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CONTENTS

Sr. No.	TITLE & NAME OF THE AUTHOR (S)	Page No.
	EXTENT OF ABSOLUTE POVERTY IN RURAL SECTOR OF HIMACHAL PRADESH: A MEASURE OF UNEMPLOYMENT RAMNA	1
2.	THE ENTREPRENEURSHIP CORE COMPETENCES FOR DISTRIBUTION SERVICE INDUSTRY SU-CHANG CHEN, HSI-CHI HSIAO, JEN-CHIA CHANG, CHUN-MEI CHOU, CHIN-PIN CHEN & CHIEN-HUA SHEN	5
3.	THE RELATIONSHIP BETWEEN MACROECONOMIC VARIABLES AND CEMENT INDUSTRY RETURNS: EMPIRICAL EVIDENCE FROM PAKISTANI CEMENT INDUSTRY	10
4.	MUHAMMAD IMRAN & QAISAR ABBAS OUTLOOK OF MANAGEMENT STUDENTS TOWARDS EFFICIENCY OF ONLINE LEARNING-A CASE STUDY OF SHIVAMOGGA CITY, KARNATAKA STATE SANDHYA.C, R. HIREMANI NAIK & ANURADHA.T.S	17
5.	TRAFFIC RELATED MORTALITY AND ECONOMIC DEVELOPMENT MURAT DARÇIN	21
6.	SUBSCRIBER'S PERCEPTION TOWARDS CUSTOMER CARE SERVICE IN MOBILE TELECOMMUNICATION WITH SPECIAL REFERENCE TO TUTICORIN CITY S. ANTHONY RABBILL COLDEN, S. DR. V. CORALANDISHNAN	27
7.	S. ANTHONY RAHUL GOLDEN. & DR. V. GOPALAKRISHNAN A STUDY OF WAVELET BASED IMAGE COMPRESSION ALGORITHMS CULTAN DUDUA CARA & DR. VISUOD ATROTIVA	31
8.	CHETAN DUDHAGARA & DR. KISHOR ATKOTIYA A STUDY OF CONSUMER'S IMPULSE BUYING BEHAVIOUR WITH REFERENCE TO EFFECT OF PROMOTIONAL TOOL IN THE OUTLETS OF CHHATTISGARH DR. MANOJ VERGHESE & POOJA G. LUNIYA	37
9.	STUDY OF CONSUMER BEHAVIOR IN CELL PHONE INDUSTRY DR. ARUNA DEOSKAR	41
10.	ANOTHER APPROACH OF SOLVING UNBALANCED TRANSPORTATION PROBLEM USING VOGEL'S APPROXIMATION METHOD DILIP KUMAR GHOSH & YASHESH ZAVERI	45
11.	PROBLEM OF NON-PERFORMING ASSETS OF STATE BANK OF INDIA: A CASE STUDY OF NAGPUR DISTRICT DR. N. K. SHUKLA & M. MYTRAYE	49
12.	INVESTMENT STRATEGY OF LIC OF INDIA AND ITS IMPACT ON PROFITABILITY T. NARAYANA GOWD, DR. C. BHANU KIRAN & DR. CH. RAMAPRASADA RAO	59
13.	PREDICTION OF DHAKA TEMPERATURE BASED ON SOFT COMPUTING APPROACHES SHIPRA BANIK, MOHAMMAD ANWER & A.F.M. KHODADAD KHAN	65
14.	SET THEORETIC APPROACH TO FUNDS FLOW STATEMENTS – A STUDY WITH REFERENCE TO STATE BANK OF INDIA DR. PRANAM DHAR	71
15.	STRATEGIES FOR THE SUCCESS OF BRAND EXTENDED PRODUCT : AN ANALYTICAL STUDY OF DEHRADUN DISTRICT WITH SPECIAL REFERENCE TO FMCG DR. AMIT JOSHI, DR. SAURABH JOSHI, DR. PRIYA GROVER & PARVIN JADHAV	80
16.	VALUE ADDED TAX AND ECONOMIC GROWTH: THE NIGERIA EXPERIENCE (1994 -2010) DR. OWOLABI A. USMAN & ADEGBITE TAJUDEEN ADEJARE	85
17 .	CORPORATE SOCIAL RESPONSIBILITY INITIATIVES BY POWER GRID CORPORATION OF INDIA LIMITED: A STUDY DR. S. RAGHUNATHA REDDY & MM SURAJ UD DOWLA	90
18.	METADATA MANAGEMENT IN DATA WAREHOUSING AND BUSINESS INTELLIGENCE VIJAY GUPTA & DR. JAYANT SINGH	93
19.	QUALITY OF WORK LIFE - A CRITICAL STUDY ON INDIAN HOSPITALS B. UMA RANI & M. SARALA	97
20.	BUSINESS ETHICS: WAY FOR SUSTAINABLE DEVELOPMENT OF ORGANISATION DR. SATYAM PINCHA & AVINASH PAREEK	105
21.	USE OF ICT TOOLS IN HIGHER EDUCATION SANDEEP YADAV & KIRAN YADAV	108
22.	CONSTRUCTING CONFIDENCE INTERVALS FOR DIFFERENT TEST PROCEDURES FROM RIGHT FAILURE CENSORED NORMAL DATA V. SRINIVAS	111
23.	RECOGNISING CUSTOMER COMPLAINT BEHAVIOUR IN RESTAURANT MUHAMMAD RIZWAN, MUHAMMAD AHMAD AHMAD ATHAR, MUBASHRA WAHEED, ZAINAB WAHEED, RAIMA IMTIAZ & AYESHA MUNIR	116
24.	SOCIO-CULTURAL EFFECTS OF ALCOHOL CONSUMPTION BEHAVIOUR OF YOUNG COMMERCIAL DRIVERS IN SOUTH WEST NIGERIA DR. ADEJUMO, GBADEBO OLUBUNMI	123
25.	MEAN-SHIFT FILTERING AND SEGMENTATION IN ULTRA SOUND THYROID IMAGES S. BINNY	126
26.	E-TAILING, ONLINE RETAILING ITS FACTORS AND RELATIONS WITH CUSTOMER PERSPECTIVE WASIMAKRAM BINNAL	131
	THE KNOWLEDGE MANAGEMENT AND THE PARAMETERS OF THE TECHNOLOGICAL INNOVATION PROCESS: APPLICATION IN THE TUNISIAN CASE MILLE MAALEJ RIM & HABIB AFFES	134
28.	THE RELATIONSHIP BETWEEN CORPORATE SOCIAL RESPONSIBILITY AND CORPORATE FINANCIAL PERFORMANCE: META-ANALYSIS ASMA RAFIQUE CHUGHTAI & AAMIR AZEEM	139
29.	AN EMPIRICAL STUDY ON STRESS SYMPTOMS OF ARTS, ENGINEERING AND MANAGEMENT STUDENTS IN TIRUCHIRAPALLI DISTRICT, TAMIL NADU S. NAGARANI	144
30.	PURCHASE INTENTION TOWARDS COUNTERFEIT PRODUCT MUHAMMAD RIZWAN, SYEDA RABIA BUKHARI, TEHREEM ILYAS, HAFIZA QURAT UL AIN & HINA GULZAR	152
	REQUEST FOR FEEDBACK	159

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THE KNOWLEDGE MANAGEMENT AND THE PARAMETERS OF THE TECHNOLOGICAL INNOVATION PROCESS: APPLICATION IN THE TUNISIAN CASE

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ABSTRACT

The theme of Knowledge Management is very clear in the information society. This shows the crucial role of knowledge and more specifically the interaction between tacit-explicit, systemic -autonomous and simple-complex knowledge in the emergence of organizational knowledge. The internal nature of innovations is more expensive to implement and more effective. We test the hypotheses using the knowledge management and innovation in the Tunisian companies operating in different sectors. The data on knowledge management, the cost of implementation, the effectiveness and the source of innovation were collected from a sample of 70 Tunisian companies. The method used in this research is the questionnaire. The results showed that knowledge management has a significant effect on the parameters of the innovation process.

KEYWORDS

explicit knowledge, autonomous knowledge, complex knowledge, source of innovation, cost of implementation and innovation effectiveness.

INTRODUCTION

aced with strong competition of the market, organizations are forced to remain profitable. They recognize they can increase their productivity and reduce the internal costs to be more competitive on their core business (Srivastava et al, 2006). In this context, as knowledge is considered to be a lever for a sustainable competitive advantage, it is primarily associated with new technologies of information and communication (ICT).

Chemitte (2008) has shown that the knowledge management is presented today as a major issue in the operation of organizations to develop innovation capabilities considered as sources of competitive advantage in more and more competitive markets.

These two interacting variables, namely knowledge management and innovation are closely correlated. They take a preponderant place in organizations because of their strategic implications (Cantner et al, 2009).

The objective of this research is to explain the influence of knowledge management on the parameters of the innovation process and t to describe a conceptual model that illustrates the relationships between these two variables already set and tests it in the context of the Tunisian companies.

REVIEW OF LITERATURE

THE KNOWLEDGE MANAGEMENT

The Knowledge management is not a new concept. As soon as the early 1990s, the term "knowledge management" emerged in literature as business leaders and researchers began to examine the role of knowledge in organizations and how to manage (Pesqueux, 2004).

In an attempt to better understand the typology of this concept, we use the work of Nonaka and Takeuchi (1995). According to this theory, there are two types of knowledge: tacit and explicit.

Concerning the tacit knowledge, Nonaka and Von Krogh (2009) define it as «knowledge disarticulated and embodied in experience. It concerns the unwritten knowledge transmitted by word of mouth and which remains in the heads of employees».

Indeed, explicit knowledge can be defined as the one that can be formulated in sentences (Nonaka and Von Krogh, 2009). It is codified and easily transferable by the information systems since it is easily captured and shared (Nonaka and Takeuchi, 1995).

The literature review shows that the majority of studies have used both dimensions of knowledge (tacit and explicit knowledge). However, Whetten (1989, p.110, cited by Gopalakrishnan et Bierly, 2001)¹ advice «two other types which are essentially: systemic / autonomous and simple/ complex».

First, Chesbrough and Teece (1996, p.112, cited by Gopalakrishnan et Bierly, 2001)² define «that autonomous knowledge can be developed and implemented independently of other knowledge and organizational processes».

Second, Das and Teng (1998) consider that «systemic knowledge requires a comprehensive exchange of information to facilitate the integration of different fields of knowledge».

Finally, the complex knowledge has been defined as «the extent to which knowledge is difficult to understand and use. It is associated with sophisticated knowledge» (Pelz, 1985).

THE PARAMETERS OF THE TECHNOLOGICAL INNOVATION PROCESS

Innovation is defined as a complex development process of new knowledge by the collective learning that involves and future success. It is an interactive learning process in which participants increase their knowledge and know-how through the exchange and experimentation (Nonaka and Takeuchi, 1995; Tidd et al, 2004).

In literature, we have identified three key decision parameters in the innovation adoption process as the source of innovation, the cost of implementation and overall effectiveness.

It represents the sources of adoption whether internally and externally. For the internal mode, it refers to the adoption of developed knowledge mainly within the company which leads to develop the basic skills of the company enabling to gain more profits (Gopalakrishnan and Bierly, 2001).

Second, «internal sourcing of innovation helps with the development of the firm's core competencies and capabilities and allow the firm to appropriate more of the profits» (Bierly and Chakrabarti, 1996a). «External sourcing of innovations saves the firm the cost of development and may increase the speed of implementing innovations » (Kessler and Chakrabarti, 1996; Gold, 1987).

The cost of innovation implementation has a strategic importance for several reasons:

- «An efficient product development process is a key element of a firm's cost leadership strategy » (Porter, 1985).
- «Lower costs allow the firm more flexibility in pursuing a broader array of projects » (Cooper and Kleinschmidt, 1987).

- «An efficient process is a critical success factor for product innovation » « (Cooper and Kleinschmidt, 1987).

The cost of implementing innovation is reduced if knowledge is transferred effectively in the various groups within the organization. Innovations are more effective in creating a sustainable competitive advantage (Grant, 1996).

HYPOTHESES

Our research aims to diagnose the effect of knowledge management on the three parameters of the innovation process. As it was illustrated in the research model, we propose that the type of knowledge should have an effect on one of the parameters of the innovation process.

THE TACIT KNOWLEDGE AND THE SOURCE OF INNOVATION

Grant (1996) found that explicit knowledge can be difficult to be seen from the outside of another organization. He added that the domestic supply of this type of knowledge helps the company to create a better basis of skills.

Moreover, Ermine (2002) found that the process that is often put forward (collections of external information followed by process of decisions or actions), justifies the preponderance of external resources and neglects some internal ones.

In fact, organizations were more effective if they could be transformed with the knowledge already contained in the memory of all the employees and business partners (Jacob and Pariat, 2000).

In literature, it is recognized that the boundaries of an organization are endless through networks it can establish. Networks are extremely important today when we know that an organization can no longer rely on internal resources to remain efficient and competitive.

The replications of internal knowledge are necessary for the preservation and development of the competitiveness of the company. They showed that the firm can improve efficiency by facilitating the dissemination of internal knowledge (Gopalakrishnan and Bierly, 2001).

Gopalakrishnan and Bierly (2001) indicated that the more explicit knowledge associated with innovation is, the less it will be an internal source of innovation. It shows that we can advance the following hypothesis.

H (1): The more explicit the knowledge associated with an innovation is , the less likely it will be internally sourced.

THE EXPLICIT KNOWLEDGE AND THE COST OF IMPLEMENTATION OF INNOVATION

The process of adoption of innovations based on more tacit knowledge is a challenging process because of the lack of codifiability and the difficult to transfer learning from one innovation decision situation to another. Therefore, «the implementation process of tacit knowledge raises many problems. It is more expensive than explicit knowledge (Brown and Duguid, 1991, p.112, cited by Gopalakrishnan et Bierly, 2001)³, and it is difficult to incorporate innovations in other areas of knowledge implied due to the difficulty of transferring knowledge through "communities of practice" within the company».

H (2): The explicit knowledge has an impact on the cost of implementation of innovation.

THE EXPLICIT KNOWLEDGE AND INNOVATION EFFECTIVENESS

Teece (1986) found that *«when explicit knowledge is successfully implemented, it is more effective in creating a sustainable competitive advantage than innovations based on explicit knowledge, because it is more difficult for competitors to imitate»*. However, it is difficult for competitors to imitate because of the difficulties of development and implementation or exploitation. They require personal experience. Therefore, we can deduce that explicit knowledge is more effective than the tacit one the effectiveness of innovation.

H (3): The explicit knowledge has a positive influence on the effectiveness of innovation.

THE AUTONOMOUS KNOWLEDGE AND SOURCE OF INNOVATION

Chesbrough and Teece (1996) indicated that *«autonomous knowledge can be developed and implemented independently from other innovations and organizational processes»*. «Unaffiliated companies linked through arm's-length contacts often cannot achieve sufficient coordination because each company wants to gain more from innovation and, therefore, is unwilling to share information freely »(Gopalakrishnan et Bierly, 2001, p.113). Every organization, due the lack of complete trust, believes the other will act in potentially opportunistic ways beyond its own ends (Das and Teng, 1998, p.113, cited by Gopalakrishnan et Bierly, 2001). There are internal and external sources of innovation.

H (4): The autonomous knowledge has a positive and significant impact on the source of innovation.

THE AUTONOMOUS KNOWLEDGE AND THE COST OF IMPLEMENTATION OF INNOVATION

Mintzberg (1979, p.113, cited by Gopalkrishnan et Bierly, 2001)⁴ considered that «the coordination costs associated with systemic innovations are higher than those of autonomous innovations because the types of structural configurations and control mechanisms required for systemic innovations are more sophisticated and more expensive to put in place than those for autonomous innovations». «Systemic innovations require greater integration of diverse knowledge areas through liaison personnel». (Galbraith, 1973 and Mintzberg, 1979, p.113, cited by Gopalkrishnan et Bierly, 2001)⁵.

Successful implementation of a systemic innovation requires that many experts work together by combining their knowledge base.

H (5): The more autonomous the knowledge associated with an innovation, the lower the cost of implementation will be.

THE AUTONOMOUS KNOWLEDGE AND EFFECTIVENESS OF INNOVATION

Lippman and Rumelt (1982) identified that« "causal ambiguity" can sustain a competitive advantage; i.e. if the components of a system are linked together in an intricate manner; it will be difficult for others to determine and imitate the source of the competitive advantage. Since systemic innovations have more causal ambiguity than autonomous ones, greater effort is required to implement them successfully. However, when their adoption is completed, employees are likely to perceive greater benefits to be derived from them. On the contrary, more autonomous innovations are easier to implement and employees perceive them as conferring fewer benefits».

H (6): The autonomous knowledge influence on the effectiveness of innovation

THE COMPLEX KNOWLEDGE AND SOURCE OF INNOVATION

Rogers (1983, p.114, cited by Gopalakrishnan et Bierly, 2001)⁶ argued that complex knowledge is difficult to understand and use. Original innovations will be perceived as more complex by organizational members because of the uncertainty associated with something new. In the same way, Kogut and Zander (1993) considered that if the technologies become more complex, companies tend to transfer them to their own subsidiaries.

THE COMPLEX KNOWLEDGE AND THE COST OF IMPLEMENTATION OF INNOVATION

Kline (1985) considers that the adoption of complex knowledge is more difficult and more costly than the simple one. Generally speaking, the implementation of complex innovations tend to be messy with multiple, cumulative and convergent, parallel and divergent streams of activity commonly termed as a 'multiple sequence pattern of adoption' (Schroeder et al., 1989; Poole, 1981, 1983, p.114-115, cited by Gopalakrishnan et Bierly, 2001)⁷.

Indeed, the processes of implementation of innovation tend to see more overlap between the steps, making the process more ambiguous the process of implementation of simple innovation tends to be more orderly, and follow what has been described as "unitary sequence model" (Gopalakrishnan and Damanpour, 1994).

The implementation of simple innovation tends to be more orderly, and follow what has been described as "unitary sequence model" (Gopalakrishnan and Damanpour, 1994).

H (8): The complex knowledge has an impact on the cost of implementing of innovation.

THE COMPLEX KNOWLEDGE AND EFFECTIVENESS OF INNOVATION

The complex knowledge« is more difficult to imitate by competitors. We can surmise that innovations, like resources, are more likely to confer competitive advantage to an organization when they are perceived by customers as rare, valuable and imperfectly inimitable» (Hall, 1996).

Hall (1996) argued that customers perceive complex knowledge as more valuable than simple knowledge because they are more creative and sophisticated. Therefore, complex knowledge is more likely to be a source of competitive advantage.

 $\mbox{H\/}\mbox{ (9): }\mbox{Complex knowledge has an influence on the effectiveness of innovation.}$

RESEARCH METHODOLOGY

THE SAMPLE

Out of the 86 companies that were contacted, only 70 returned the questionnaires, of which 16 proved actually usable (ie a response rate of 63.3%). Our final sample consists of 70 companies

OPERATIONALIZATION OF VARIABLES

In order to deal with this variable, we used different researches such as those of Anderson and Gerbing (1991), King (1992) and Gopalakrishnan and Bierly (2001). The respondents were asked to indicate their level of perception on each item for each variable.

AUTONOMOUS KNOWLEDGE

Literature is rich in studies that have used empirical measures of autonomous knowledge. Three items are used to measure the independent variable. They were inspired by the study of Gopalakrishnan and Bierly (2001) in which the respondents were asked to respond to statements on a 5-point Likert scale where 1 isequivalent to "very low" and 5 to "very high."

COMPLEX KNOWLEDGE

Complex knowledge is an independent variable measured by a Likert scale where 1 is equivalent to "very low" and 5 to "very high."

They were inspired by the study of Gopalakrishnan and Bierly (2001).

SOURCE OF INNOVATION

It is a dependent variable measured by a dichotomous nominal scale. The respondents should indicate whether the source of innovation within their business is external (coded 0) or internal (coded 1). This scale is used in previous studies (Gopalakrishnan and Bierly, 2001).

COST OF IMPLEMENTATION OF INNOVATION

The cost of implementation is a variable measured by a Likert scale where 1 is equivalent to "very low" and 5 to "very high."

EFFECTIVENESS OF INNOVATION

The effectiveness of innovation is a dependent variable. These were inspired by the study of Gopalakrishnan and Bierly (2001). Therefore, it is measured by a Likert scale where 1 is equivalent to "very low" and 5 to "very high."

DATA ANALYSIS AND INTERPRETATION OF RESULTS

DATA ANALYSIS

The information about knowledge management, the source of innovation, the cost of implementation and effectiveness of innovation have been collected from the questionnaire survey. In this research, two methods have already been used, namely the linear regression and the discriminant analysis.

EXPLICIT KNOWLEDGE AND SOURCE OF INNOVATION

Explicit knowledge has a significant effect on the source of innovation due to its weight (1.541) in the study of the discriminant function between the two groups (hypothesis 1). Therefore, Tunisian firms tend to explain the effect of this knowledge and to consider it as the most important factor in making the nature of the source of innovation. The Chi 2 test is 1. The Statistics Fisher T attributed to this variable is 0.193. The value of Wilk's Lambda is 0.968. This hypothesis was confirmed (Table 1 and 2).

TABLE 1: COEFFICIENTS DES FONCTIONS DISCRIMINANTES CANONIQUES STANDARDISEES

	Fonction
	1
Connaissances explicites	1,541
Connaissances autonomes	,252
Connaissances complexes	-1,048

AUTONOMOUS KNOWLEDGE AND SOURCE OF INNOVATION

The variable "autonomous knowledge" has a significant effect on the source of innovation due to its weight (, 252) in discriminating between the two groups. The Chi 2 test is 1. The value 0.984 is the proportion of the total variance in the discriminant scores not explained by the differences between the groups. The T Fisher is 0.351. The value of Wilk's lambda is high (0.984), the variable is less discriminating. Hypothesis 4 was confirmed (Table 1 and 2).

COMPLEX KNOWLEDGE AND SOURCE OF INNOVATION

According to tables 1 and 2, "complex knowledge" has a significant effect on the source of innovation due to its weight (-1.048) in discriminating between the two groups. The T Fisher attributed to this variable is high (0.482) and more discriminating. In contrast, most of Wilk's lambda is high (0.991) and the variable is less discriminating. The Chi 2 test is 1. Hypothesis 7 was confirmed.

TABLE 2: TEST D'EGALITE DES MOYENNES DES GROUPES

	Lambda de Wilk's	F	ddl1	ddl2	Signification
Connaissances explicites	,968	1,737	1	53	,193
Connaissances autonomes	,984	,885,	1	53	,351
Connaissances complexes	,991	,501	1	53	,482

The linear regression shows the influence of the independent variables on the dependent ones, to measure the quality of the adjustment and to deduct the interpretation and the significant character of the estimated parameters. In this research, hypotheses H2, H3, H5, H6, H8 and H9 were analyzed by the method of the linear regression.

EXPLICIT KNOWLEDGE AND THE COST OF IMPLEMENTATION OF INNOVATION

Hypothesis H2 tries to establish the influence of the explicit knowledge about the cost of implementation. The percentage of the variance explained is 19.74%. The estimated regression coefficient is significant (β = 0.474, p <0.05, Table 3). In other words, explicit knowledge has a significant influence on the cost of implementation of innovation. H2 hypothesis is confirmed.

TABLE 3: MATRICE DES CORRELATIONS DE PEARSON

Etude des variables	Coût de mise en œuvre	Efficacité	Connaissances explicites	Connaissances autonomes	Connaissances complexes
Coût de mise en œuvre	1				
Efficacité	0,340	1			
Connaissances explicites	0,474	0,286	1		
Connaissances autonomes	0,506	0,340	0,805	1	
Connaissances complexes	0,423	0,403	0,843	0,849	1

^{**.} La corrélation est significative au niveau 0.01 (bilatéral).

^{*.} La corrélation est significative au niveau 0.05 (bilatéral).

AUTONOMOUS KNOWLEDGE AND COST OF IMPLEMENTATION OF INNOVATION

Our research showed that Hypothesis 5 proposed that the more autonomous knowledge associated with innovation is, the lower the cost of implementation is. The regression of the variable cost of implementation of innovation explains (23.41%) of variations of the variable autonomous knowledge. The coefficient β is significant (Table 3, β = 0.506, p <0.05). For this variable, the standardized model takes the following form: Y = 0.506 X1 + ϵ . Hypothesis H5 is confirmed.

COMPLEX KNOWLEDGE AND COST OF IMPLEMENTATION OF INNOVATION

The tables below indicate the regression of the variable cost of implementation of innovation that explains the rate of (14.829%) the variable complex knowledge. The estimated coefficient of regression is significant (β = 0.423, p <0.05). In other words, autonomous knowledge has a significant influence on the cost of implementation of innovation. Hypothesis H8 is confirmed.

The model is presented as follows:

 $Y = 0.423 X2 + \varepsilon$

(1)

EXPLICIT KNOWLEDGE AND EFFECTIVENESS OF INNOVATION

Hypothesis H3 predicts the existence of a relationship between the dependent variable (the effectiveness of innovation) and the independent variable (explicit knowledge). This is not consistent with the results of a regression between these variables as the percentage of the explained variance is very low (8.2%). The estimated coefficient of regression is significant (β = 0.286, p <0.01). In other words, explicit knowledge has a significant impact on the effectiveness of innovation. Hypothesis H3 is confirmed. In fact, the model is:

 $Y = 0.286 + \varepsilon X3.$ (2)

AUTONOMOUS KNOWLEDGE AND EFFECTIVENESS OF INNOVATION

Hypothesis 6 predicted that autonomous knowledge has an influence on the effectiveness of innovation. Autonomous Knowledge explains 11.6% of the effectiveness of innovation. The estimated coefficient of regression β is positive and significant at the 0.05 level's (β = 0.340, p <0.05, Table 3). The model of this variable is shown as follows:

 $Y = 0.340 + \epsilon X4.$ (3)

Hypothesis H6 is confirmed.

COMPLEX KNOWLEDGE AND EFFECTIVENESS OF INNOVATION

Our research shows that hypothesis 9 is confirmed by the analysis of the linear regression. The percentage of the explained variance is 14.829%. The complex knowledge has a significant influence on the effectiveness of innovation ((β = 0.403, p <0.05, Table 3). The standardized model takes the following shape:

 $Y = 0.403 + \epsilon X5.$ (4)

Generally, the standard model is presented as follows:

 $Y = 0.506 \times 10.423 \times 286 \times 2 + 0.403 \times 30.340 \times 4 \times 5 + \epsilon.$ (5)

RESULTS AND DISCUSSION

The main contribution of this paper is that we introduced and supplied a partial development of the concept of knowledge management, the source of innovation, the cost of implementation and the effectiveness of innovation.

The purpose of this exploratory study is to a develop research in the areas of knowledge management and innovation.

EXPLICIT KNOWLEDGE

According to the results, explicit knowledge affects the nature of the source, the cost of implementation and the effectiveness of innovation. This relationship is confirmed in previous studies that have shown the link between knowledge management and innovation process. These results converge with the work of Gopalakrishnan and Bierly (2001) and that of Czarnitzki and Wastyn (2009).

AUTONOMOUS KNOWLEDGE

The results concerning the hypothesis define the relationship between autonomous knowledge and the innovation process, regarding the nature of the source, the cost of implementation and the effectiveness of innovation, confirm very clearly the significant relation. The same result was found by Gopalakrishnan and Bierly (2001).

COMPLEX KNOWLEDGE

The validation of the hypothesis associated with the complex relationship between knowledge and the innovation process, regarding the nature of the source, the cost of implementation and the effectiveness of innovation, shows the importance of knowledge management in improving the innovation process within the Tunisian company. This observation is coherent with that of Gopalakrishnan and Bierly (2001).

CONCLUSION

In the context of globalization of competition, accelerating of innovation, increasingly enhanced, this work examines the role of knowledge management in enterprises

The combination of different types of knowledge aims to improve the process of technological innovation through the creation of new knowledge that will lead, eventually, to the creation of a new product or service, etc. In an environment that is constantly changing. Knowledge and innovation remains an economic major stake to assure the sustainability of companies. The literature review showed that there is a relationship between knowledge management and the technological innovation process. In this perspective, Villacicencio (2000) explains that tacit knowledge increasingly interested the researchers as far as they support a part of the creative and innovative activity of firms. The review of the literature allowed to highlight the different factors of knowledge management that influence the process of technological innovation. It is important to consider the contribution of each factor on the process of innovation.

Through the main conclusions resulting from this research, it is likely to make a real contribution at two levels:

Firstly, at the theoretical level, this research comes to enrich the literature on the subject of knowledge management in relation to the innovation process in the Tunisian companies.

Secondly, at the practical level, this study could lead managers of companies to dedicate more resources to systems of knowledge management (KM) susceptible to improve the process of technological innovation However, it is advisable to underline that the present research contains certain number of temporal limits and sampling.

On the other hand, the fact that this research is largely based on the perception of different responsible businesses, we confront a subjectivity that may generalize the results. In the end, we intend to suggest some future avenues of research. It would be interesting to study the effect of the variables including that of tacit knowledge in the presence of other control variables.

NOTES

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