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Abstract

This paper analyzes processes and effects of ICT enabled innovation in the Dutch design sector. Although the adoption of Information and Communication Technologies (ICT) is considered as vital in the design sector, little is known about whether and how ICTs affect the firm performance of small and medium-sized companies (SMEs) in the industry. In introducing a conceptual distinction between ICT supporting the *information processing* and *communication*, the paper first examines the determinants of ICT adoption. Next, we analyze the effects of ICT adoption on product and process innovation as well as on firm performance, focusing on the mediating role of the innovation processes. The analyses rest on survey data of a sample of 189 Dutch companies in the Web, Graphic, and Industrial Design Sector in the Netherlands. The results indicate that information processing role of ICT supports the *exploitation* and communication role facilitates the *exploration* in organizational learning. The exploitation enables process innovation while exploration enables product innovation. Lastly, Information processing technologies and product innovation are important determinants of superior firm performance.

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1. Introduction

Organizational learning (OL) is central for the healthy survival of SMEs. Information and communication technologies (ICT)[2] provide unique opportunities for SMEs by providing IT-enabled learning mechanisms (Lopez-Nicolas & Soto-Acosta, 2010). ICT facilitates firms to react quickly to changes in the industrial environment, which has an impact on new product development options, tooling designs, production engineering and marketing (European Commission, 2011; Vanchan & MacPherson, 2008). In this study, we look at the ICT adoption and its implications in the SMEs of Dutch Design Sector in the Netherlands. In this study, we take ICT into its two basic capabilities, i.e., information processing and communication. The design sector is an interesting case to study the adoption of ICT and innovation. The design sector works across multiple industries and provides novel solutions to the problems of manufacturing & services firms and has been an important interface with respect to knowledge flows, creativity and artistic expressions (Kirkels & Duysters, 2010; Vanchan & MacPherson, 2008). The firms which work across multiple sectors and engage in knowledge transfer across them are termed as "Knowledge Brokers" (KB) by Hargadon (1998), and design firms are one of the examples of KB which contributes to product and process innovation by gathering, exploring and synthesizing knowledge from different domains (Bertola & Teixeira, 2003). ICT has potential to vitally change the design process (Steinmueller, 2000) and enable codification of knowledge-set at the core of design activities (David & Foray, 1995). ICT also facilitates virtual exchanges across time and space particularly in Design firms (Salter & Gann, 2003) hence ICT may support the innovation process in design firms better than in the traditional firms. Further, Mitchell, Inouye, & Blumenthal (2003) argue that recently, ICT is forming strong alliance with creative practices in arts and design which has been resulting into significant economic value and IT is a glue that keeps clusters of creative activity together. We aim at studying two phenomena in the design sector. First, we study determinants of the adoption of ICT company owner's perception of how ICT enables OL. Second, we analyze the effects of adopted technology on firm innovation and financial performance.

We put two novel ideas to the test. First, we argue that in addition to the traditional arguments of the adoption of technology, more attention should be paid to the subjective criteria i.e., company owners' perception of the importance of ICT for specific forms of knowledge management. As we will explain in more detail in the next section, we argue that ICT can fulfill (at least) two different functions with respect to OL i.e., "exploration" and exploitation" and based on these function, firms adopt distinct types of ICT. Second, we

[2] The terms ICT and IT will be used interchangeably throughout the paper

discuss the relationships between ICT adoption and firm performance. We argue that ICT capability based distinction provide us important insights into how ICT serves to be an essential input for innovation (e.g. product or process). Also, taking ICT as a general technology may be misleading (Ciarli & Rabellotti, 2007). Furthermore, product and process innovation, in turn, explain the effect of ICT adoption on firm performance. Accordingly, one aim of this study is to understand how firm perception about the importance of particular ICT types affects the adoption of different types of ICT. Secondly, we aim at clarifying how ICT creates value at the most operational level by enabling the firm to share ideas and produce innovative designs. Our main research question serves to investigate how organizational learning influences the process of technology adoption and innovation in creative firms.

The article is structured as follows. In section 2, we summarize the theoretical and empirical findings of the literature on organizational learning, ICT and innovation. Here, we also describe important characteristics of the Dutch design sector. In section 3, we explain our arguments which lead to a number of hypotheses about determinants of the adoption of ICT and the effects of ICT adoption on innovation processes and firm performance. In section 4, we illustrate the research design. Our study utilizes information of a random sample of 189 firms in the Dutch design sector. We provide some descriptive findings. In section 5, the results of the hypotheses testing are discussed. In the final section, we summarize the findings and discuss their implications for further research on the relationship between ICT and firm performance. Moreover, we point to a number of practical implications for company managers who consider the adoption and application of ICT in their businesses.

2. Theoretical Background

2.1 The design sector

In this section, we discuss about the nature of creative sector and explain that by taking the case of Web, Graphic and Industrial Designers. Product development in a creative sector is essentially based on intellectual capital; hence their primary activity is information processing and knowledge acquisition. The firms which work as an intermediary between firms and users and facilitate the transfer of knowledge and operate into multiple markets are labeled as “knowledge brokers” (KB) (Hargadon, 1998). He further explicate that in a new development project, knowledge brokers learn as much and as fast as possible about the ideas of the industries they are entering and have to speedily work on a given problem by extensive user testing, training, colloquiums, benchmarking. We can see that design firms possess these characteristics. According to Bertola & Teixeira (2003), design activities adapt to different contexts in accessing different knowledge domains, hence they regard them as knowledge broker. The role of KB has been analyzed in knowledge management studies for

a decade now (Alavi & Leidner, 2001; Kankanhalli, Tan, & Wei, 2005; Pfeffer & Sutton, 1999)[3].

Design, which has different connotations in various fields, is generally defined as a plan or convention for the construction of an object for a system. Any business activity which involves the use of imagination or original ideas comes under the "creative industries" paradigm. Creative Industries are defined as "industries which have in their origin individual creativity, skill and talent and which have a potential for wealth and job creation through the generation and exploitation of intellectual property" (DCMS, 2001: 5). However, there are areas where creative activity criss-crosses a variety of sectors such as design (OECD, 2005; (Lazzeretti, Boix, & Capone, 2008). Design deals with creative problem solving. Web[4], Graphic[5] and Industrial Design[6] all deal with solving problems using design to communicate the solution and span across multiple markets. This study takes the above mentioned three types of Design firms. Problem solving in industrial design means optimizing the function, value and appearance of the product; in graphic design providing the right answers to visual communication problems of every kind and in every sector of society (ICOGRADA, 1995) and in web design it's about enhancing user experience, communicate ideas through organizing and manipulating words and pictures (Veen, 2000). Problem solving involves synthesizing information and knowledge across organization's stakeholders to reach a solution which develops a symbiotic relationship between the manufacturer and user of the product or service. This results in spread of knowledge across sectors which stimulate the creation of new knowledge and organizational innovation for the firm (Kogut & Zander, 1992; Pfeffer & Sutton, 1999). Hence, Design firms become an interesting case to understand the process of continuous innovation where products are continuously updated and regularly modified.

We define designing in our context as "Set of activities involving social interactions by exploiting individual talents and sharing and communicating ideas of each other that provide mutual benefits to the involved parties". There is a plethora of literature dealing with clustering of creative industries after Florida (2003) such as Lazzeretti, et al., (2008) and (1999) etc. However, the process through which these creative sectors acquire knowledge and distribute information is less intensively studied and we discuss that in the following section by taking the case of "creative sector" in general and "design" in particular.

[3] Venture capitalist and consulting firms are regarded as common examples of knowledge broker.
[4] Web designing is a multidisciplinary pursuit pertaining to the planning and production of Web sites, including, but not limited to, technical development, information structure, visual design, and networked delivery (Powell, 2000)
[5] Graphic designing is an intellectual, technical, and creative activity concerned not simply with the production of images but with the analysis, organization and methods of presentation of visual solutions to communication problems (ICOGRADA, 1995)
[6] Industrial Design is the use of both applied art and applied science to improve the aesthetics, ergonomics, functionality, and/or usability of a product, and it may also be used to improve the product's marketability and even production.(Noblet, 1993)

2.2. Organizational Learning, ICT and Innovation in the design sector

In this section, we argue that OL mechanisms in firms result in ICT adoption and this IT-facilitated learning mechanism produce distinct innovation outcomes. Organizations design and develop ICTs which augment strategic learning even at distance (Thomas, Sussman, & Henderson, 2001) but how learning is conducted through ICT is not known (Small & Irvine, 2006).

ICT provides unique opportunities for design and engineering by supporting the processes in design, managing the regular internal business processes and organizational decision making (Gann, 2000; Salter & Gann, 2003; Steinmueller, 2000). Hence, design sector is more prone to using ICT tools compared to other sectors which makes design sector interesting to study ICT adoption and its implications.

There has been a general consensus about the contribution of knowledge towards innovation. Innovation is the channeling of creativity so as to produce a creative idea and/ or product that people can wish to use (Sternberg, Kaufman, & Pretz, 2003). Hargadon (1998) states that each development project generates "valuable spillovers of information", which are exploited by KB to produce innovative outcomes and with each project, KB accumulates knowledge to be subsequently applied on later projects. Also, KB's access to a wide range of otherwise disconnected sectors; constantly learning outside of the given project, access to broader range of industries, moving knowledge from one context to the other provides them a leading edge to their innovative strategies. Further, lack of communication between divisions of large firms' creates a gap in firm's knowledge sharing and KB can bridge this gap. In the design context, the knowledge obtained from users, network and organization itself can promote business innovation (Bertola & Teixeira, 2003). The first two resides outside while the last one exists within the organizational boundaries.

A similar distinction is developed by March (1991) in OL who studies exploration and exploitation as core activities of OL. Exploration refers to the hunt for out-of-box solution, acquisition of untried technologies and products with unknown demand, replacing existing content within organization's memory with new knowledge (Abernathy, 1978; Kane & Alavi, 2007; March, 1991) while exploitation is making use and modification of on-the-hand knowledge, technologies and products that the organizations have more certain knowledge about (Greve, 2007). Both exploration and exploitation require resources and thus organizations need to make a balance between these two modes of organizational learning

(Levinthal & March, 1993). The link between OL and ICT is discerned (Pentland, 1995) therefore ICT is a tool that helps facilitate both exploration and exploitation.

Recently, the effects of ICT on exploration and exploitation in OL have been investigated by (Kane & Alavi, 2007) and they call it "IT-enabled learning mechanism[7]" which are communication technology, knowledge repositories of best practices and groupware. These IT-enabled learning mechanisms facilitate capabilities that have distinct effects on the exploration and exploitation. An important contribution of this paper is that they emphasize distinct ways IT enables that support the learning processes e.g. it can supports sharing of structured knowledge (KPRs) or unstructured or tacit knowledge (email). Also, firms' investment in IT assets is driven by firms' strategies (e.g. cost leadership or innovation) (Aral & Weill, 2007). In this context, IT roles and not investment in IT becomes important. In the past, the IT roles were considered important from a diffusion perspective (Fichman, 1992) and now from OL's perspective.

To understand the importance of IT-enabled mechanisms or capabilities, conceptual ideas come from a number of studies (Aral & Weill, 2007; Kohli & Grover, 2008; Nevo & Wade, 2010; Vallabh Sambamurthy, Bharadwaj, & Grover, 2003). They lead to identify two central roles of IT which are *"information role"* and *"communication role".* The information role of IT refers to provision and distribution of corporate or commercial information to stakeholders (Huizingh, 2000). In this role, ICT can be seen as a channel for information dissemination and data access across functional boundaries and organizational levels (Bafoutsou & Mentzas, 2002); providing one way electronic information to stakeholder(s) (Lopez-Nicolas & Soto-Acosta, 2010). The literature which explains the *information role* and its implications include (Davenport TH, 1990; Laudon & Laudon, 2011; V Sambamurthy & Zmud, 2000; Weill, 1992). In communication role, ICT provide a two-way information exchange, facilitating collaboration across stakeholder(s) which is thoroughly discussed (Andersen, 2001; Bardhan, Krishnan, & Lin, 2007; Lai & Mahapatra, 1998; Sproull & Kiesler, 1992; van den Hooff & van de Wijngaert, 2005).

ICT adoption can be driven by objective (e.g. firm's characteristics) and/or subjective (firm's recognition of needs to adopt) criteria. In case of SME's, the adoption is particularly driven by subjective criteria as we will argue in Section 3.2. OL is regarded as key to management innovation (Stata & Almond, 1989). Further, each type of technology adoption, because of facilitating a particular learning mechanism, has different impact on innovation and firm

[7] These IT-enabled learning mechanisms in their paper refer to both the Technologies themselves (e.g. email, listservs) and the organizational capabilities and structures these technologies enable

performance. In view of the above, we examine how the quest for explorative and exploitative learning mechanisms result in adopting particular types of ICT which cause innovation and superior firm performance.

3. Hypotheses

3.1. Choice of technology adoption

In this subsection, we explain why firms adopt distinct type of ICTs. Organizations allocate dedicated resources to OL and knowledge acquisition through for instance R&D departments, training, hiring new employees etc. ICT is one tool that helps facilitate conducting both explorative and exploitative research (Alavi & Leidner, 2001; V Sambamurthy & Subramani, 2005). The IT-enabled mechanisms may influence complex OL processes (Kane & Alavi, 2007). The opposite that OL is an important antecedent to IT capability building is also studied (Bhatt & Grover, 2005). The KBs (design) firms acquire and utilize knowledge from within and outside organizational boundaries to conduct OL. This process of OL requires IT-enabled mechanisms to undertake more complex OL processes (e.g. product and process innovation).

We take the case of two basic types of technologies i.e., Information Processing Technologies (IPTs) and Communication Technologies (CTs). IPTs process information so that it is accessible and ready to use in the simplest possible form while CTs are meant to share novel ideas and designs among the stakeholders. Examples of IPTs are fax, scanner, electronic calendars and document management systems while for CTs, examples include social media, VOIP and teleconferencing etc.

Since exploitation refers to learning gained via local search, experimentation refinement and reuse of existing routines (Baum, Li, & Usher, 2000), IT which helps the firm to process information according to pre-defined routines, models and roles and present it in a form tailored to the needs of users is more appropriate to conduct exploitation in a firm. These roles are accomplished by IPT. Exploration, on the other hand, refers to learning gained through processes of concentrated variation, planned experimentation and play (Baum, et al., 2000). CT which integrates valuable information from outside the firm boundaries augments the process of exploration in a firm. We can therefore hypothesize:

Hypothesis 1A: The Firms considering ICT as an important factor in exploiting and retrieving in-house information are more likely to adopt "Information Processing Technologies" than the firms which do not.

Hypothesis 1B: The Firms consider ICT as an important factor in conducting explorative activities outside the own firms (i.e., with buyers, supplier and competitors) are more likely to adopt "Communication Technologies" that the firms which do not.

3.2. The relationship between types of adopted technologies and organizational innovation

In this subsection, we explain how ICT can enable product and process innovation at firm level. Economics and Management literature addresses innovation in four main types i.e., Product, Process, Organization and Marketing innovation out of which Product and Process innovation have been greatly discussed. ICT can enable process innovation for the adopter if routines are changed and new system is operational and can permit product innovation if it is successfully able to deliver product or service which is perceived as new to the firm (Koellinger, 2008). ICT supports innovation and pushes out invention possibility frontier (Brynjolfsson & Saunders, 2010) but it is important to identify IT roles to assess how and what kind of innovation is supported by IT.

European Commission indicates that ICT enables almost half of the process innovations (Eurostat, 2003). Molle & Djarova (2009) examines ICT to be mainly contributing to process innovation and finds positive relationship between various ICTs' use, improved speed, reliability of business processes and cost reduction. The objective of process innovation can be cycle time reduction, coordination and management of functional interdependencies, and improving financial performance by reducing costs (Davenport, 1993b). The studies on Western Europe uncover ICT to be the major driver of product innovation.

IPT by acquiring, processing, storing, and transmitting information makes the information flow easier from department to department and supports process innovation (Davenport, 1993a). Digital information reduces cycle time, smoothes the complex workflow process, well-integrated into other application systems, more secure via number of applications and enhances organizations ability to produce more in lesser time. In other words, digital information enables modules that help facilitate significantly improved production or supply method (Bresnahan, Brynjolfsson, & Hitt, 2002).

While IPTs are also assumed to enable product innovation, their role is more eminent in process innovation as pointed out by (Davenport, 1993b).

Hypothesis 2A: Firms that have adopted more IPTs perform better in undertaking "Process Innovation" than firms that have adopted less IPTs.

Communication is found to have a significant impact on product innovation in a direct manner (Damanpour & Aravind, 2006; Harder, 2011; Wolfe, 1994). Communication technologies provide unique opportunities for rich information flows in-and-outside the organization's boundaries for the companies. The use of electronic communication, as compared to face-to-face communication, has shown to increase overall communication in the organization (Hiltz, Johnson, & Turoff, 1986). The most straight forward way of how IT impacts organizational functioning is by having an impact on horizontal coordination (Dewett & Jones, 2001). Communication technologies help in increasing the incidences of problem solving (Edmondson & Moingeon, 1998) and allowing organizations to explore new modes of structuring their workforce (Dewett & Jones, 2001). Today, social media have an indispensable presence in business which adds value by insuring value adding communication among customers, employees, and enterprises. Social media are now becoming a valuable asset for marketers, product developers to harness the upcoming business challenges through valuable feedback from customers, gaining insightful competencies from collaborators and most importantly engaging customers in building companies' strategies (Kaplan & Haenlein, 2011). Video conferencing is a way to share voice and image data among the partners. Designers can share CAD files over internet and through video conferencing global rather than local specialized talent can be pooled. VoIP delivers voice communication and multimedia sessions over IP eliminating long distance and long telephone charges and new VOIP systems support unified voice mail, email, click-to-call capabilities and soft phones (Guffey, 2007). In other words, these CTs supplement information exchange and group memory. Further, CTs mitigate the overall costs of larger groups in communities of shared knowledge and reduce search costs for problems already sorted out and induce division of labor which creates further gains (Steinmueller, 2000). Hence Ciarli & Rabellotti (2007) find that CTs are correlated with product innovation. We therefore hypothesize that:

Hypothesis 2B: Firms that have adopted more CTs perform better in undertaking "Product Innovation" than firms that have adopted less CTs.

In design, problem solving involves lots of information processing (Pahl, Wallace, & Blessing, 2007) and communication is recognized for providing main access to thinking and problem solving (Stempfle & Badke-Schaub, 2002). This makes design sector a good case to study the phenomena of innovation initiated by ICTs.

3.3. The relationship between type of adopted ICT, organizational innovation and firm performance

In this sub section, we explain how ICT and innovation influence firm performance. First, based on the assumption that IT tools are adopted to help in conducting exploration and exploitation activities in a firm, we test how these IT-enabled learning mechanism affect firm performance. Second, using the arguments from Cainelli, Evangelista, & Savona (2006), Gera & Gu (2004) and Hempell, Van Leeuwen, & Van Der Wiel (2004), we see how innovation is affecting firm performance under the adoption of ICT tools.

Looking at impact of IT-enabled learning mechanisms on organizational performance, we see the literature identifies effective knowledge management resulting into increased competitive advantage (Conner & Prahalad, 1996), innovation (Antonelli, 1999; Carneiro, 2000), superior use of information (Carneiro, 2000) and improved financial performance (Teece, 1998). The informational role of IT is associated with superior financial performance (Aral & Weill, 2007) while the communication role is associated with facilitating communication among stakeholders across functional and geographical peripheries which enhances coordination of activities that positively affect the firm performance (Andersen & Foss, 2005). The link of CTs with firm performance is therefore not direct but indirect one. In our case, as we argued above, CTs help creating novel designs therefore, they may result in retaining and even acquiring new clients. CTs direct role with profitability and net income is not obvious.

As for innovation, it is a well-established fact in economic theory that innovation matters for output growth (Audretsch, 1995), competitive advantage and therefore superior profitability and revenue growth (Roberts & Amit, 2003; Thornhill, 2006). The economists have been testing the hypothesis for all major types of innovations. Product innovation may result into at least briefly earning monopolistic profits (Schumpeter, 1950), above average profits (Artz, Norman, Hatfield, & Cardinal, 2010; Prajogo, 2006; Roberts, 1999) and high market valuation in IPO (Deeds & Decarolis, 1999). Process innovation on the other hand has not been much acknowledged to contribute towards economic performance(Staw & Epstein, 2000) while some recent works attribute it to complement product innovation (Beers & Zand, 2013). In case of any type of innovation, the relationship between innovation and a firm's profitability is intricate as competitors may copy the innovation and erode any additional benefits taken from the innovation (Koellinger, 2008). In addition, firms can reap benefits not only by adopting ICT but also by developing complementary organizational capital such as human resource practices and other organizational routines that make smart use of ICT

(Brynjolfsson & Hitt, 2000). The substantial variation in the returns to IT (Brynjolfsson & Hitt, 1995) is often attributed to differences in the adoption of complementary organizational practices (Bresnahan, et al., 2002). Several economists argue that superior human resource and organizational practices improve returns from IT (Aral, Brynjolfsson, & Wu, 2012; Ichniowski & Shaw, 2003).

In context of the above arguments, we formulate the following hypotheses:

Hypothesis 3A-I: The adoption of more IPTs positively affects increase in number of clients, profitability and net monthly income of the firms.

Hypothesis 3A-II: The adoption of CTs positively affects number of clients but has no affect on profitability and net monthly income.

Hypothesis 3B-I: The adoption of more IPTs positively affects increase in number of clients, profitability and net monthly income via product innovation and not via process innovation.

Hypothesis 3B-II: The adoption of more CTs positively affects increase in number of clients via product innovation and not via process innovation.

Figure 1 provides pictorial representation of all our hypotheses.

4. Research Design, Measurement and Data Analysis

4.1. Research Design

We test our hypotheses based on data from a survey of Dutch Design Companies. The research method used a computer-assisted telephone interview (CATI) with the founders of design firms in the summer of 2011. In the survey, we explored the adoption of ICT, innovation activities and productivity statistics of the firms. We sampled firms from Web, Graphic and Industrial Design sector using the Dutch version of the Yellow Pages (in Dutch: 'De Gouden Gids)'. We randomly selected firms from each page. We approached 737 companies. From these, 200 companies took part in our study, 238 did not want to participate and 299 could not be contacted. This implies a response rate of 27%. The number of companies active in Industrial Design is 75, in Web Design 75, and in Graphic Design 90. Because some firms fall into more than one category, these numbers are approximations. Note that the actual number of cases used in the analyses is sometimes a

bit smaller than 200 because of missing observations in dependent and independent variables.

4.2. Measurements:

4.2.1. Independent Variables:

For testing whether ICT adoption is influenced by exploration, respondents are first asked whether ICT is important in maintaining relationship with their buyers, suppliers and other designers and for testing if ICT adoption is persuaded by exploitation, we ask about how important ICT is in information storage and dissemination inside the firm. The respondents have to respond on 3 points Likert Scale.

We further ask the firms about adoption of specific ICTs. On the basis of information provided by the firms, we construct an exhaustive list of technologies provided by the companies. In general, firms are using four types of IPTs; i.e., Scanner, Fax, Document Management System and Electronic Agenda and three types of CTs; i.e., Teleconferencing, Voice over IP (VoIP) and Social Media (Facebook, linkedin, Twitter etc). So the adopted IPTs and CPTs are both count variable where they can take any of the four and three possible non-negative values respectively.

Information on CEO is obtained through variables such as CEO's level of education, gender, professional education and number of design firms previously founded. The information on the company is obtained through company age, number of employees, sector in which the company operates.

4.2.2. Dependent Variables:

The outcome variable includes two set of factors i.e., Innovation and Performance. Innovation is mostly addressed in the literature in the form of product and process innovation. We ask whether the company has introduced any radically new design or commenced a significantly improved process during the past 12 months. This gives us dummy variables on Product and Process innovation of the firms. The Performance is defined by three set of variables which are "Number of clients", "Net monthly salary" and "Profitability". "Net monthly salary" is a categorical variable indicating monthly salary at five different levels where '1' indicates salary lower than €1000 and '5' denotes salary above € 6000. "Number of clients" is also a categorical variable where '3' indicates increase, '2' denotes no change and '1' indicates decrease in the number of clients. "Profitability" is a

dummy variable indicating 1 if the company has been profitable during the past 12 months and 0 otherwise.

The dependent and independent variables are given in Table 1.

[Table 1 about here]

4.3. Descriptive Analysis of Interviews

4.3.1. Characteristics of Design Firms

Many of the firms are working in two sectors. If we consider the mutually exclusive firms, then Web Designing includes 46, Graphic Designing 51 and Industrial Designing 63 firms. There are 28 firms working in Web and Graphic Design, 11 firms in Graphic and Industrial Design and only 1 firm in Web and Industrial Design. No firm is working in all the three sectors. 70% of the entrepreneurs in the design sector are male, and around 62% have a professional design education. About 40% of the firms are more than 10 years old. The firm characteristics show a considerable amount of heterogeneity in our sample except in terms of size. Our sample is highly skewed towards micro firms (firms having size smaller than 10). Around 69% of the companies have only CEO working in the company. The details of company characteristics are shown in table 2.

[Table 2 about here]

4.3.2. Exploration in Design Firms

First, the exploration consists of three variables as explained earlier. We use Principal Component Analysis (PCA) technique to reduce the data dimensions and identify small set of variables that account for large part of total variance in the original dataset. In this way, we explain the variance out of most important components from the three variables. From the exploitation perspective, we have just one variable that explains importance of ICT in conducting in-house search.

The three variables on which we perform PCA are:

1) Importance of ICT in maintaining relationship with buyers
2) Importance of ICT in maintaining relationship with suppliers
3) Importance of ICT in maintaining relationship with other designers

The first step in PCA consists of testing whether the variables show sufficient correlation. For this, both the correlation matrix and Bartlett's test of sphericity have been analyzed. The coefficients are Pearson correlation which confirms presence of significance. Bartlett's test of

sphericity is a technique to test the null hypothesis that the correlation matrix is an identity matrix. The test indeed rejects the null at 0.001 which means that it is reasonable to use PCA for data dimension reduction.

For determining the number of components to retain, one of the rules namely “Kaiser’s Rule” suggests to retain PC’s with eigenvalue exceeding unity. This reflects the idea that the PCs should explain more than the variance of one variable. The result of correlation matrix and screeplot are shown in Appendix 2.

4.3.3. Process of Technology Adoption in Dutch Design Firms

The descriptive of the technology usage show that design companies in our sample adopt very basic technologies. Design companies use Scanner (74%) and Social Media (68%) to the greatest extent from information processing and communication technologies respectively. Design companies are also active users of Document Management System and Electronic Agenda.

In the technology adoption hypothesis, our dependent variables are the number of IPTs and CTs adopted. Estimating an outcome variable by Linear Probability Model has several weaknesses because predicted probabilities may take negative values which are inappropriate in case of number of technologies adopted as this variable is always non-negative. Taking a log transformation can also yield biased results because of value zero for a large fraction of observation. In such cases, we can use one of the models of count data i.e., Poisson model. If the outcome variable has a Poisson distribution which is also the case in Count Data, then the conditional maximum likelihood estimator are fully efficient. The use of Poisson model requires a very strict assumption that the variance of outcome is equal to its mean and this assumption can be violated in various applications. A weaker assumption allows the variance-mean ratio to be any positive constant. This assumption is used in Generalized Linear Model (GLM) therefore we can use Poisson GLM model. If the variance-mean ratio is greater than unity, this is the called over-dispersion and if it is less than one, it is termed as under-dispersion. We checked for both IPTs and CTs and find out that variance in both cases is approximately 1 so we can use Poisson GLM for estimation. This method is generally called as General Least Squares (GLM) and the solution is explained in great detail by (Wooldridge, 2000). The descriptive on technology adoption are provided in table 3.

[Table 3 about here]

4.3.4. Innovation Activities

In terms of innovation, 36% of the design companies have introduced radically new designs while 26% of the companies underwent process innovation during last year. The actual number of innovations could be higher because creative sectors perform continuous innovation which cannot be completely accounted for by such companies (Miles & Green, 2008).

4.3.5. Performance Indicators

In terms of net monthly income, 22% of the respondents have no idea or they do not want to provide information on their monthly salary. This may bias our estimates as we can expect firms with very high or low salary levels may be reluctant to provide this information. The highest number of firms (around 23% from our sample) earn between € 1000 - 2000 while 22.11% companies earn between € 2000 - 3000. There are only 2.65% of firms who earn more than € 6000 per month. Most of the companies in our sample incurred a profit over the past 12 months. In terms of number of clients, around 47% of the companies experienced an increase in the number of clients and 12.37% incurred a decrease in the number of clients. Variables on performance are shown in Table 4.

[Table 4 about here]

5. Results

5.1. Relationship between type of ICT adopted and OL (Hypotheses 1A & 1B)

From theory and hypotheses section, we know that organizations conduct learning and search related activities from within itself (Exploitation) and outside the firm boundary such as buyers, suppliers and other designers (Exploration). Firms may consider ICT as important in maintaining relationship with its buyers, suppliers and competitors. Firms may also consider ICT to be important in conducting the exploitative search. We test whether the relative importance of ICT have different implications for adoption of a particular type of technology.

The results from the table 5 give us very interesting findings. The firms which consider ICT to be important for maintaining relationship outside the company boundaries (in our terms, conducting more explorative search) indeed adopt more “CTs”. Using Poisson regression under GLM, the coefficient on the variable obtained through PCA which we refer to “Importance of ICT for exploration” indicates that one unit increase in this variable increases the log count of number of CTs by 0.1322. The coefficient on the variable “Importance of ICT

for exploitation" shows one unit increase in the variable increases the log count of number of IPTs by 0.1468. The coefficients of both variables are positive and significant. Intuitively, the number of IPTs would increase by 1.14 when the firms consider ICT to be important for exploitation and the number of CTs will increase by 1.15 when the firm believes ICT to be important for exploration. This confirms both hypothesis 1A&B suggesting that the firms which consider ICT to be important for exploration adopt more CTs and the ones which consider ICT to be important for exploitation adopt more IPTs.

Further, the CTs are less likely to be adopted by older companies and a one unit increase in the age of the company decreases the log count of number of CTs by 0.0269. Also, firms are less likely to adopt CTs when their owners have founded a firm and in case when the owner has previously founded a company; that decreases the log count of number of technologies by 0.3498. Both variables are significant.

[Table 5 about here]

5.2. Relationship between ICT type and innovation (Hypotheses 2A & 2B)

To estimate the relationship between ICT type and innovation, we use logit model which is the logarithm of the ratio of frequencies of two different categorical and mutually exclusive outcomes such as being innovative or not. We run the logit regressions to investigate how the number of IPTs and CTs affect product and process innovation. The results are given in Table 6. We run two separate logit regressions for product innovation and process innovation as dependent variables. The results show that the number of IPTs is positive and significant for process innovation, whereas the number of CTs is positive and significant for product information. For every one unit increase in number of IPTs, the log odds of the process (versus no process) innovation increases by 0.6248. The number of CTs positively and significantly affects the product innovation. For every one unit change in number of communication technologies, the log odds of the product (versus no product) innovation increases by 0.2739. These findings confirm our support for hypothesis 2A and 2B. Results also suggest that firms with male CEOs tend to carry out more product and process innovations. Having a male CEO, compared to a female CEO in the firm leads to about 94.47% $(\exp(0.63900.6651) - 1 = 0.9447)$ increase in the odds of having product innovation and also doubles $(\exp(1.7016) - 1 = 4.4827)$ the odds of having process innovation.

[Table 6 about here]

5.3. Relationship between ICT type, innovation and firm performance (Hypotheses 3A-I,II, 3B-I-II)

We proxy firm performance by three variables; A) “Increase in the number of clients” as categorical variable (where 3 indicates increase, 2 indicates no change and 1 represents decrease in number of clients), B) “Profitability” as a dummy variable which is 1 has been profitable and 0 otherwise, and C) “Net monthly income” as a categorical variable (Ranging between 1 and 6). We run ordered logit regressions for increase in the number of clients and net monthly income and logit regression for profitability.

5.3.1. Ordered Logit: Dependent variable = Number of clients increase, unchanged or decreased

For ordered logit regression, we use increase, unchanged or decrease in the number of clients to determine the changes in number of clients from higher to lower level. The complimentary organization capital is proxied by ‘maintenance of up-to-date financials’ and superior ‘Human resource practices’. The results of ordered logit regression are shown in Table 7A and indicate that IPT is positive and significant for increase in number of clients. Firms using more number of information technologies have a greater likelihood of higher number of clients which is 0.2. CTs have no impact on increasing number of clients. In terms of organizational practices, companies that keep up-to-date financials have a significant and positive likelihood of achieving greater number of clients which is 0.71. In this way, we find support for 3A-I and but do not find support for 3B-II when we use Number of clients as dependent variables. The results are shown in Table 7A.

When we include product and process innovation in this equation, the IPT remains positive and significant and the magnitude of the coefficient also remains the same. Product innovation affects number of clients positively and significantly by log odds of 0.53. In this case also, keeping up-to-date financials continue to remain positive and significant with log odds of 0.69. Other complementary organizational which is human resource practices in the organization is insignificant in all cases. It is possible that the impact of human resource practices is not visible in micro and small size firms as most of the firms in our study are single owner firms. Therefore again, we find support for hypothesis 3A-I but do not find support for 3A-II using number of clients as dependent variable. The results are shown in Table 7B.

5.3.2. Ordered Logit: Dependent variable = Net monthly Income

For net monthly income as an outcome variable, we use ordered logit model to ascertain the changes in net income from lower to higher level. The results which are shown in Table 7A again confirm that IPTs plays a positive and significant role in predicting net monthly income. For a one unit increase in IPT, the net monthly income increases by 0.36. Company age, gender of the CEO and up-to-date financials all seems to affect net month income positively and significantly product innovation. As we hypothesized, CTs have no affect on Net monthly income of the company. We therefore find support for both 3B-I and 3BII when we use Net monthly income as the dependent variable. The results are shown in Table 7A.

When product and process innovation are added in the equation, neither product nor process innovation matter for net monthly income. The role of IPTs remains positive and significant with a coefficient 0.37. Also in this case, company age, gender and up-to-date financials affects net monthly income positively and significantly and in addition, firms' past experience is also positively significant. We therefore find support partial support for 3B-I and 3B-II. The results are shown in Table 7B.

5.3.3. Logit regression: Dependent variable = Profitability

In this model, the profitability does not seem to be affected by any form of technology or innovation. It seems that we need a more quantitative measure than a qualitative measure like profitability. Hence we do not find support for hypothesis 3C-I and 3C-II. The results are shown in Table 7A & B.

[Table 7A about here]
[Table 7B about here]

6. Summary, Limitations and Recommendations and Conclusion

6.1. Summary

This paper explains process of ICT adoption and its implication in design firms using OL literature. OL literature emphasizes the role of ICT in knowledge management but does not tell enough about how knowledge management affects the adoption of ICT. The study provides new evidence of explaining "what" subjective factors are behind ICT adoption, "what" is the role of ICT in a firm and "how" it affects the firm performance. We use a unique survey data from the Dutch design firms to investigate the relationship between ICT, innovation and firm performance. This survey constitutes 200 firms from overall Netherlands for year 2011. We use five measures of organizational performance i.e., product and

process innovation, profitability, number of clients and monthly income in logit and ordered logit model.

We draw several insightful conclusions from our study. First, small businesses have a larger impact of subjective measures such OL mechanisms on ICT adoption than the previously identified objective variables such as number of employees, CEO's experience, higher level of education and gender which do not play an important role in the ICT adoption decisions of SMEs. Second, in this study, we classify ICTs into two main types; Information Processing Technology (IPTs) and Communication Technology (CTs). We find that the process of ICT adoption is not linear and contingent upon type of technology. Firms which perceive ICT to be important for exploitation adopt more IPTs and the firms which recognize ICT to be important for exploration adopt more CTs. Third, the question as to "how" ICT has an impact on firm performance becomes clearer with the classification of ICTs into their distinct types. IPTs are strongly connected to Process innovation while CTs are significantly related to Product innovation. This is important in the study of innovation as it can be strongly affected by different roles ICT has in the organization. Fourth, an important finding of this study is the strong role of IPTs towards other performance variables such as "Increase in number of clients" and "Net monthly income" of the firms. The CTs however does not provide support for firm performance measures other than "Product innovation". Further, neither IPTs nor CTs are found to support "Profitability" variable. This is in line with the recent work of Zand & van Beers (2010) and Koellinger (2008) which also could not find support for the profitability variable. They explain that profitability is a subjective measure and a quantitative variable is more appropriate to be used. Fifth, the study sheds light on the important mediation role of innovation in the IT value creation process of firm performance. Product Innovation is important in increasing the number of clients as it enables the adopting firm to introduce newer designs thereby increase the clientele base of the companies. Process innovation, however, does not predict any measure of organizational performance and it can serve a complementary role towards Product innovation as pointed out by Beers & Zand (2013). Information technology remains important for increase in the number of clients even after the inclusion of innovation though the coefficient slightly decreases in magnitude. Finally organizational practices such as better accounts managements also seem to positively influence the performance measures of the companies.

6.2. Limitations and Future Research

As stated above, the data used in the study is unique and interesting in various ways, but it does have shortcomings. First, it is more desirable to obtain panel data to observe the causality of ICT on innovation and firm performance. In addition, panel data would enable to

control for unobserved heterogeneity at the firm level. One important implication of using net monthly income as one of the outcome variables might have potential biases as firms in general are sensitive about this form of information. That is why we see that 25% of the firms did not provide information on it and exclusion of this great number of firms from analysis might have possible consequences on the results. Profitability is a subjective measure which can be affected by the aspiration level of respondent. It is possible that the firm which was objectively profitable did not report itself to be profitability and vice versa.

The similar analysis can be done on other sectors with more or less knowledge incentive activities and looking at the results show how knowledge incentive firms are different from less knowledge incentive firms in terms of reaping benefits from ICT. Such an analysis would unravel considerable differences between sectors with regard to how they use ICT and how firms create value from ICT. A more advance classification of ICT would further clarify the link of ICT with firm value. Future research also needs to clarify the complementarities between ICT and certain organizational characteristics and practices. In this respect, synergies between different ICT typologies especially when they are jointly adopted shall be studied as well.

6.3. Recommendations

The paper provides useful insights on how organizational learning mechanism influence ICT adoption and how IT-facilitated OL mechanism enable innovation and superior firm performance. In small firms, the CEO needs to be more aware about the benefits and implications of technology as CEO's role is very eminent in case of small companies in the adoption of technology. Also, differences in roles of technology are important to understand how technology enables innovation and enhance business value. As pointed out by recent literature, some technologies have orthogonal impact to each other (Aral & Weill, 2007). Hence it is very important for the CEO to develop know-how about technology roles. Further, firms that need to capitalize on a particular performance measure need to understand the type of technology and invest accordingly. In addition, the actual performance implications of technology adoption is also contingent upon firm specific factors that influence the ability of a company to successfully transform technology adoption into innovation and other firm performance variables. The study highlights enabling mechanisms for managers to innovate products and processes, and achieving organizational routines which in turn are likely to lead to higher firm performance. It points out that the IT portfolio managers can pick up an ideal suite of technology which caters to the requirements of the company for superior firm performance.

6.4. Conclusion

Although, recent studies have examined the relationship between IT and firm performance, this research stream continues to be hampered by the lack of widely accepted conceptualization of ICT. Organizational learning (OL) is often considered to be important strategic factor behind successful ICT adoption and usage in SMEs but the mechanism through which OL has an impact on ICT adoption is not so clear in the literature. Secondly, literature highlights the importance of classifying ICT into types depending on the roles they perform. For this study, we use insights from OL to investigate the role of Information and Communication Technologies (IPTs and CTs). When certain OL mechanism facilitates particular ICT type, we call them IT-enabled learning mechanisms. Prior research emphasizes to study the impact of IT-enabled learning mechanisms on innovation and superior firm performance. Hence our study gives answer to the questions of how IT-enabled learning mechanisms are created and how do they have an impact on firm performance. We find out that OL is an important factor behind certain types of IT adoption. Secondly, each IT-enabled learning mechanism facilitates a certain innovation type. Thirdly, IT-enabled learning mechanism influences firm performance positively with or without innovation.

Appendix 1

Table 1

	Independent/ Control Variables	
Variable Name	Variable Type	Variable Definition
Importance of ICT for exploration	3 point Likert scale variables	Three questions regarding importance of ICT in maintaining relationship with stakeholders. Q1. Does ICT have any role in maintaining relationship with buyers? Q2. Does ICT have any role in maintaining relationship with suppliers? Q3. Does ICT have any role in maintaining relationship with competitors? After performing PCA, single variable has been obtained
Importance of ICT for exploitation	3 points likert scale variable	Q. Does ICT have any role in storing, retrieving and maintaining information within the company
Log Employees	Continuous	Logged number of employees in the company
Company Age	Continuous	Age of the company in years
Previous Experience	Binary	1 if the owner has founded other design firms in past
CEO Gender	Binary	1 if the CEO is female
CEO higher education	Binary	1 if the CEO has obtained HBO or higher level of education
Keeping up-to-date financials	Binary	1 if the company keeps up-to-date financials
Human resource practices	Binary	1 if the company has valuable human resource practices like work from home,

	Dependent Variables	
Variable Name	Variable Type	Variable Definition
No. of information technologies	Count	Total number of information technologies adopted from fax, scanner, document management system and electronic agenda
No. of communication technologies	Count	Total number of communication technologies adopted from social media, VoIP, and video conferencing.
Product Innovation	Binary	1 if the company has introduced radically new design
Process Innovation	Binary	1 if the company has conducted process innovation
Number of clients increased, decreased or stayed the same	Categorical	1 if the number of clients have decreased, 2 if it stayed the same, 3 if it increased
Profitability	Binary	1 if the company experienced growth in profitability
Net income increased, decreased or stayed the same	Categorical	1 if the net income has decreased, 2 if it stayed the same, 3 it increased

Table 2: Characteristics of Design Companies

Characteristics				
	Yes		**No**	**N**
Active in Web Designing	75		125	200
Active in Graphic Designing	90		110	200
Active in Industrial Designing	75		125	200
	Male		**Female**	**N**
Gender of CEO	140		60	200
	Micro (1-9)		**Small (10-50)**	**N**
Employment Size	193		7	200
	Yes		**No**	**N**
CEO having Professional Education	122		76	198
Company Age	**(0-10) Yrs**	**(11-20) Yrs**	**(20-52) Yrs**	**N**
	120	51	29	200

Table 3: Information and Communication Technology Usage in Dutch Design Companies

Technology Usage	**Yes**	**No**	**N**
Information Processing Technologies			
Scanner Use	144	52	196
Fax	25	169	196
Document Management System	113	83	196
Electronic Agenda	126	70	196
Communication Technologies			
Teleconferencing	57	139	196
Voice over IP	86	110	196
Social Media	134	62	196

Table 4: Performance Indicators of Dutch Design Companies

		Relative Frequency	**N**
Net to Monthly Income			189
	No Idea/ Did not provide information	21.69%	
	<1000	19.05%	
	1000-2000	23.28%	
	2000-3000	20.11%	
	3000-4000	9.52%	
	4000-6000	3.70%	
	>6000	2.65%	
Profit	Has your company been profitable over last 12 months? Yes	77.54%	187
No. of clients com: Comparison last financial year with the year before:	Increased	46.91%	194
	Decreased	12.37%	
	Stayed the same	36.08%	
	No Idea	4.64	
No. of employees com: Comparison last financial year with the year before:	Increased	6.52%	184
	Decreased	3.25%	
	Stayed the same	90.22%	

Table 5: Poisson GLM estimates of technology adoption

Organizational Learning and Adoption of Technologies		
var1 & var2 obtained through PCA	***Using GLM***	***Using GLM***
	# Information Technology	**# Communication Technology**
Importance of ICT for exploration	0.0272 (0.0474)	0.1322** (0.0561)
Importance of ICT for exploitation	0.1468* (0.0776)	0.1299 (0.0939)
Log (No. of employees)	0.1117 (0.705)	0.1421 (0.0913)
Company Age	-0.0002 (0.0059)	-0.0298*** (0.0086)
Previous Design Firms Founded	-0.1880 (0.1457)	-0.3498* (0.1856)
CEO Gender	0.0960 (0.1190)	-0.0204 (0.1402)
CEO Higher Education	0.0499 (0.1276)	0.0470 (0.1589)
Constant	0.4272** (0.1764)	0.4671** (0.2063)
Sector Controls	Yes	Yes
N	189	189

****: coefficient is significant at 0.01 level; **: coefficient is significant at 0.05 level, and *: Coefficient is significant at 0.1 level.*

Table 6: Relationship between ICT and Innovation

ICT and Innovation		
	Product Innovation (Using Logit)	***Process Innovation (Using Logit)***
No. Information Technologies	0.1659 (0.1774)	0.6248*** (0.2191)
No. Communication Technologies	0.2739* (0.1644)	-0.0017 (0.1777)
Log(No. of employees)	0.0917 (0.2400)	-0.0361 (0.2701)
Company Age	-0.0023 (0.0189)	-0.0463* (0.0237)
Previous Firms Founded	0.3456 (0.4333)	-0.3066 (0.5154)
CEO Gender	0.6651* (0.3817)	1.0716** (0.4531)
CEO Higher Education	-0.3858 (0.4009)	-0.0293 (0.4376)
Constant	-2.1988*** (0.6798)	-2.8638*** (0.7985)
Sector Controls	Yes	Yes
N	189	189
Prob>Ch2	0	0
Log likelihood	-115.96	-98.54

****: coefficient is significant at 0.01 level; **: coefficient is significant at 0.05 level, and *: Coefficient is significant at 0.1 level.*

Table 7A: Relationship between ICT and Firm Performance- I

ICT and Firm Performance - I			
	No. of Clients ***(Using Ordered Logit)***	***Profit*** ***(Using Logit)***	***Net Monthly Income*** ***(Using Ordered Logit)***
No. of Information Technologies	0.2885* (0.1653)	0.2769 (0.2216)	0.3599** (0.1789)
No. of Communication Technologies	-0.0577 (0.1478)	-0.1134 (0.1928)	0.0885 (0.1571)
Log(No. of employees)	0.3017 (0.3478)	0.7198 (0.5595)	-0.1392 (0.4126)
Company Age	-0.0524*** (0.0175)	-0.0050 (0.0241)	0.0662*** (0.0212)
GEO Gender	-0.3855 (0.3405)	0.2758 (0.4265)	1.1321*** (0.3881)
CEO Higher Education	-0.0929 (0.3641)	0.5363 (0.4566)	-0.0097 (0.4182)
No. Previous Design Firms	-0.2307 (0.3858)	-0.1477 (0.5264)	0.8276* (0.4458)
Keeping up-to-date financials	0.7197** (0.3060)	1.0558*** (0.3719)	0.9616*** (0.3530)
Human Resource Practices	-0.1264 (0.1801)	-0.2035 (0.2591)	0.2124 (0.2106)
Sector Controls	Yes	Yes	Yes
Constant	-	-1.8773** (0.9308)	-
N	183	176	140
Prob>Ch2	0	0	0
Log likelihood	-195.75	-87.49	-197.67

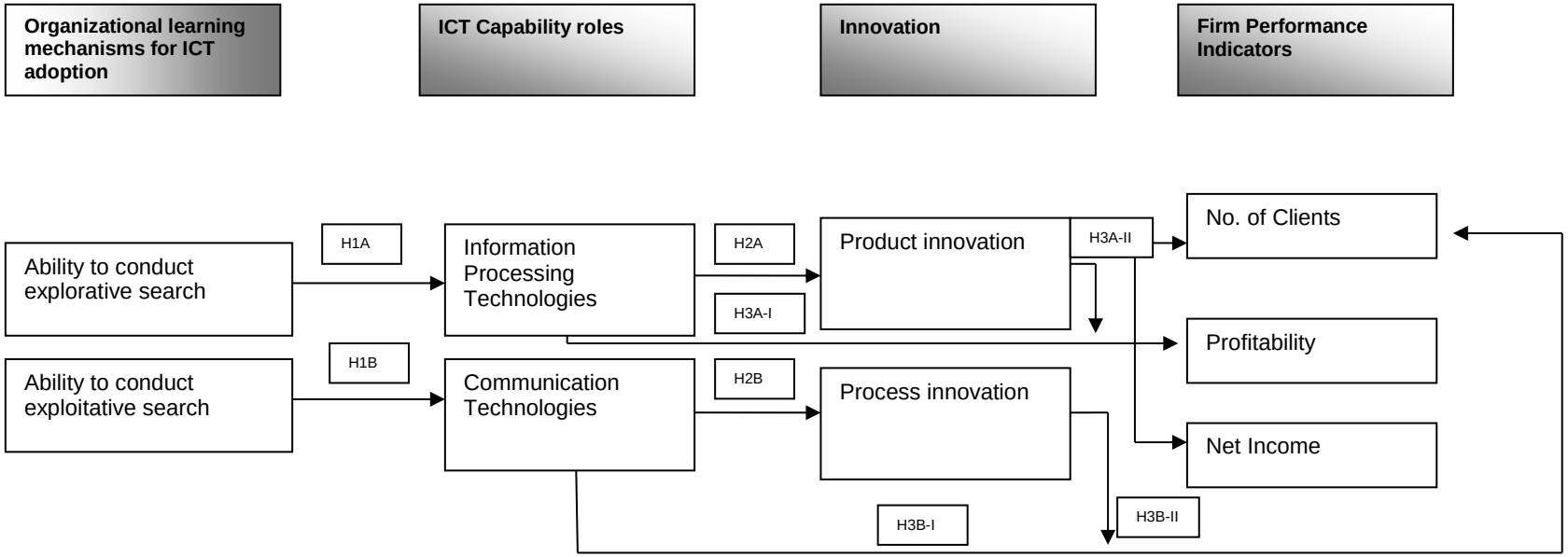
****: coefficient is significant at 0.01 level; **: coefficient is significant at 0.05 level, and *: Coefficient is significant at 0.1 level.*

Table 7B: Relationship between ICT, Innovation and Firm Performance

ICT, Innovation and Firm Performance			
	No. of Clients (Using Ordered Logit)	***Profit (Using Logit)***	***Net Monthly Income (Using Ordered Logit)***
Product Innovation	0.5328* (0.3127)	0.2779 (0.4250)	0.2020 (0.3386)
Process Innovation	-0.1170 (0.3482)	0.1746 (0.4703)	-0.1603 (0.3655)
No. of Information Technologies	0.2785* (0.1676)	0.2446 (0.2271)	0.3709** (0.1848)
No. of Communication Technologies	-0.0731 (0.1486)	-0.1179 (0.1927)	0.0714 (0.1587)
Log(No. of employees)	0.2373 (0.3546)	0.7342 (0.5631)	-0.1998 (0.4191)
Company Age	-0.0516*** (0.0175)	-0.0030 (0.0243)	0.0649*** (0.0215)
GEO Gender	-0.4446 (0.3491)	0.2197 (0.4347)	1.1757*** (0.4044)
CEO Higher Education	-0.0992 (0.3659)	0.5518 (.4588)	0.0030 (0.4189)
No. Previous Design Firms	-0.3116 (0.3908)	-0.1765 (0.5291)	0.7898*** (0.4482)
Keeping up-to-date financials	0.6909** (0.3099)	1.0119*** (0.3776)	0.9548*** (0.3583)
Human Resource Practices	-0.1005 (0.1860)	-0.2221 (0.2642)	0.2362 (0.2130)
Sector Controls	Yes	Yes	Yes
Constant	-	-1.8670*** (0.9358)	-
N	183	176	140
Prob>Ch2	0	0.1	0
Log likelihood	-194.19	-87.22	-197.38

****: coefficient is significant at 0.01 level; **: coefficient is significant at 0.05 level, and *: Coefficient is significant at 0.1 level.*

Figure 1: Explaining the role of ICT in Information Processing and thereby creating value for the organization.



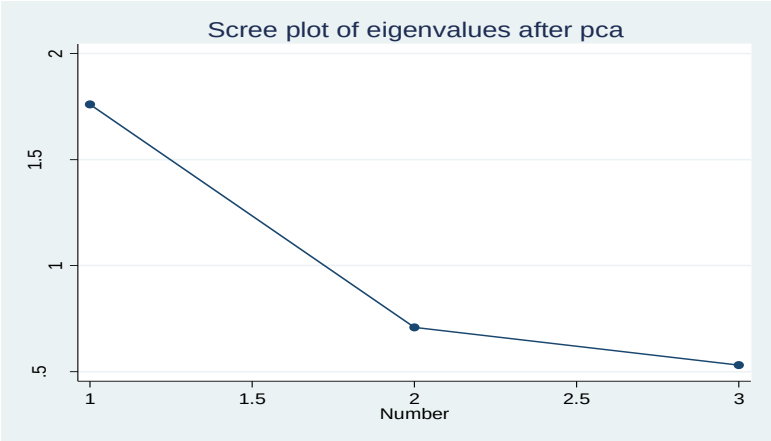
Appendix 2

Table A.2.1. Correlation Matrix for Importance of ICT

	ICT Client	ICT Supplier	ICT Other Designer
ICT Client	1.000		
ICT Supplier	0.3521***	1.000	
ICT Other Designer	0.4662***	0.3155***	1.000

*** *Significance at the 0.001 level*

Figure A.2.1. Screeplot of eigenvalues after PCA



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