhotra *et al.* (2005), knowledge management is also poised to become a critical imperative in supply chain interactions. Knowledge scanning refers to an organisational mechanism

that enables firms to identify and capture relevant external and internal knowledge and technology (Tu *et al.*, 2006). Recognition and implementation of new practices requires information about available alternatives (Lenox and King, 2004). Activities such as market tracking, benchmarking, and technology assessments may all be involved in this process. Knowledge scanning has also been suggested to include the ability to research the supply base (Giunipero *et al.*, 2006). These types of capabilities can best be utilised at the beginning of the procurement process, when looking into a competitive supply market for new suppliers, new products, and new services. Knowledge scanning skills of the purchasing unit combined with the increased scanning capabilities and information provided by e-sourcing tools can thus have a strong interaction effect on price performance.

Hypothesis 8: As knowledge scanning increases, the positive impact of
a) e-sourcing tools on price performance increases

The hypotheses originating from our literature review are presented in the conceptual model in Figure 1. We now discuss how data were collected and analysed to test these hypotheses.

Insert Figure 1. Conceptual model

3. Data collection and analysis results

3.1 Data collection
The data used for this study were collected in the first round of the International Purchasing Survey (IPS), a multinational survey examining purchasing practices and their effects on performance. The survey has been developed by a group of researchers from universities in ten European and North American countries (Knoppen *et al.*, 2011; Luzzini *et al.*, 2012). During the preparatory stage of the survey, several methodological actions were taken to improve the construct and measurement equivalence of responses (Bensaou *et al.*, 1999; Hult *et al.*, 2008), including the TRAPD (Translation, Review, Adjudication, Pre-testing and Documentation) procedure to translation (Harkness *et al.*, 2003). Moreover, the survey instruments were tested locally while modifications were

centrally coordinated in order to develop one source document that included the modifications needed to be clear in all local contexts.

The sampling design followed centrally established guidelines (e.g., minimum size of companies; ISIC codes to be involved) to make the samples as comparable as possible (Lynn *et al.*, 2007). However, in line with Kish (1994), some flexibility was also allowed in sampling in relation to population (association's membership list; commercial database or statistics bureau list; self-owned lists of contacts) and the method of contact (obtained pre-agreement from respondent prior to sending a questionnaire; no pre-agreement from respondent).

3.2 Constructs

In order to measure the use of e-purchasing tools, six-point scale questions were used ranging from "never" to "always". Specifically, *E-sourcing* contained three items: use of electronic supplier database (Croom, 2000; Presutti, 2003; Subramaniam and Shaw, 2004;) reverse e-auctions (De Boer *et al.*, 2002; Jap, 2002; Hartley *et al.*, 2004; Wagner and Schwab, 2004) and electronic request for quotations / proposal / information (Bartezzaghi and Ronchi, 2005; Croom and Brandon-Jones, 2007). *E-process* was measured with four items on the use of e-catalogues (Croom and Brandon-Jones, 2007), electronic workflow (Yen and Ng, 2003), order tracking (Barnes and Vidgen, 2002) and document and contract management (Croom, 2000; Croom and Brandon-Jones, 2007). *E-transaction* contained three items: use of purchasing cards (Sriram and Stump, 2004), electronic data interchange (De Boer *et al.*, 2002), and electronic invoicing and payment (Lancioni *et al.*, 2000; Croom and Brandon-Jones, 2007). The five absorptive capacity constructs were based on Tu *et al.* (2006) with the wording modified to fit the purchasing context of the study. Specifically, buyer and manager competence contained three and four items respectively, with statements on buyers' and managers' knowledge of business aspects, education, and competence among others. For these two constructs, a six-point scale from "totally inadequate" to "totally adequate" was used. Communications climate consisted of four items on employee's supportiveness to each other, sense of belonging, free communications, and willingness to accept change. Communications network contained two items on communication within the purchasing organisation and between it and other functions. Finally, knowledge scanning was measured with four items, relating to market tracking, benchmarking, and learning from

new technologies and suppliers. For the latter three constructs, a six-point scale from "not at all" to "completely" was used.

Purchase category performance was measured using four single-item scales relating to purchasing price, process cost, contract compliance, and user satisfaction. Measuring self-reports using single-item scales is now widely accepted practice (Scarpello and Campbell, 1983; Sackett and Larson, 1990; Wanous *et al.* 1997; Brandon-Jones *et al.* 2010; Brandon-Jones and Silvestro, 2010). For example, in examining the relative merits of job satisfaction measures, Scarpello and Campbell (1983) argue that a single-item scale is more reliable that a multi-item scale based on a number of specific job facets. Wanous *et al.* (1997) argue that single-item scales help to reduce survey length and so improve response rates. In addition, they avoid concerns over the face validity of seemingly repetitive questions in some multi-item scales. A seven-point scale from "much worse than target" to "much better than target" was used. This means that for purchasing price, a higher score indicates better performance. Appendix 1 provides details on the survey instrument.

3.3 Data collection, sampling, and pre-analysis tests

The first round of IPS resulted in 681 responses from purchasing directors or equivalent positions from organisations ranging in size and industry. As noted earlier, in this particular study we wanted to focus on large organisations that typically use different types of e-purchasing tools and can be expected to differentiate their usage of tools across purchase categories. Pearcy and Giunipero (2008) have revealed a significant relationship between firm size and e-procurement application. In addition, Vaaland and Heide (2007) discuss the resource limitations of SMEs in implementing e-supply strategies. Larger firms not only have access to greater financial resources but also are better positioned to assume the risk of investing in various technologies (Pearcy and Giunipero, 2008). Therefore, all companies with less than 250 employees were removed.

Prior to analysis, surveys from the 319 respondents in firms with over 250 employees were assessed for missing data, outliers, normality, inter-correlations, and non-response bias. Missing Value Analysis indicated that missing data were low (<5%) suggesting no variables needed deleting prior to analysis. In addition, an overall test of randomness was performed, indicating no significant differences between patterns of missing and non-missing data (*MCAR Test*: Chi-Square 6593.859, DF 6533, Sig .296). Examination of outliers initially involved looking at variable histograms to check the tails of distribution

fall away at the extremes. We then examined box-plots to check for identified outliers for each variable. Hair *et al.* (1998) argue that unless the outlier is unrepresentative of any observation in the population, one should not delete it from analysis, as improved multivariate analysis comes at the cost of generalisation. Therefore, rather than deleting all respondents with an outlier scores, we deleted only those respondents with more than two outlier scores (22 respondents). The remaining dataset had 297 respondents with complete questionnaires.

Normality testing revealed that data exhibit multivariate normality, with limited skewness and kurtosis. As such, the variables are suitable for multivariate analysis. Empirical examination of factor analysis adequacy was assessed using the *Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy* and *Bartlett's Test of Sphericity.* The overall *KMO* statistics for all exceed all the most stringent minimum cut-off mark of .80 suggested in the literature (Hair *et al.* 1998). Bartlett's test of sphericity also indicates a high level of correlations between variables in the correlation matrix. Finally, T-tests comparing early and late respondents found no significant differences between the means of the two groups for any variables in our model.

To reduce common method bias, proximal separation was employed in designing the survey (Podsakoff *et al*., 2003). The three sets of variables (e-purchasing tools, AC and performance) were located in three different sections of the survey with different question types in between to create separation between the predictor and criterion variables. Respondents were asked to select a purchase category they are knowledgeable about and the use of e-purchasing tools and performance were both measured for that specific purchase category.

3.4 Confirmatory factor analysis

Confirmatory factor analysis (CFA) was conducted using AMOS to test construct validity and unidimensionality of latent and manifest variables. The CFA includes all independent and moderating multi-item constructs. All indicators within the measurement model were checked for low factor loadings to delete items to improve model fit. The model was identified. Table 1 provides descriptions, loadings and t-values for the manifest variables of each construct. As suggested by Shah and Goldstein (2006), we report multiple measures of fit. Specifically, we utilized the χ^2 test; the normed χ^2, the comparative fit index (CFI); the Tucker–Lewis index (TLI); and the root-mean-square error of approximation index (RMSEA). The fit of the CFA to the data was good: [χ^2

(161) = 263, p = .000; normed χ^2= 1.63; CFI = .96; TLI = .94; and RMSEA = .046]. Because the χ^2 itself is a problematic measure of fit, the ratio of χ^2 to degrees of freedom corrects it for model size (Shah and Goldstein, 2006). Small values of normed χ^2 (<1.0) can indicate an over-fitted model and higher values (>3.0-5.0) may indicate an underparameterized model (Jöreskog, 1969).

Several procedures were then conducted to check for convergent and discriminant validity. The convergent validity of the scales was supported as estimated coefficients of all indicators were significant (t > 2.0). For average variance extracted (AVE), a minimum of 0.50 is recommended to justify the use of a construct, whilst for composite reliability values, a minimum of 0.70 is recommended (Hair *et al.*, 1998). For all but one construct, these criteria were satisfied. For e-sourcing, the AVE value was 0.47, and CR was 0.63. However, at this stage we decided to retain this construct in our model at it is close to the recommended cut-off. For communications network, the CR was 0.03 below the cut-off rate and the AVE above it, so this construct was also retained. We will look to refine the e-sourcing and communications network constructs in subsequent research. Table 2 provides the correlations between constructs as well as the AVE and CR values.

Insert Table 1. Confirmatory factor analysis results
Insert Table 2. Correlations and summary statistics

3.5 Regression analyses

To test our hypotheses, we used hierarchical moderated regression analyses. All independent variables were first standardised, and the interaction components were calculated as the product of the independent and the moderator variable (Aiken and West, 1991). The results of the regression analyses are presented in Table 3. We ran the regression analyses with direct effects of the e-purchasing tools first, and then added the AC constructs and the interaction effects in a second step. In order to save space, we only report the coefficients of the second step. The ΔR^2 and hierarchical F refer to the differences between the first and the second step. For all regression analyses presented in this paper, estimated variance inflation factors (VIFs) varied from 1.00 to 3.37, suggesting that multicollinearity does not pose a threat to the interpretation of results (Cohen *et al.*, 2003).

The results show that there are few significant direct effects of e-purchasing tools on performance. Only the use of e-process tools has a significant direct positive effect on

price performance, and the use of e-transaction tools on user satisfaction. This means that of Hypotheses 1, 2, and 3, only Hypotheses 2a and 3b are supported. However, adding the AC constructs and their interactions with e-purchasing tools leads to significant increases in the model F for all four regressions.

Insert Table 3. Regression results

There are direct positive effects of the use of e-process tools on price performance and of e-transaction tool usage on user satisfaction. There are also direct positive effects of communications network on process cost performance, contract compliance, and user satisfaction. A significant positive coefficient for an interaction term indicates that the respective AC construct supports that e-purchasing tool in achieving higher performance. From Table 3, we read that buyer competence supports e-sourcing tools in achieving price performance and e-process tools in achieving process cost performance. Manager competence supports e-transaction tools in achieving price performance, and communications climate supports e-sourcing tools in achieving process cost performance. This means that of Hypotheses 4 to 8, Hypotheses 4a, 4c, 5d, and 6a are supported. In order to really understand each interaction effect, the interaction should be plotted following the procedures described in Aiken and West (1991). The cut values for low and high levels were plus and minus one standard deviation from the mean. The plots for the four significant interactions are provided in Figure 2.

Insert Figure 2. Plots for significant interactions

From the interaction plots, we gain the following insights. In three of the cases (Plots A, C, and D), performance is not significantly improved by the presence of the absorptive capacity dimension, as indicated by the flat solid lines (The solid line in plot D appears to show an increase, but a simple slope analysis reveals this increase is not significant). However, performance is hurt when the respective e-procurement tool is used and the absorptive capacity dimension is absent. Taking plot A as an example: In a situation of high usage of e-sourcing tools, price performance is lower when buyer competence is absent than when it is present. Plot B shows a slightly different interaction. Unlike the other three plots, there is an increase in the solid line and this is significant. As such, the plot shows that cost performance improves only if e-process tools are used to a high extent *and* there is a high degree of buyer competence in the organisation.

4. Discussion and conclusions

While some firms achieve successful outcomes when implementing e-purchasing tools, others continue to fall victim to the technology productivity paradox – spending far more on IT than the benefits achieved (Tippins and Sohi, 2003). Various explanations for this paradox have been offered, including management's failure to leverage IT potential, ineffective implementation, and incomplete performance measures. Whilst imperfect market factors can allow temporary profits from new technologies, increased competition and changing conditions often destroy this competitive value (Lenox and King, 2004). Many technologies can easily be purchased in the market, so a stand-alone e-procurement system may, at best, deliver a temporary advantage. Our results support this view by demonstrating that e-tools in themselves have a performance increasing impact in only two of the eight relationships tested.

Feisel *et al.* (2011) note the increasing importance of managerial skills in helping the purchasing function add organisational value. Our results point to a similar conclusion. While electronic purchasing tools in themselves appear to have a limited ability to contribute to purchase category performance, some elements of purchasing absorptive capacity moderate the relationship by increasing their performance impact. Our analysis thus indicates co-specialisation as well as complementarity in combining e-purchasing tools with absorptive capacity. Co-specialisation means that one capability has less, or no, value without another one, while complementarity arises when the value of a capability is enhanced by the presence of another one, due to synergistic effects (Ordanini and Rubera, 2008).

Specifically, our results demonstrate that when a direct relationship between e-tools and performance exists (only in two cases: H2a and H3b), AC constructs do not moderate such relationships. This means that e-process tools enable price reduction and contract compliance, and e-transaction tools increase user satisfaction in a purchase category regardless of the absorptive capacity of the purchasing function. This is likely due to the strong impact of those tools on performance, as evidenced in previous literature (Croom, 2000; Cuganesan and Lee, 2006). In other cases, AC constructs are necessary to increase performance, and in particular moderate the impact of e-sourcing tools on purchasing price (H1a) and process cost (H1b); the impact of e-process tools on process cost (H2b); and the impact of e-transaction tools on purchasing price (H3a). It appears that in these cases e-purchasing tools can provide performance improvements

only when combined with various aspects of the absorptive capacity of the purchasing function. Lack of absorptive capacity can hurt performance, suggesting it as a basic requirement for a purchasing organisation. This is in line with findings from Yassine *et al.*, (2004) within the context of product customisation, who find that establishing an IT infrastructure is ineffectual unless the organisational structure is capable of employing the data it provides.

Overall, our findings demonstrate that AC appears essential in gaining performance improvements from the use of electronic purchasing tools. Buyer competence and manager competence appear particularly important in moderating the beneficial effect of e-purchasing tools on category performance, and in many cases, the existence of absorptive capacity in itself, especially a strong communications network, appears in itself to bring increased category performance. This reinforces the view that in many cases the human capital in a purchasing function is as important as, if not more than, the existence of electronic purchasing tools. This is in line with earlier findings on manufacturing technology implementation, where human elements have also been found to be crucial to success (Maffei and Meredith, 1994; Co *et al.*, 1998).

In conclusion, Tippins and Sohi (2003) have shown that organisational learning plays a significant role in determining the outcomes of IT on firm performance. Our study extends these results to the context of purchasing. Our analysis supports the view that organisations which not only possess the technical capabilities for automation but also the ability to learn and share information are most likely to be successful in implementing e-purchasing tools (Zahay and Handfield, 2004). Increased levels of AC play an important moderating role in the extent to which adopted technologies contribute to category performance. In addition, they appear to have a direct effect on category performance, regardless of the use of e-purchasing tools for that category. Absorptive capacity is clearly needed as an organisational-human interface to maximise the increased operational capabilities and information provided by e-purchasing tools.

4.1 Contributions to managers and practice

Our findings raise a number of interesting implications for managers and practice. Firstly, of the seven possible direct relationships between e-purchasing tools and performance that we examined, only two (e-process tools leading to improved purchase price performance, and e-transaction tools leading to improved user satisfaction) are significant. This demonstrates that simply investing in e-purchasing tools rarely leads to

improvements in performance. As such, the focus for managers should be less on whether or not the adoption of e-purchasing tools will lead to improved performance, but rather *how* to effectively implement these technologies to drive performance.

Secondly, our analysis demonstrates that in a number of cases, the relationship between e-purchasing tools and performance is positively influenced by the extent to which purchasing functions are able to acquire and assimilate information from their supply partners – i.e. their absorptive capacity. Buyer competence, manager competence, communications climate, communications network, and knowledge scanning are all human capabilities that, when in place, help to maximise the potential of e-purchasing tools and when absent hinder performance. As such, when making investment decisions, organisations should carefully consider the complementarity of e-purchasing technologies and the human skills necessary to maximise their value. Specifically, our analysis suggests that organisations should pay particular attention to the development of buyer competence and manager competence aspects of absorptive capacity, given their important effect in maximising the potential value of e-purchasing tools.

Thirdly, it is clear that organisations face important trade-off decisions in their investments in various e-purchasing tools and different aspects of human capability (absorptive capacity). Deciding on key performance objectives is an important first step in this decision-making process. For example, a manager who is particularly keen to improve price performance has two obvious options. The first is to invest heavily in in e-process tools, which should lead directly to improved price performance regardless of the levels of absorptive capacity within the organisation. The second is to focus on other e-purchasing tools, but with matched investments in different human capabilities – e-sourcing tools with buyer competence, or e-transaction tools with manager competence. Conversely, if a manager is more interested in improving process cost performance, they cannot do this by simply adopting an e-purchasing tool. This leaves two obvious options to consider. The first is to invest in e-tools, but with matched investments in specific human capabilities – e-process tools with buyer competence or e-sourcing tools with communications climate. The second is to invest heavily in the communications network (in terms of coordination, information flows, and benchmarking), which would directly improve process cost performance without the need for investment in e-purchasing tools. Organisations with limited resources should make these decisions based on (1) their key performance objectives; (2) what e-purchasing tools they already have in place or are able to gain access to; and (3) what human capabilities they have strength in at present or

feel they are able to improve through investment. It appears that many organisations have traditionally tried to invest in too many different e-purchasing tools without ever maximising the potential of any. As such, focus and co-specialisation of resources appear to be crucial.

Finally, our study suggests that in some circumstances organisations with high levels of absorptive capacity in their purchasing department, but limited e-purchasing tools, may outperform other organisations with extensive e-purchasing tools but lower levels of absorptive capacity. The implication of this finding is that organisations should be careful not to fall into the trap of investing too heavily in e-purchasing tools to the exclusion of investments in the human capabilities required to maximise their potential. In fact, it may be sensible to initially invest heavily in human capabilities and then transition to investments in e-purchasing tools that are shown to compliment these different aspects of absorptive capacity.

4.2 Contributions to academics and theory

In this paper, we have drawn upon contingency theory to study the impact of e-tools on performance and the moderating impact of human capabilities in terms of absorptive capacity. In terms of contingency theory, our findings support the arguments of Sousa and Voss (2008) that operations management practices are only effective under certain contextual conditions. Specifically, we show that elements of absorptive capacity are needed to bring performance improvements from the use of electronic purchasing tools in several instances.

Academic interest in absorptive capacity, which has grown rapidly over the past two decades, has focused on its effect on organisational learning, knowledge sharing, innovation, capability building, and firm performance (Flatten *et al.*, 2011). To date, empirical studies on absorptive capacity have been focused largely on R&D intensive companies in medium- and high-tech sectors (Spithoven *et al.*, 2011). As such, this study contributes to the theory on absorptive capacity by extending it empirically to the purchasing context and by additionally demonstrating it to be a valid construct/concept at a functional level. Furthermore, Tu *et al.* (2006) argue that despite the growing popularity of the absorptive capacity construct under different settings, empirical research on absorptive capacity has been hindered by the lack of clear definition and operationalisation of the construct. In supporting this view, Flatten *et al.* (2011) note that AC is often treated as a uni-dimensional construct through a variety of proxy measures,

such as R&D outputs, R&D intensity, R&D investments, and personnel training investment. Such measures fail to capture the richness and multidimensionality of the construct (Simonin, 2004). Therefore, we adopted the measures for AC developed by Tu *et al.* and validate the instrument in a functional context. We show that the five sub-dimensions of AC are valid not just at firm level but also at a functional level, and act as moderating factors between the use of electronic tools and performance. In addition, we have answered calls to transfer the concept of absorptive capacity to the supply-management realm (Schiele, 2007) to enrich our understanding of the mechanisms and human interfaces that allow companies to benefit from the use of e-purchasing tools.

An important contribution of this study is its focus on the purchase category level; most studies so far have analysed the impact of electronic purchasing and supply chain management tools on firm level performance. Yet most organisations increasingly apply a portfolio approach in purchasing management (Gelderman and Van Weele, 2003; Zhu *et al.*, 2010) and thus implement different tools for different categories. Pohl and Förstl (2011) have found support that product group strategies differ from the central purchasing strategy, in accordance with the notions introduced by Kraljic (1983) regarding segmented purchasing and argue that this level is a more appropriate level of analysis for future research. A large proportion of managerial advice provided in purchasing research suggests tailoring practices to suit the category and the purchasing context, yet the empirical research remains predominantly at the aggregate level. To our knowledge, this is the first large scale empirical purchasing survey study to focus on category level practices and it is hoped will pave the way for a shift in academic practice away from organisation-level purchasing studies towards category-level studies.

4.3 Limitations and future research

This paper has a number of limitations. Firstly, whilst we examine the relationship between purchasing tools, absorptive capacity, and performance at the category level, the analysis does not consider the specific features of the purchase category. In future research, adding characteristics of the purchase category such as value/profit impact and demand/supply characteristics could provide interesting additional insights in terms of the most efficient contexts for various e-purchasing tools in gaining improved performance. Secondly, the explanatory power of the regression models is relatively low. Low R-squares of this type are common in these kinds of studies, where several internal and external variables influence performance (See for example, Capon et al., 1990;

Adam, 1994; Wagner and Bode, 2008; Gonzalez-Benito, 2010). For example, Wagner and Bode (2008), in their study of the impact of supply chain risks on supply chain performance, report an R-square of 0.06, whilst Gonzalez-Benito, 2010, in his study of supply strategy's impact on business performance, reports R-squares ranging from 0.03 to 0.10. However, future research could look to explore other key drivers of performance constructs. Thirdly, whilst this study examines different types of e-purchasing tools, classifying them into e-sourcing, e-process, and e-transaction, it does not consider the different adoption modes, i.e. buyer-hosted, seller-hosted or intermediary-hosted. A future study might investigate whether specific tools are more or less effective when implemented through different adoption modes. Finally, the study only tests whether e-purchasing tools directly lead to improved category performance and whether combining tools with absorptive capacity leads to a stronger improvement effects. Whether purchase category performance improvements act as a source of sustainable competitive advantage for the firm, however, is beyond the scope of this study and is left for further research.

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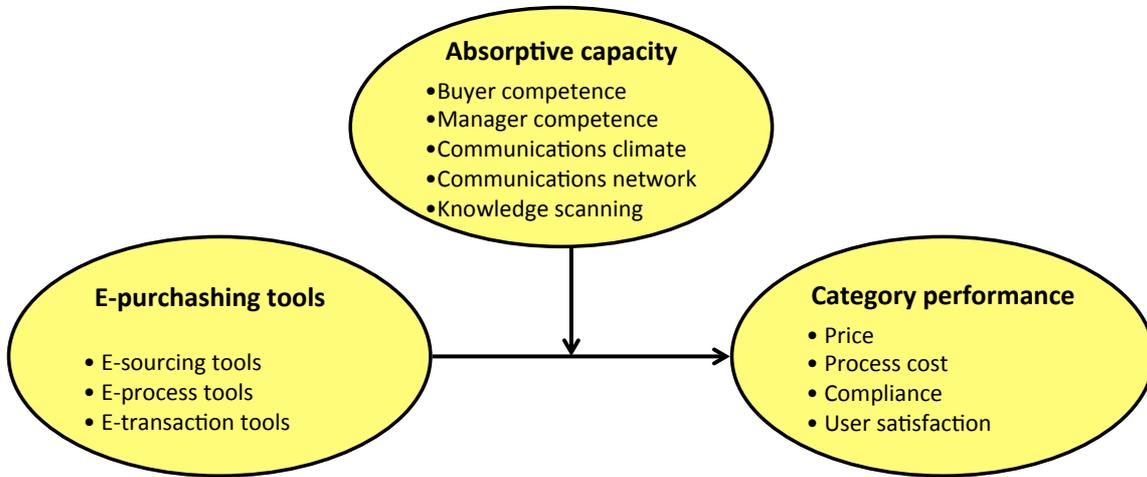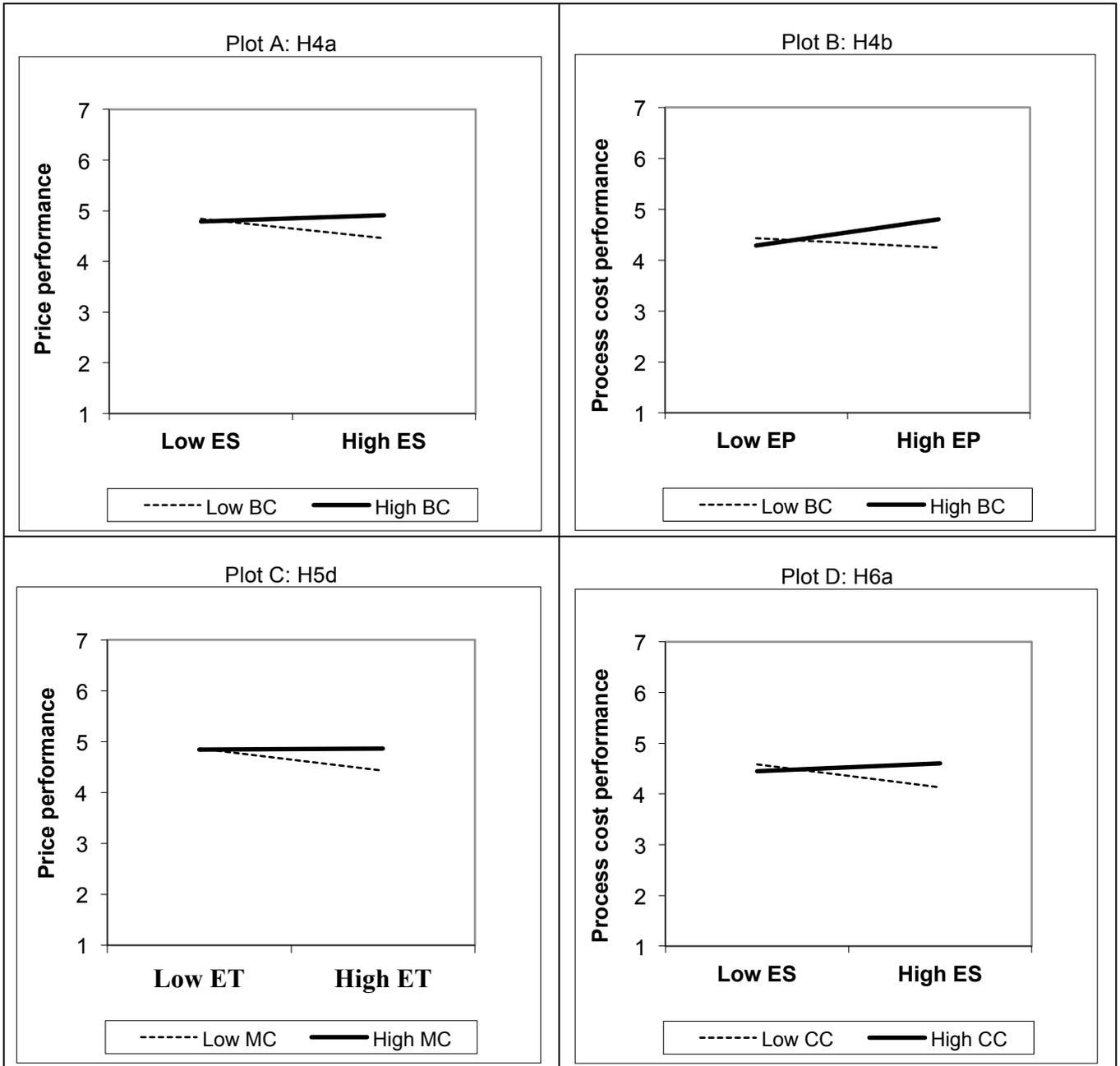**Figures and tables**

Figure 1. Conceptual model

Figure 2. Plots for significant interactions

Table 1. Confirmatory factor analysis results

Variables and items		Std loadings	Std error	t-value
E-sourcing	Use of:			
	Reverse e-auctions	0.61	0.09	5.85
	Electronic request for quotation / proposal / information (RfX)	0.75	-[a]	-[a]
	Electronic catalogues	-[b]		
E-process	Use of:			
	Electronic workflow and order management	0.84	-[a]	-[a]
	Order tracking and tracing	0.71	0.06	11.80
	Electronic document and contract management	0.68	0.06	11.28
	Electronic supplier database	-[b]		
E-transactions	Use of:			
	Electronic invoicing and automated payment	0.80	-[a]	-[a]
	Electronic data exchange (EDI, XML, web-EDI) with suppliers	0.78	0.09	10.54
	Purchasing cards (P-cards)	-[b]		
Buyer competence	The knowledge of buyers on business aspects	0.77	0.06	14.59
	Average education level of buyers	0.85	-[a]	-[a]
	Overall job competence of buyers	0.84	0.05	16.14
Manager competence	The knowledge of purchasing manager(s) when:			
	Making business decisions	0.78	0.07	12.17
	Dealing with new technologies	0.80	-[a]	-[a]
	Dealing with human issues (e.g. human resource management, internal and external communications)	0.62	0.09	10.04
	Managing daily operations	-[b]		
Communications climate	To what extent:			
	Are employees supportive of each other?	0.78	0.08	11.42
	Do employees have a sense of belonging to your organisation?	0.72	-[a]	-[a]
	Do employees share ideas freely with each other?	0.76	0.09	11.27
	Are employees willing to accept change?	-[b]		
Communications network	To what extent:			
	Do purchasing supervisors and subordinates communicate in your organisation	0.69	-[a]	-[a]
	Are new ideas from the purchasing department communicated to other departments	0.73	0.11	10.52
Knowledge scanning	To what extent:			
	Do you seek to learn from benchmarking best practices in purchasing?	0.83	-[a]	-[a]
	Do you seek to learn from trying out new technologies?	0.80	0.07	12.25
	Do you seek to learn from tracking new market trends in your supply industry?	0.64	0.07	10.49
	Do you seek to learn from your suppliers?	-[b]		

Notes: All t values are significant at $p < 0.001$. [a]Item was fixed to 1 to set the scale. [b]Item deleted during purification.

Table 2. Correlations and summary statistics

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. E-sourcing	1											
2. E-process	0.353	1										
3. E-transactions	0.332	0.569	1									
4. Buyer competence	0.071	0.104	0.089	1								
5. Manager competence	0.002	0.025	0.054	0.543	1							
6. Communications climate	-0.027	0.124	0.023	0.320	0.275	1						
7. Communications network	-0.039	0.081	0.031	0.431	0.463	0.599	1					
8. Knowledge scanning	0.201	0.202	0.198	0.323	0.297	0.250	0.382	1				
9. Purchasing price	-0.023	0.097	-0.002	0.163	0.151	0.075	0.216	0.129	1			
10. Process cost	-0.025	0.102	0.106	0.155	0.130	0.177	0.251	0.205	0.393	1		
11. Contract compliance	0.178	0.097	0.078	0.083	0.228	-0.001	0.163	0.121	0.116	0.202	1	
12. User satisfaction	0.127	0.112	0.126	0.162	0.199	0.160	0.214	0.239	0.272	0.376	0.418	1
Mean	2.27	3.70	3.03	4.43	4.54	4.31	3.98	4.25	4.77	4.44	4.21	4.46
Standard deviation	1.17	1.41	1.57	0.78	0.73	0.78	0.84	0.76	1.14	1.04	0.88	0.99
Cronbach's alpha	0.59	0.79	0.77	0.86	0.77	0.80	0.67	0.80	N/A	N/A	N/A	N/A
Composite reliability	0.63	0.79	0.77	0.86	0.78	0.80	0.67	0.80	N/A	N/A	N/A	N/A
Average variance extracted	0.47	0.56	0.63	0.68	0.55	0.57	0.51	0.58	N/A	N/A	N/A	N/A

Notes: Correlation coefficients above 0.115 are significant at the 0.05 level; above 0.150 are significant at the 0.01 level.

Table 3. Regression results

	Purchase price	Process cost	Contract compliance	User satisfaction
E-sourcing (ES)	-0.07	-0.07		
E-process (EP)	0.16†	0.08	0.08	
E-transaction (ET)	-0.10	0.07		0.12*
Buyer competence (BC)	0.10	0.10		
Manager competence (MC)	0.10	-0.02		
Communications climate (CC)		0.08		
Communications network (CN)		0.19*	0.14**	0.21***
Knowledge scanning (KS)	0.09			
BC x ES	0.13†	0.05		
BC x EP		0.18†		
BC x ET		-0.13		
MC x ES	-0.09	-0.04		
MC x EP		-0.06		
MC x ET	0.12†			
CC x ES		0.15*		
CC x EP		0.07		
CC x ET		-0.01		
CN x EP		-0.11	0.01	
CN x ET		-0.04		-0.03
KS x ES	0.00			
Intercept	4.75***	4.44***	4.21***	4.47***
Model F	2.20*	2.56**	3.44*	6.34***
R^2	0.07	0.14	0.03	0.06
ΔR^2	0.06	0.12	0.03	0.05
Hierarchical F	2.40*	2.67**	3.73*	7.04**

Notes: N = 297. All entries are unstandardized coefficients. † $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$