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The impact of lead users on innovation success

The mediating impact of knowledge sharing case of IT companies

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Abstract

Purpose – The purpose of this paper is to study the impact of lead users (LUs) on innovation success by proposing and validating an integrative model that links LUs, innovation success and knowledge sharing (KS) variables.

Design/methodology/approach – The authors research is quantitative in nature and data were collected through a survey conducted among 30 information technology Tunisian companies. The authors preliminary analysis was explored using the "SPSS" software and processed through exploratory factor analysis and regression analysis methods.

Findings – Results showed that LUs who possess advanced skills and valuable knowledge can contribute to enhance new successful innovations, and hence, enable companies to gain short and long-term profits. Besides, the authors confirmed that the impact of LUs on innovation success is mediated by the "KS" behavior.

Practical implications – An integrative framework that links LUs, innovation success and a third variable called KS is presented to see beyond the intended importance of this type of user regarding the development of new innovations.

Originality/value – The paper offers new insights to the topic of LUs by emphasizing the role of "KS" variable in strengthening the LUs – innovation success relationship.

Keywords Knowledge sharing, Lead users, Innovation success, IT companies

Paper type Research paper

1. Introduction

It is being realized that changing business environments are characterized by intensive competition and dynamic customers' needs, which requires an imperative need to innovate.

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Yet, companies faced big failures to achieve expected benefits from innovations that they follow and this is mainly because of the set of procedures and strategies adopted in the implementation's stage of innovation (Klein & Knight, 2005).

Since 1997, empirical studies revealed a new products' failure rate of 40 per cent (Castellion & Markham, 2013), out of the products that survive, only a few become widely accepted (Utterback, 1994) and only one out of every five projects ever initiated is viable (Van der Panne et al., 2003). Hence, the challenge faced by firms is "how to keep innovations alive" to sustain a competitive advantage.

At first, companies adopted the "open innovation" concept, which is described as:

> [...] a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model (West, Salter, Vanhaverbeke, & Chesbrough, 2014, p. 806).

Moreover, the use of internal sources of knowledge and skills to generate new ideas. However, both strategies did not offer satisfactory improvements for companies to innovate. Besides, it was found that companies need to involve external parties with innovative sets of knowledge and skills to cope with the challenge they face.

As an example of external sources of innovation, empirical research studies evoked the "lead user (LU)" concept. It was introduced by Von Hippel (1986) and has attracted a lot of attention from scholars. LUs are defined as consumers of a product or service who face needs unknown to other members of the marketplace and benefit significantly by acquiring solutions to those needs (Tuarob & Tucker, 2015).

The LU method was introduced and successfully tested in companies such as 3M, Johnson & Johnson and Hilti (Lüthje & Herstatt, 2004). It was approved that the intervention of this category of users can minimize the new products' failure rate (Enkel, Perez-Freije, & Gassmann, 2005), especially as up to 90 per cent of new product launches fail (Reichwald, Meyer, Engelmann, & Walcher, 2007).

Through this paper, we aim to study the impact of LUs on innovation success using a conceptual model based on the synergies between LUs and innovation success. We adopted "knowledge sharing (KS)" as a mediating variable that affects the relationship between the "LUs" and "innovation success" variables.

We will start by developing a literature review using previous empirical research studies. Then, we will propose our conceptual model with its hypotheses. Finally, a practical part to test the hypothesis and validate the model will be presented.

Unlike previous articles that dealt with both successful innovation and LU issues and characterized by the exploratory qualitative aspect, our paper is quantitative in nature using a survey on innovation success that will be conducted among 30 information technology (IT) companies in Tunisia.

Besides, while previous research studies focused on LUs "identification and their involvement into industrial and consumer markets for new products, processes and services development" (Lilien, Morrison, Searls, Sonnack, & Hippel, 2002; Von Hippel, 1986), our paper will differently contribute in dealing with the LUs issue by exploring how such specific users could affect the generation of successful innovations.

Our paper is organized as follows: Section 2 presents the literature review, Section 3 describes the conceptual framework and related hypothesis. Section 4 describes the methodological procedures. Section 5 discusses the measurement scales of the model variables. Section 6 describes data analysis techniques. Section 7 reports our experimental results, and Section 8 discusses multiple regression analysis, followed by findings in Section 9. Finally, Section 10 concludes the results.

2. Literature review

2.1 Lead user theory

2.1.1 Definition and characteristics. LUs are defined by Von Hippel (1988, p. 107) as: "users who face needs earlier than the bulk of the market place encounters them and will benefit significantly by obtaining a solution for those needs."

The LU method is perceived as one of the most persuasive approaches that boost the development of new ideas and concepts for the generation of new products with high commercial attractiveness (Kratzer, Lettl, Franke, & Gloor, 2016). Because they often help to find solutions to some specific problems and enable firms to better improve their new product development activities (Lilien et al., 2002).

LUs display two characteristics with respect to it:

> They face needs that will be general in a marketplace – but face them months or years before the bulk of that marketplace encounters them, and
>
> They expect to benefit significantly by obtaining a solution to those needs
>
> (Von Hippel, 1986, p. 796).

Unlike other users who are not able to identify new product attributes (Von Hippel, 1988), LUs can forecast future tendencies because of their real-world experience (Churchill et al., 2009), as well as their focus on new requirements rather than on existing products (Lilien et al., 2002).

According to Hienerth, Lettl, & Keinz (2014), these types of users have expressed the ability to develop new solutions with high commercial attractiveness (Hienerth et al., 2014).

LUs' innovative activities have been linked to their two main characteristics: first, LUs face certain needs months or even years earlier than the mass market (trend leadership). Second, LUs gain high benefits from a solution to their needs and are, therefore, highly motivated to contribute in innovative activities (high expected benefit) (Hienerth et al., 2014).

2.1.2 Types and process. Churchill et al. (2009) proposed four different types of LUs:

(1) *LUs in the target application and market:* they are experts relative trends detected in the target market (Churchill et al., 2009).

(2) *LUs of similar applications in advanced analog markets:* they are concentrated in more demanding but related markets and they can be identified in analogous user groups, and in areas with high potential benefits for users (Von Hippel, 1986).

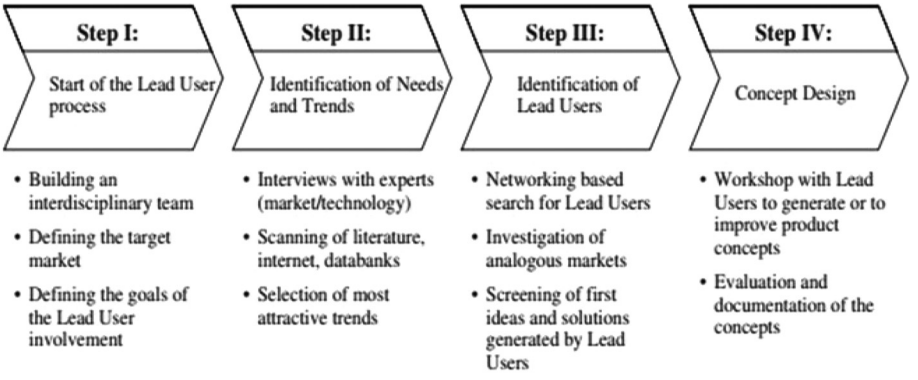
(3) *LUs with respect to important attributes of problems faced by users in the target market:* they are users at a leading-edge with respect to relevant attributes of needs and requirements encountered. However, they could be experts in only a small domain relative to the target application (Churchill et al., 2009).

(4) *Opinion leadership:* those who have a prominent leading edge status (LES) that characterizes them by "opinion leaders" who enhance the development of new products and participate in the product marketing step (Schreier, Oberhauser, & Prügl, 2007).

Lüthje & Herstatt (2004) proposed an appropriate visualization of the LUs approach that includes four specific steps as follows (Figure 1):

(1) Start of the LU process;

(2) Identification of needs and trends;



Source: Lüthje and Herstatt (2004)

Figure 1.
Four-step process of the LU method

(3) Identification of LUs; and

(4) Concept design.

The first step focuses on building the interdisciplinary LU identification team based on resources questions such as the time availability and the adequateness and usefulness for the search in the given context (Lüthje & Herstatt, 2004).

In this context, general constraints such as budgets and development times are identified and an interdisciplinary team with experienced employees from marketing, R&D and manufacturing is composed (Hienerth et al., 2014).

In the second step, needs and trends are identified relative to technological or market changes in the search field or to more general economic, legal and social developments through interviews with experts, searches on the internet, in databanks, etc (Lüthje & Herstatt, 2004).

It is important to identify needs and trends because they present the basis for the generation of new potential one and describe general and long-term developments (Hienerth et al., 2014).

The third step of the process is to explore the indicators that will allow for the identification of a LU (Lüthje & Herstatt, 2004).

To identify LUs, the team first develops a set of attributes that distinguish LUs from ordinary users. The set of attributes combines LU characteristics and the trends and needs explored in the previous step (Hienerth et al., 2014).

The fourth step is associated with LUs' involvement. This phase deals with the identification of the best methods of using LUs' knowledge (arranging workshops, continuous interviews) (Lüthje & Herstatt, 2004).

After these workshops or interviews are made, the final results are oriented to decision-makers and managers. If any evaluation is required, the standard development and examination process of the company is applied (Hienerth et al., 2014) (Table I).

2.1.3 Lead users' identification

2.1.4 Criticism of the lead users' method. The limitations of the LU approach are associated with its high potential risk, which implies that LUs cannot be identified or no trend can be determined or making confusion between LUs and other users so that some wrong persons

Models	Definition
Von Hippel (1988) mode	1. Specify LU indicator (trends and expected benefits identification) 2. Identify LU group 3. Develop LU product concept 4. Test whether LU concept appeals to typical users Von Hippel (1988)
Netnography (1990)	It is a Web-based systematic approach that links two components, internet and ethnography to systematically examine online communities. Pajo, Verhaegen, Vandevenne, & Duflou (2015a, 2015b)
Von Hippel techniques: screening, pyramiding, broadcasting and content analysis (2005)	1. Screening: a quantitative and qualitative technique based on written and online questionnaires and telephone interviews 2. Pyramiding: some referrals create a network by referring to someone between them in appropriateness 3. Broadcasting: To transmit a specific problem to an online community to find successful problem solvers 4. Content analysis: an effective search and analysis process to identify LUs in analogous and target markets Von Hippel (2005)
The virtual stock market approach (2009)	The use of virtual stock markets by creating a group of participants via the internet and asking them to trade shares of virtual stocks. Spann, Ernst, Skiera & Soll (2009)
A model based on computing competencies (2010)	Customer competence can be used as an indicator to measure LUs because they have higher competencies than common users In this model, the major dimensions for identifying LUs are innovation, cooperation, communication and knowledge. He and Yu (2010)
Mountaineering (2013)	An opportunistic identification strategy that uses different search forms simultaneously. The research process involves a variation of individual methods such as screening and pyramiding. Mäkinen et al. (2013)
Fast lead users' identification (2015)	A semi-automated approach that uses data mining techniques to systematically identify LU on social networking sites. Pajo et al. (2015a, 2015b)

Table I.
Models of LUs identification

can be treated as LUs. In addition, the LU approach faces the challenge of fairness with respect to the resulting intellectual property rights (Hienerth et al., 2014).

2.2 Innovation

2.2.1 Definition. One of the initial challenges faced by researchers is defining exactly what innovation is. According to Read (2000), there is no common clarified definition of the term "innovation." However, common to all definitions, innovation is perceived as "something new or novel" (Bechina Arnzten & Voransachai, 2008; Read, 2000).

Based on all definitions presented in previous empirical studies, we define "innovation" as following:

> Innovation is the development of new products, services or processes and the creation of novel ideas, behaviors or knowledge to benefit both organizations and stakeholders and to facilitate new business outcomes.

It comprises a range of types including new product or service, new process technology, new organization structure or administrative systems or new plans or programs pertaining to organization members.

2.2.2 Dimensions. According to Gopalakrishnan and Damanpour (1997), innovation has three dimensions as follows: the types of innovation, the stages of innovation and the level of analysis (Table II).

Types	Stages	Level of analysis
Product innovation (the development of a new or improved good or service with respect to its characteristics) versus *service innovation* (one or more improved service functions that are new to the firm) Utterback and Abernathy (1975) *Product/service innovation* (new products or services ready to be sold) versus *process innovation* (the application of a new production method that boosts products or services development). Edquist and Hommen (1998) *Technical (technological) innovation* activities related to the operating component and affect the technical system of an organization) versus *administrative (organizational) innovation* (activities relative to the administrative component and affect the social system of an organization). Damanpour, Szabat, and Evan (1989) *Component innovation* (one or more modular modifications within a larger system that remains intact) versus *architectural innovation* (the modification of the overall system design) Hellstrom (2007) *Radical innovation* (implies destroying the existing process and replacing it with something completely new) versus *incremental innovation* (small modifications in a product to improve its performance) Norman and Verganti (2014)	*The generation of innovation:* a process of idea creation, problem solving and decision-making relative to new products/ processes development *The adoption of innovation:* a process of organizational change, which directly affects the technical and social systems of an organization. Gopalakrishnan and Damanpour (1997)	*Industry level of analysis:* follows either an extra-industry focus that deals with the relative differences in innovation development patterns and innovation magnitude among industries or an intra-industry focus that deals with the relative differences in the timing of innovation adoption and the innovation's implications for organizational performance *Organizational level of analysis:* explores contextual, structural and behavioral characteristics that distinguish innovative from non-innovative organizations *Subunit level of analysis* evaluates departmental phenomena that are associated with innovation *Innovation level of analysis:* Detects innovation characteristics, such as cost, relative advantage, complexity and radicalness that affect the rate of diffusion of innovation within an industry. Gopalakrishnan and Damanpour (1997)

Table II. Innovation dimensions

2.2.3 Process. The innovation process can be broadly divided into four major stages:

(1) *Creation of a new idea:* in this stage, new ideas are created based on strategies and conditions that guarantee the generation of valued benefits (Ruggles & Little, 1997).

(2) *Development of idea generated*: in this stage, ideas can be either supported or rejected by the company through "the idea portfolio management," which is the process developing and sustaining a strong portfolio of ideas that contributes to business improvements (Ruggles & Little, 1997).

(3) *Implementation of new idea generated*: in this stage, new ideas can be implemented either internally in a market where value is expressed through better operations, higher efficiencies, improved quality or increased profitability or externally where value can be measured by market penetration, number of units sold, copycat competitor products (Ruggles & Little, 1997).

(4) *Diffusion of innovation:* the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 1995).

Thousands of papers have been written and many thousands of projects carried out on the basis of the innovation diffusion theory. However, many scholars revealed some limitations of this theory (Lyytinen & Damsgaard, 2001; Giacomini Filho, Estevão Goulart, & Pegurer Caprino, 2007 and Wani & Ali, 2015).

According to Wani & Ali (2015), the first criticism is that the theory was more agrarian in approach, as it originated from agricultural fields and was difficult to be applied for innovations of other sectors. Second, the adoption pattern varied and the rate of adoption differed and sometimes practitioners expressed negative attitudes about good innovations. Third, some problems turned around the static nature of categories of adopters, as anyone can be an innovator if innovations are associated with organizations targeted for adoption (Downs & Mohr, 1976).

Lyytinen & Damsgaard (2001) discovered that innovation did not necessarily meet all different stages of adoption for an individual to adopt it. Sometimes adoptions took place in dyadic relationships and it became difficult to identify the stages of adoption. It was found that some of the laggards defined in the theory were more visionary than the innovators (Lyytinen & Damsgaard, 2001).

Diffusion was perceived to be difficult to quantify due to the complexity of human and human networks (Damanpour, 1996). In addition, this theory can never account for all variables, and therefore, might neglect critical predictors of adoption. This variety of variables has also led to inconsistent results in research, reducing the heuristic value (Mohr, 1976).

Feedback: it tends to evaluate outputs and maintain performance (Ruggles & Little, 1997).

2.2.4 Models. In the early 1990s, Rothwell (1992) proposed five generations of innovation models as follows:

(1) *Technology push (1G):* deals with innovation as a simple, linear and sequential process with considerable focus on R&D. Relatively, the market is related to R&D activities (Rothwell, 1992).

(2) *Market pull (2G):* considers the innovation process as simple, linear and sequential with a focus on the market (Rothwell, 1992).

(3) *Coupling of R&D and marketing (3G):* innovation is perceived as an area where both R&D and marketing are coupled through structured innovation processes (Rothwell, 1992).

(4) *Integrated business processes (4G):* focus on the role of feedback and the learning with customers and suppliers (Rothwell, 1992).

(5) *System integration and networking (5G):* companies focused on systems integration and networking to gain flexibility and speed of development (Rothwell, 1992).

2.2.5 The open innovation concept.

> Open Innovation means that valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well (Chesbrough, 2003, p. 43).

Laursen & Salter (2006) argued that an "open innovation" approach tends to involve external parties and support them to develop innovation (Laursen & Salter, 2006).

Most recently, the definition of open innovation was extended as follows:

> [. . .] a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model (Chesbrough & Bogers, 2014, p. 17).

Open innovation offers rich opportunities for novel, fundamental discoveries, including empirical and theoretical developments and corporate experiments in openness (West et al., 2014).

Enkel, Gassmann and Chesbrough (2009) argued that three core processes can be differentiated in open innovation. These are:

(1) *The outside-in process:* this process integrates suppliers, customers and external knowledge sources to improve the firm's knowledge base and enhance its innovativeness (Gassmann & Enkel, 2004).

(2) *The inside-out process:* this process focuses on exporting ideas to the outside environment to make profits (Gassmann & Enkel, 2004).

(3) *The coupled process:* this process includes coupling the outside-in and inside-out processes by working in alliances with complementary partners (Gassmann & Enkel, 2004).

2.3 Knowledge sharing

2.3.1 Definition. One of the most important steps in knowledge management (KM) is to spread and make knowledge accessible within and between an organization member (Paulin & Suneson, 2015). As it was realized that KS is a critical factor that enhances knowledge creation, organizational learning and performance achievement (Bartol & Srivastava, 2002).

Ipe (2003, p. 341) defined KS as "the process by which knowledge held by an individual is converted into a form that can be understood, absorbed and used by other individuals."

2.3.2 Factors that influence knowledge sharing. Based on research studies related to KS, the major factors that influence KS between organizations' members are the nature of knowledge, motivation to share, opportunities to share and the culture of the work environment (Ipe, 2003).

2.3.2.1 Nature of knowledge. Wang, Noem and Wang (2014) define knowledge as information obtained by individuals, including ideas, facts, expertise, and judgments

relevant for the individual, team and organizational performance. They conduct that knowledge exists in both tacit and explicit types and determine that KS provides other employees with explicit knowledge (such as formulas, processes and routines) and tacit knowledge (sharing experiences and know-how) to enhance individuals accomplish goals, collaborate with others to find solutions, create new ideas or implement policies or procedures (Wang et al., 2014).

Compared to explicit knowledge, which is codified and can be easily communicated and transferred. Tacit knowledge is implicit, hard-to-conceptualize and subjective (Schoenherr, Griffith & Chandra, 2014).

2.3.2.2 Motivation to share. According to Ipe (2003), only people with strong personal motivation are likely to share knowledge. Those people express some motivational factors that can be divided into internal factors (the perceived power attached to the knowledge and the reciprocity that results from sharing) and external factors (the relationship with the recipient and rewards for sharing).

2.3.2.3 Opportunities to share. They can be both formal, which include training programs, structured work teams and technology-based systems and informal, which include personal relationships and social networks (Ipe, 2003).

2.3.2.4 Culture of the work environment. Culture is represented by the values, norms and practices of the organization, where values are expressed in norms that, in turn, form specific practices (Ipe, 2003).

3. The conceptual framework and related hypotheses

Based on both knowledge and user participation mainly LUs involvement repositories, we realize that companies can ensure the generation of successful innovations by using both KS and LU attributes.

Consequently, we ground our model development in the KS and LUs theories because these theories are complementary to affecting firm's innovation success.

Unlike previous research studies, which studied the effects of isolated variables with less attention paid to the integrative effects that these variables could have when jointed together, this paper focuses on the interplay between LUs, KS and innovation success variables.

Based on previous models presented in empirical studies, we found that:

- KS has a positive impact on innovation success (Madhoushi, Sadati, Delavari, Mehdivand, & Mihandost, 2011; Mei & Nie, 2007; Wang & Wang, 2012);
- the user's involvement mainly LUs affects positively successful innovations' generation (Hau & Kang, 2016); and
- according to Ashok, Narula and Martinez-Noya (2016), it was approved that investments in KM mediate the relationship between user collaboration and process innovation.

Consequently, we assume that KS mediates the relationship between LUs and innovation success.

We present our research model based on the LUs variable, which presented in terms of the lead userness ("being ahead of the market" and "having high benefits from innovation") construct, the KS variable and the innovation success variable.

Next, we develop our hypotheses associated with arguments that discuss the individual effects of the variables, and the role of the interaction effect of "mediator."

3.1 The impact of lead userness on innovation success

Compared to typical users with common interest in existing products only, LUs contribute effectively upon creating novel innovations. Hence, LUs play a powerful role in generating innovative ideas and new products and services through the lead userness, which determines the LUs two distinct characteristics:

(1) being ahead of the market trend; and

(2) high benefits from innovation (Hau & Kang, 2016).

Being ahead of the market trend implies that LUs face needs earlier related to a certain problem and high benefits from innovation mean that LUs expect relatively high benefits from obtaining solutions for their needs, which provides them with sufficient motivation to innovate (Hang & Kau, 2016).

LU theory implies that the more leading-edge users who are ahead of market trends and expect significant benefits from innovations are involved, the more commercially attractive products and successful innovations are created. Typically, LUs are characterized by great expertise and usage experience, and they possess personality traits such as a high locus of control and strong innovativeness. These characteristics enable them to detect their needs and problems and to develop effective solutions to those needs (Mahr & Lievens, 2012).

Franke, Von Hippel & Schreier (2006) tested the following hypothesis: "the higher the intensity of lead – user characteristics displayed by a user the greater the likelihood that the respective user yields commercially attractive innovations" and the study confirmed it.

We adopted our first hypothesis from Franke et al. (2006) research and suggested that lead userness is positively related to innovation success.

H1. Lead userness has a direct positive impact on innovation success.

3.2 The impact of lead userness on knowledge sharing

LUs, because of their characteristics, are perceived as knowledge contributors to the community through exploring their KS behavior to the other community's members (Jeppesen & Laursen, 2009).

Mahr and Lievens (2012) perceived LUs as generators of great knowledge obtained from two sources as follows: "usage experience" related to products' consumption and "product environment-related knowledge" that results from various sources such as general know-how about the product's structural design, technologies used in existing products or general market trends (Mahr & Lievens, 2012).

According to Jeppesen and Laursen (2009), LU characteristics relate positively to making contributions to the community by sharing their knowledge base. Hence, LUs are considered as key agents in the KS process (Jeppesen & Laursen, 2009).

Unlike most scholars who considered the two characteristics "being ahead of the market trend" and "the high benefits from innovation" as independent dimensions in the "lead userness" construct, Hau and Kang (2016) used lead userness as a formative construct composed of the being ahead of the market trend and the high benefits from innovation in the research model and hypothesized lead userness to be positively related to innovation-related KS in the online user community. The hypothesis was approved (Hang & Kau, 2016).

Accordingly, we hypothesize:

H2. Lead userness is positively and directly related to KS.

3.3 The impact of knowledge sharing on innovation success

Firms need to search for important criteria that ensure innovation success. One of these factors is knowledge, as knowledge created, transferred and shared among the organization's members is the main source for innovation (Yeşil, Koska & Büyükbeşe, 2013).

In many studies, KS is perceived as a crucial factor in enhancing innovation capability and firms' performance (Yeşil et al., 2013). As it was approved that sharing knowledge with respect to three main conditions: mutuality, trust and respect will contribute to higher performance and increasing profits (Wang & Hu, 2017).

According to Liao, Fei and Chen (2007), KS tends to boost knowledge exchange and development in the organization to gain competitive advantages (Liao et al., 2007) and creates opportunities to generate solutions and efficiencies that add value to a successful innovation project (Wang & Hu, 2017).

According to Yeşil et al. (2013), KS is regarded as a major factor in improving the innovation capability and performance of the firms. We build our third hypothesis on the basis of Yeşil et al. (2013) research and we formalize this argument in the following hypothesis:

H3. KS has a direct and positive impact on innovation success.

3.4 The mediating effect of knowledge sharing

It was confirmed that firms, which involve LUs in their innovative processes are capable to guarantee their performance because of the knowledge gained from these users and shared among all its members.

Specifically, we suggest that KS, once extracted from LUs and exchanged between the rests of the community, helps to extract benefits from LUs for innovation success, as:

> [. . .] knowledge sharing behavior of lead users is evident as such users – when connected – may provide needed know-how and task information; thus sustaining the level of knowledge supply in the community (Jeppesen & Laursen, 2009, p. 2).

However, previous empirical studies did not consider the "knowledge" behavior as an intermediate factor affecting the impact of LUs on innovation success. This is a reason to make assumptions on how could KS be a mediator variable that explains the relationship between LUs and innovation success variables.

Based on the research of Ashok et al. (2016), which analyzes how user collaboration and investments in KM practices influence the outputs of process innovation, we tried to build our fourth hypothesis.

We adapted the hypothesis proposed by Ashok et al. (2016) to our paper context and we suggest that KS (investments in KM) may serve as a mediator between LUs (user collaboration) and innovation success (process innovation) (Figure 2).

H4. KS mediates the lead userness–innovation success relationship.

Accordingly, we suggest the following model for our research:

4. Methodological procedures

4.1 Research approach

The study uses a quantitative approach to answer the research questions and hypotheses and to reach a better understanding of the importance of LUs as a key success factor in innovation development.

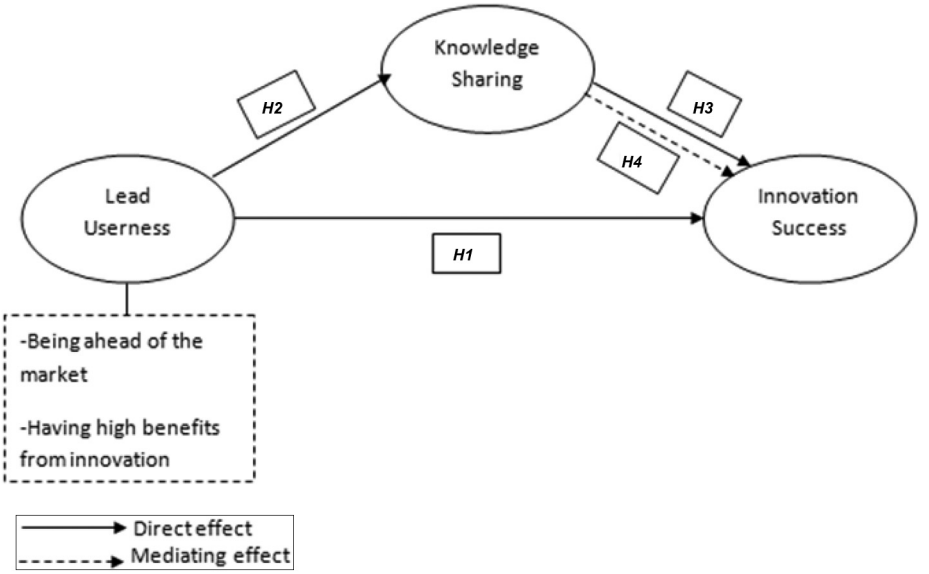


Figure 2.
The conceptual model

4.2 Research method

We selected a quantitative research method to reach a better understanding of the importance of lead uses as a key success factor in innovation development. It implemented hypothesis testing to collect data that signified a relationship between dependent and independent variables.

We conducted our research in the IT sector. The reason behind the selection of "IT" as our target activity sector came after a deep investigation on different Tunisian economy sectors and discovering that the majority of those sectors as the banking one, for example, do not consider LUs as a strategic tool for their organizational improvement.

The study is directed strictly to Tunisian companies. We defined the boundary of study by our desired theories including "LU," "innovation" and "KS."

To test the theoretical model and the related hypotheses, we designed a survey on the basis of a comprehensive literature review to identify a set of items that ensured content validity.

The aim of the survey was to determine all patterns that will meet the research's objectives.

4.3 Data collection technique

We used an online questionnaire to gather direct data. It was created using "Google Forms" platform and was written in English and translated into French.

Due to time and geographic issues, scheduling meetings with employees was challenging. By developing an online questionnaire, we approached different companies in an alternative way, covering the three main discussed concepts through the questions included there.

The survey was initiated and launched online using "LinkedIn" platform for better access by us and the respondents, better engagement and higher quality responses.

We started by sending the digital version by e-mail to all the companies that make up our sample, then we proceeded to phone calls to confirm the survey reception and to solicit answers.

4.4 Sample description

The population of our survey is made up of Tunisian companies. This study analyzes data at the firm level and the sample includes mid-size IT companies.

On the basis of the data provided by the survey, we have drawn up a sample composed of 30 companies, almost companies has a number of employees equal to or less than 50.

Moreover, our respondents are selected by considering different job titles, among them, we cite: chief executive officer, network consultants, web developers, IT managers and IT specialist [. . .].

This study analyzes data at the firm level. The sample includes mid-size IT companies.

By selecting a sample to be studied rather than attempting to study the entire population of all IT companies available in Tunisia, we avoid interpretations and analysis of huge amounts of data. Hence, we can accomplish this research within time constraints.

Table III summarizes the firm activity sector and size (based on employees).

5. Measurement scales of the model variables

5.1 Lead userness measurement scale

Lilien, Morrison, Searls, Sonnack, & Hippel (2002) proposed the LES construct, which contains four types of measures: the first two, benefits recognized early and high benefits expected, represent the two elements of the original LU definition. The third represents direct elicitation of the overall construct (both self-reports and from third parties). The fourth set represents measures of innovative activities that have been hypothesized to be associated with benefits recognized early and high benefits expected (Morrison, Roberts, & Von Hippel, 2000) (Table IV).

The scale was characterized by unidimensionality and the measurement model for the LES construct was regarded as highly reliable (alpha of 0.83) (Morisson et al., 2002).

We adapted and modified the measure regarding our research' requirements as following:

- Item 1: We are usually ahead of other companies in recognizing and planning new solutions.

Activity sector	Firm size (No. of employees)
Consulting, audit and computer engineering (30%)	
Development of programming, operating and management software's (36.7%)	<50 (69%)
Installation and maintenance of computer networks (10%)	
Internet/online services (3.3%)	50-99 (10.3%)
Software engineering, website creation, mobile application development and point-of-sale systems (3.3%)	100-200 (20.7%)
Consulting, support and IT services (3.3%)	
Project management assistance; integration; strategic study and technical assistance (3.3%)	
Trade of informatic equipment and remote management (3.3%)	
Price comparator site (abandoned site) (3.3%)	
Documentary information systems, documentary services and archival missions (3.3%)	

Table III.
Firm activity sector and size

Scale item	Item wording	Scale	Alpha if item deleted
Benefits recognized early	We are usually ahead of other libraries in recognizing and planning new solutions to problems	Five-point scale: 1 = definitely false 5 = definitely true	0.81
High level of benefits expected	This library can benefit significantly by the early adoption and use of technological innovations	Five-point scale: 1 = definitely false 5 = definitely true	0.85
Perceived LES			
(a) By self	How the leading edge is the library you work in? (definition of LU given)	Seven-point scale: 1 = not LU 7 = highly LU	0.80
(b) By others	A count of how often the library is mentioned by others as being a LU	Integer variable	0.84
Applications innovativeness	We often find that we are suggesting new applications to equipment developers	Five-point scale: 1 = strongly agree 5 = strongly disagree	0.80
	We have been used as a test site for prototype versions of new equipment	Ditto	0.81
	We have close relationships with technology suppliers.	Ditto	0.81
	We are regarded as having pioneered some applications of technology	Ditto	0.79

Source: Morisson et al. (2002)

Table IV.
Measurement scale of LES construct

- Item 2: The company can benefit significantly by the early adoption and use of technological innovations.
- Item 3: How leading edge the company you work in? (definition of LU given).
- Item 4: A count of how often your company is mentioned by others as being a LU.
- Item 5: We often find that we are suggesting new applications to equipment developers.
- Item 6: We have been used as a test site for prototype versions of new equipment.
- Item 7: We have close relationships with technology suppliers.
- Item 8: We are regarded as having pioneered some applications of technology.

5.2 Knowledge sharing measurement scale

Jian and Wang (2013) proposed six measurement items for KS and responses were based on five-point Likert scale ranging from strongly disagree to strongly agree. In this research, we adopted this scale because it is associated with the KS behavior of employees.

To what extent do the following statements represent your organization:

- Item 1: Your company is willing to share information related to service with cooperative partners.

- Item 2: Cooperative partners are willing to share market information or customers' needs with your company.
- Item 3: Cooperative partners are willing to share information related to service with your company.
- Item 4: Your company shares information on market share and customers' needs with cooperative partners.
- Item 5: Your company shares technology change information on important product/service with cooperative partners.
- Item 6: Your company and cooperative partners share a strategy or its change mutually.

5.3 Innovation success measurement scale

Moorman (1995) used a four-item scale, which deals with new product performance. It is a unidimensional and a five-point scale (where 5 = strongly agree and 1= strongly disagree). The scale is considered to be highly reliable with alpha of 0.95.

The scale aims to rate the extent to which the product has achieved the following outcomes during the first 12 months of its life in the marketplace:

- Item 1: Market share relative to its stated objective.
- Item 2: Sales relative to its stated objective.
- Item3: Return on assets relatives to its stated objective.
- Item4: Profit margin relative to its stated objective.
- Item5: Return on an investment relative to its stated objective.

6. Data analysis techniques

To analyze the questionnaire data we required the following analysis techniques:

6.1 Exploratory factor analysis

Exploratory factor analysis (EFA) consists in reducing the initial variables in a small number of factors, which result from linear combinations of the initial variables whose coefficients are provided by the factorial weights. Practically, it appears in some cases that some initial variables contribute more than others to the formation of a particular axis or that some variables have high factorial weights on one or more axes.

6.2 Regression analysis

Multiple regression is a generalization of the simple regression model in which several explanatory variables are included.

This technique requires identifying a dependent variable (to be explained) and the others as being independent (explanatory).

The objective of this type of regression is to put an interdependence relation between the endogenous variable that we are trying to explain and explanatory exogenous variables.

7. Experimental results

This work analyzes data at the firm level. The sample includes mid-size IT companies.

From April 10, 2018 to April 31, 2018, we had sent out 50 questionnaires by mail with 30 returned, with the response rate of 60 per cent.

We explore the preliminary analysis for model validation using EFA and multiple regression analysis for model variables.

7.1 Exploratory factor analysis

7.1.1 Factor contributions of the "knowledge sharing" variable measurement scale. The table of the factor analysis of the measurement scale of the variable "lead userness" is presented in Document 1:

The obtained results show that all factor contributions are statistically significant. In addition, the representation quality of the items is good, as the items have a quality of distribution superior to 0.5.

The table also shows that the results of the principal components analysis (PCA) are generally satisfactory, as shown by the Bartlett test and the Kaiser–Meyer–Olkin (KMO) index.

First, the Bartlett test shows a level of significance (0.000) indicating that the items of the scale of measurement of the "lead userness" variable are factorizable. Second, the value of KMO is greater than 0.5 (0.887) so we can say that there is an intercorrelation between the items.

For internal consistency, Cronbach's alpha coefficient shows good reliability between items of the "lead userness" variable with a coefficient of 0.909.

With regard to the factors on which depends the "lead userness" variable, we can retain a single axis, which represents 62,838 of the information. The variable "lead userness" is thus unidimensional.

7.1.2 Factor contributions of the "knowledge sharing" variable measurement scale. The table of the factor analysis of the measurement scale of the variable "KS" is presented in Document 1.

The representation quality of the item is good, as all items have a quality of distribution greater than 0.5.

In addition, the table shows that the PCA results are generally satisfactory, as shown by the Bartlett test and the KMO index.

Indeed, the Bartlett test shows a level of significance (0.000) indicating that the items of the measurement scale of the variable "KS" are factorizable. Then, the KMO value is greater than 0.5 (0.880) so we can say that there is an intercorrelation between the items.

We notice that the unidimensionality is strong, as the measurement items of the variable "KS" are very closed to the first factor, which recovers (76.578 per cent) of the information.

Regarding the construct reliability, the index is equal to 0.931 and is significantly greater than 0.5. Also, the measurements used are reliable and constructed for good internal consistency.

7.1.3 Factor contributions of the "knowledge sharing" variable measurement scale. The table of the factor analysis of the measurement scale of the variable "innovation success" is presented in Document 1.

The obtained results show that all factor contributions are statistically significant. Similarly, the representation quality is good, as all items have a quality of distribution greater than 0.5. In fact, the factor contribution of each item varies between 0.703 and 0.850, which far exceeds the threshold of acceptability (0.5).

The results of the PCA are generally satisfactory, as shown by the Bartlett test and the KMO index. Hence, the Bartlett test shows a level of significance (0.000) indicating that the items in the measurement scale of the "innovation success" variable are factorizable. Then,

the value of KMO is greater than 0.5 (0.773) so we can say that there is an intercorrelation between the items.

We notice that the unidimensionality is strong, as the measurement items of the variable "innovation success" are very close to the first factor, which recovers (60.803 per cent) of the total variance.

For internal consistency, the Cronbach's alpha coefficient shows very good reliability between the items of the "innovation success" variable with a coefficient equal to 0.829.

8. Multiple regression analysis

We study the impact of the variables (lead userness and KS) on innovation success using the" multiple regression" method.

The table that summarizes the regression results is presented in Document 1.

8.1 Impact of lead userness on the innovation success of Tunisian companies

The variance R^2 measures the variation proportion of one variable that is explained by the other variable.

In our case, R^2 has a value of 0.457, so 45.7 per cent of the variations in the "innovation success" variable is explained by the "lead userness" variable of the model, which is an acceptable percentage.

The overall significance of the model is examined by the Fischer test, which has a value of less than 0.05 ($p = 0.000$), this proves that the model is globally significant.

In this case, we can analyze the individual significance of each of the selected explanatory variables.

The multiple linear regression method is applied to the *H1* test, which links the "lead userness" variable to the success innovation of Tunisian companies.

The analysis retains the "lead userness" variable as a predictor of the Tunisian companies' innovation success. With a positive regression coefficient of 0.534, which proves to have a considerable weight on success innovation.

The student's T of 4.899 is well above the norm (1.96). The results confirm a positive effect of the lead userness variable on innovation success.

H1 is confirmed.

8.2 Impact of lead userness on knowledge sharing of Tunisian companies

H2 supposes the existence of a positive link between lead userness and KS of Tunisian companies.

First, the coefficient of determination R^2 is equal to 15.2 per cent, which reflects a good quality of linear adjustment between the dependent variable and the independent variable.

Thus, the explanatory variables have a significant influence on the variable to be explained and the R^2 values prove the overall significance of the model.

As shown in the table above, the *F*-statistics test measures the general importance of the model. As p is less than 0.05 for our model, the model is proved to be significant.

Thus, the combination of the variables significantly predicts the dependent variable ($F = 5.038$, $p < 0.05$) for our research model.

In this case, we can analyze the individual significance of each explanatory variable selected.

The results of the multiple regression enable us to detect a considerable influence of lead userness on KS. The regression coefficient is in the range of 0.463 at a significance level of 0.033.

In T student, T exceeds the commonly accepted limit (T = 2.245 > 1.96). These results are sufficient to confirm the existence of a positive influence of these two variables.

H2 is confirmed.

8.3 Impact of knowledge sharing on the innovation success of Tunisian companies

The result of the study of the impact of KS on the success innovation of Tunisian companies (Model 3) reveals a relevant relationship between these two variables.

Indeed, the value of R^2 (55.9 per cent) and adjusted R^2 (54.3 per cent) show a strong linear adjustment, thus a strong explanation of the success innovation of Tunisian companies by KS.

The overall significance of the model is examined by the Fisher test, which has a value of less than 0.05 (0.000). This means that the model is globally significant.

If we examine the KS variable, we find that it has a positive and significant coefficient ($p < 0.01$). This leads us to confirm hypothesis *H3*.

H3 is confirmed.

8.4 Mediating effect of the "knowledge sharing" variable

To measure the impact of the mediating variable, we compare the values of the regression results obtained before and after the introduction of the "KS" variable. We summarize the results obtained in Table V: the impact of the mediating variable "KS."

H4 supposes the existence of a positive link between lead userness and success innovation under the mediation of the KS. The regression results (Table VI) allow deducing that the significance of the model is very satisfactory at the 0.01 threshold. The regression coefficient is in the order of 0.582 with a significance level of 0.050. The T Student is 2.024, thus exceeding the commonly accepted limit (1.96). This allows us to argue that innovation success is partially explained in terms of lead userness under the mediating effect of the KS variable (Table VI).

The overall significance of the model, examined by the Fisher test, shows a value of 0.002 that is less than 0.05, which proves that the model is globally significant (Table VI).

Based on the results noted in Table VII, we notice a significant variation of the R^2 value in both cases, following the introduction of the mediator variable "KS" in the model. The values obtained from R^2 in both cases show an average fit of the specified models.

The strong value of R^2 (36.7 per cent) and adjusted R^2 (32 per cent) show a strong linear fit. This result implies a strong explanation of the success innovation variable by the lead userness variable under the mediating effect of the KS variable (Table VII).

Items	Representation quality	Component
Item 1: Market share relative to its stated objective	0.612	0.782
Item 2: Sales relative to its stated objective	0.596	0.772
Item 3: Return on assets relatives to its stated objective	0.495	0.703
Item 4: Profit margin relative to its stated objective	0.722	0.850
Item 5: Return on investment relative to its stated objective	0.616	0.785
% of the explained variance		*60.803*
Cronbach's alpha of the factor		*0.829*
KMO		*0.773*
Bartlett test		*0.000*

Table V.
Factor contributions of the "innovation success" variable measurement scale

Items	Representation quality	Component
Item 1: We are usually ahead of other companies in recognizing and planning new solutions	0.668	0.817
Item 2: The company can benefit significantly by the early adoption and use of technological innovations	0.685	0.828
Item 3: How leading edge the company you work in? (definition of LU given)	0.482	0.618
Item 4: A count of how often your company is mentioned by others as being a LU	0.586	0.765
Item 5: We often find that we are suggesting new applications to equipment developers	0.841	0.917
Item 6: We have been used as a test site for prototype versions of new equipment	0.702	0.838
Item 7: We have close relationships with technology suppliers	0.803	0.896
Item 8: We are regarded as having pioneered some applications of technology	0.460	0.600
% of the explained variance		*62.838*
Cronbach's alpha of the factor		*0.909*
KMO		*0.887*
Bartlett test		*0.000*

Table VI.
Factor contributions of the "lead userness" variable measurement scale

Items	Representation quality	Component
Item 1: Your company is willing to share information related to service with cooperative partners	0.744	0.863
Item 2: Cooperative partners are willing to share market information or customers' needs with your company	0.761	0.872
Item 3: Cooperative partners are willing to share information related to service with your company	0.795	0.891
Item 4: Your company shares the information on market share and customers' needs with cooperative partners	0.860	0.928
Item 5: Your company shares technology change information of important product/service with cooperative partners	0.894	0.945
Item 6: Your company and cooperative partners share a strategy or its change mutually	0.541	0.735
% of the explained variance		*76.578*
Cronbach's alpha of the factor		*0.931*
KMO		*0.880*
Bartlett test		*0.000*

Table VII.
Factor contributions of the "KS" variable measurement scale

We have estimated a positive relationship between lead userness and success innovation through KS. The regression analysis allowed us to highlight this relationship.

H4 is confirmed.

9. Findings

First, we demonstrated that lead userness is perceived as a determining factor of companies' innovation success.

We confirmed that the LUs characteristics are responsible for the positive impact on the probability that the LU, once involved, can produce a commercially attractive innovation.

	Model 1 Dependent variable (innovation success)	Model 2 Dependent variable (KS)	Model 3 Dependent variable (innovation success)	Model 4 Dependent variable (innovation success)
Consistency	−0.165 (−2.196)**	−0.313 (−2.601)**	−0.284 (−3.826)***	−0.480 (−2.712)**
Lead userness	0.534 (4.859) ***	0.463 (2.245)**		0.582 (2.024)**
KS			0.588*** (5.955)	0.916 (3.296)***
Innovation success				
R^2	0.457	0.152	0.559	0.367
R^2 adjusted	0.438	0.122	0.543	0.320
F-statistic	23.606	5.038	35.464	7.816
p-value	0.000***	0.033**	0.000**	0.002***

Notes: ***Significant at the 1 per cent level; **significant at the 5 per cent level; *significant at the 10 per cent level

Table VIII. The multiple regression results

	Dependent variable: innovation success	
	Without introducing the "KS" variable	After introducing the "KS" variable
R^2	0.457	0.367
F	23.606	7.816
Sig. (*F*)	0.000	0.000

Table IX. The impact of the mediating variable "Knowledge Sharing" on innovation success

Franke et al. (2006) found that the more innovations are developed by the user, the more commercial promises are achieved and this by adding resource-related variables based on the technical expertise of users.

Our result is consistent with the findings of Hang & Kau (2016), who assumed that the significant benefits of an innovation are related to LUs expectations of relatively high benefits from obtaining solutions that meet their needs and this leads them to obtain a sufficient motivation for generating innovations. In fact, the researchers proposed that users with *z* high personal need for innovation and who is ahead a significant market trend are more likely to develop considerable innovations (Franke et al., 2006).

Second, in our research, we analyzed KS behaviors within IT companies, and in this context; we examine the role of LUs. We proposed a model describing LUs as problem solvers with a high probability of being able to provide knowledge to others in the community.

In agreement with our assumption, Hau & Kang (2016) confirmed in their research that users who reflect LUs' characteristics are more likely to share knowledge in the online community (Hau & Kang, 2016).

We suggested that LUs are a potentially interesting unit of analysis who are able to explain how new knowledge is integrated into communities and how it is disseminated locally in the community. Besides, results have shown that to make predictions about the sources of knowledge provision, it may be useful to focus on individuals who may be expected to hold useful knowledge for sharing.

Jeppesen & Laursen (2007) supported our findings by demonstrating that the LU contribute in making adjustments, recombining or extensions of existing principles in the

field. Hence, LUs tend not only to find and absorb knowledge outside the community but also importantly, our results indicate that they share knowledge within the community.

Third, results showed that KS is significantly related to success innovation.

Yang & Wu (2008) argued that firms create organizational innovations in terms of operations, service and products and that they can also create barriers to their competitors because of the tacit, dynamic, irreducible and scalable knowledge they possess.

In many studies, KS is considered to be an important factor in improving innovation capacity and business performance (Yang & Wu, 2008).

Our results are confirmed by Yeşil et al. (2013), who examined the impact of the KS process on companies' innovation capacity and innovation performance.

Accordingly, we found that a deep understanding of how a KS process could impact an innovation leads us to know how to improve the organizational climate with respect to innovation capacity and innovation performance, hence, innovation success.

Fourth, the main contribution of this research is to examine the mediating role of KS in the relationship between LUs and innovation success.

Ritala & Hurmelinna-Laukkanen (2013) found that there is a tension between the absorption of knowledge associated with incremental innovation and the adoption of new knowledge associated with radical innovation. Hence, investments in KM practices help companies mitigate this tension by developing the internal innovation capabilities needed to effectively translate external knowledge into the organizational context (Ritala & Hurmelinna-Laukkanen, 2013).

Du Plessis (2007) explains that the collaboration with partners improves tacit knowledge gathering and has a positive impact on KM practices, which, in turn, help companies to control the costs and risks of innovation. We, therefore, argued that the impact of LU contribution on innovation will depend on the extent to which the company invests in KM practices specifically KS, as these investments will shape the absorptive capacity of the company.

According to the results of previous research studies, our assumption that presents KS as a mediating variable influencing the relationship between LUs and innovation success could be validated.

10. Conclusions

Compared to previous research studies, which focused mainly on the identification of LUs and the examination of their specific characteristics, this paper highlights the impact of LUs on the firm's innovation success.

Consequently, we provided an integrated framework based on the synergies between LUs and innovation. Based on literature review, it was found that "KS" can be considered as a key variable that influences positively the relationship between LUs and innovation success, as LUs share their knowledge and exchange their skills and competencies with other members of the community to develop innovative ideas, products, services or processes. Hence, the researchers studied the mediating role of the "KS" variable.

To validate our hypothesis and test the proposed model, we conducted a survey among 30 IT companies to perform both EFA for the model's variables preliminary analysis and multiple regression analysis to validate the conceptual model. We used SPSS software to explore our findings.

Overall, we conclude that:

- Lead userness has a direct positive impact on innovation success.
- Lead userness is positively and directly related to KS.

- KS has a direct and positive impact on innovation success.
- KS mediates the lead userness–innovation success relationship.

As all our hypotheses were supported, we can admit that Tunisian IT companies consider the LUs as important units on their innovation activities' enhancement, as integrating such users in their business processes will guarantee long-term benefits' development.

10.1 Practical implications

This dissertation studies the impact of LUs' contribution to innovation activities to leverage the firm's innovation success. We explored an integrative framework that links LUs, innovation success and a third variable called "KS" to see beyond the intended importance of this type of user regarding the development of new innovations. KS is introduced in this research as a mediating variable that examines the impact of LUs on innovation success. First, LUs can be a profitable resource for companies to enhance successful innovations because of their knowledge and problem-solving skills. Moreover, the "KS" behavior among LUs and with the rest of the marketplace can enhance innovation activities and thereby mediates the impact of LUs on innovation success. Finally, as the LUs method enables to identify opportunities for future products and to gather new product ideas from leading edge customers, managers should plan to make it a part of their future new product development practices.

10.2 Limitations and directions for future research

Like any other research, this study has its limitations:

- We can obtain different results if we choose other fields (e.g. the banking sector), and therefore, we are not able to generalize our findings. Hence, it is required to explore other Tunisian activity sectors.
- Companies that have been selected for the study are all located in one city (Tunis) with relatively small sample size. It is, therefore, recommended that further research work on companies across all the country considering a high sample size, which would help detect hypothetical relationships. In addition, future studies could include other variables that may affect innovation performance.
- We selected a quantitative approach for the purpose of this paper. Generally, quantitative research methodology requires a large sample size and this is not the case of our study. Consequently, it would be better for future researchers to take into account mixed method research designs, which linked quantitative and qualitative data collection and analysis to guarantee a more complete and comprehensive understanding of the research problem than either quantitative or qualitative approaches alone.
- The innovation diffusion theory developed by Rogers (1962) has had a considerable positive impact on many fields of research. As expressed in this definition, innovation, communication channels, time and social system are the four key components of the diffusion of innovations. The innovators and the early adopters represent 2.5 and 13 per cent, respectively (Rogers, 2003). According to Giacomini Filho et al. (2007), the analysis of "diffusion of innovations" reveals that Roger's studies do not fully address the social and communication demand on diffusion of innovations, deserving a concerted revision of social and communication's configurations (Giacomini Filho et al., 2007). Accordingly, future research studies need to focus on critical factors that

negatively affect the diffusion of innovations and determine the key determinants of successful innovations with regard to the "diffusion innovation" theory criticism.

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