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The role of structural capital in leveraging innovation

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Abstract :
The intensity of the competitive landscape pushes firms to be innovative. This can be done by offering new goods, using new production processes, adopting a new organization structure, or implementing new marketing channels. Innovation process necessitates an important investment in intellectual capital, notably in structural capital. This paper focuses on the study of the relationship between structural capital components, innovation, and firm performance through the study case of a sample of Algerian enterprises. The results obtained show an important firm efforts in term of using an efficient information system, investing in ICT, stimulating R&D activities, protecting their intellectual property rights and trademarks leading them to leveraging innovation and improving performance.

Keywords: Structural capital, Information system, ICT, Innovation, Performance.
Jel Classification Codes: O34, O30

Introduction

In the field of knowledge economy, firm must be innovative to develop its market, improve its performance and enhance its competitive edge. Structural capital plays a crucial role in supporting, and facilitating the success of innovation process.
In the field of knowledge economy, the firm must be innovative to develop its market, improve its performance, and enhance its competitive edge. The emphasis is based on the components of intellectual capital, notably structural capital. This component plays a crucial role in assisting the success of the innovation process (Cabrilo & Dahms, 2018; Farzaneh et al., 2022). Indeed, the structure supporting human resources through technologies, information resources, organizational

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processes, procedures, and intellectual property rights facilitates and stimulates innovation (Malhotra, 2003). Also, structural capital encompasses database structures, training materials, and manuals used by firms at the practical level (Van Caenegem, 2002). According to Edvinsson & Malone (2001), these elements are needed by firms to access information that will be codified into knowledge. According to Bontis et al., (2000), a firm including structural capital has a value on the market greater than its financial value. Consequently, structural capital is the mirror of a strong supportive culture that stimulates workers to solve problems, try new ways, and suggest new ideas that can be recorded as invention patents and licenses to store knowledge (Gonan et al., 2015). In other words, relationship management and leadership could be in favor of communicating, learning, and sharing knowledge.

So, what is the impact of structural capital elements on innovation and performance of firm?

This paper aims to analyze the relationship between several structural capital elements, innovation and performance through a study case of some Algerian companies. We propose a model analysis including the main latent variables and their interconnections. The quantitative approach was adopted through a questionnaire tool intended for managers of 35 enterprises (public and private) located in some cities of Algeria (Oran, Tlemcen, Belabess, Algiers, and Bejaia). Data collected was treated by SPSS V.25.

1. Literature Review and hypotheses development

1.1. Definitions

1.1.1. Structural Capital (SC)

For Rehmen et al., (2022) structural capital includes knowledge located in information systems, manuals, procedures and processes, patents and intellectual property rights, and other elements related to organization culture that have a positive impact on the creation, transmission, and implementation of new ideas and accumulation of organizational knowledge. Indeed, structural capital is considered as an enabler of innovation through its different components(Cabrilo et al., 2024).

1.1.2. Innovation

Ding et al., (2022) highlight that innovation subject has attracted the attention of academics, managers, and policy makers as a driver and booster of change and economic growth. The innovation concept has a long conceptual history with many connotations and denotations (Godin, 2015). However, innovation represents an outcome of a process; a degree of newness of a change; or a degree of usefulness or success in applying something new in the world, in a nation, or in a firm.

According to Beltramino et al., (2020) acquisition of information, knowledge management, organizational learning culture, organizational structure, information systems, and processes impacts positively the capacity of innovation within firms and improve their performance level. Several researchers such as Nambisan and Baron, (2013); Kapoor and Lee, (2013) highlight the role played by innovation ecosystems to improve innovation based on a network of relationships throughtout talents, financial resources, and information flow lead firms to find a coherent customer-facing solution (Adner, 2006). Also, the innovation ecosystem is related to a technology platform incompassing a set of shared interfaces and assets underpinning an activity system surrounding it (Thomas et al., 2014).

1.1.3. Performance and competitive advantage

Every firm needs to compete in the market through a competitive advantage creation related to high technology, high quality of human resources, high level of innovation, creativity, and motivation of employees, high quality of products and services, high level of efficiency in the production process, etc. These competitive advantages lead the firm to be performant.

The performance represents the outcome of an individual's work and can be done within a specific time frame, together with the amount of the firm's value or standard for which the individual works. For Freeman (1984), the firm performance is the total value created through its activities. It can be measured by increasing sales level, market segment evolution, supply of new products and services, etc.

1.2. The impact of SC components on innovation

1.2.1. Information systems (IS) and Innovation

IS encompasses a pyramid of systems (Laudon et al., 2020), promoting strategy-as-practice to support managerial planning through technology applications, leading to develop and execute content strategies and achieving firm objectives (Whittington 2014). Many such as Chen et al., (2010), Whittington (2014), Marabelli and Galliers, (2017), and Wang & Byrd, (2017) highlight the crucial role of IS in allowing top management to build a strong strategy with capabilities and objectives well defined at the strategic level. In other words, using an efficient IS within a complex environment leads firms to support strategic planning processes including awareness, situation analysis, conception, formulation, implementation, and control planning (Newkirk and Lederer, 2006). Managers can make decisions by processing row input, collected from several internal and external sources, into meaningful information. Also, at the operational level IS facilitates analyzing problems, and visualizing complex subjects by employees leading them to be more performant, innovative, and create new products and services. Besides, many actors interact with information systems by feedback information such as executives, employees, clients, and providers. This means that information systems are important for monitoring to seize opportunities and avoid threats. Efficient IS enhances innovation performance through a competitive advantages creation (Wolf and Floyd, 2017). For Jääskeläinen and Luukkanen (2017), effective use of IS enhances communication with employees and monitoring them to know whether goals are being met, strengthens collaboration among employees teams, and improves the commitment of top management in performing operations. Also, they highlight the role of strategic control in ensuring the effective and efficient use of resources through IS which generates and integrates important data/information. By IS information flows activate intellectual processes, determine the economic behavior of firms, build strategies, and lead them to gain strategic competitiveness. The information represents an intangible resource overcoming the barriers of firms and becoming a player in globalization processes, and a source of competitive advantage. Therefore, the following hypothesis is assumed:

H1: IS as a component of structural capital has a positive impact on innovation.

1.2.2. ICT and innovation

Since information quality and its flows is also linked to Information and Communications Technologies (ICT) adopted by firms, then information capital is defined as an internal resource based on technological aspects. In other words, information potential management and maintaining its quality positively impact the firm's sustainability. Using ICT to search, gain, produce, store, disseminate, codify, analyze, and apply the knowedge needed by a firm to manage its functions at the internal environment, and get insight into the external environment contribute to improve innovation capabilities and the organizational performance level (Martinez-Navalon et al., 2023).

ICT improve communication by facilitating the contact between individuals, information exchange, learning, collaboration, sharing knowledge, and absorptive capacity which enables integration of previously fragmented knowledge flows (Kermaly, 2002; Zhang etal., 2018; Cecchi et al., 2022; Deng et al., 2023).

In simple words, ICT stimulates organizational knowledge accumulation, and estabish an organizational culture encouraging autonomy in decision-making, and strenghtening engagement in innovation process (Agostini & Nosella, 2017).

Besides, external intellectual potential related to relational capital impacts the firm's image. Information about technological monitoring focused on technological evolution and technology transfer impacts the firm's innovation capabilities and its market capitalization. Using recent and developed ICT permits firms to present new products that are difficult to imitate, difficult to replace with substitutes, with more perceived value, and command premium prices. Despites, increasing investments in ICT are not seen in financial statements, they rise the market value of the firm (Gonan et al.,2015). In this perspective, structural capital represents an asset value of the organization. Thus, the following hypothesis is suggested:

H2: ICT as a component of structural capital has a positive impact on innovation

1.2.3. Processes, procedures and innovation

Internal processes developed and adopted by individuals within a firm leading them to be productive, effective, and innovative constitute an important part of structural capital that belongs to the organization. Besides, procedures, methods, manuals, routines, and methodologies embedded in the firm represent the static category of the structural capital and the supportive intangible infrastructure enabling human capital to function (Carson et al., 2004; khavandkar et al., 2016). Therefore, this set of elements are important to improve innovation from the internal environment. In other words, the internal innovation system has to work before it is reasonable to involve other stakeholders such as customers (Maarit Parjanen et al., 2020). Thus, the following hypothesis is suggested:

H3: Processes and procedures included in SC have a positive impact on innovation.

1.2.4. Patents and intellectual property rights

Economic progress requires a constant flow of new ideas and new products aimed at improving the quality of life. Innovation and creativity allow firms to make a

difference in the markets. For acquiring a leader position, firms based on patents and intellectual property rights have an important investments in research and development activities. In simple words, trademarks, industrial designs, utility models, authors' rights, know-how, trade secrets, exclusive techniques, and talents are the key success of firms. Intellectual property rights incompasses Industrial property, and copyright. It represents the reflection of the creations made by human intelligence. It includes creations, inventions and industrial designs or models.
It also includes trademarks, service marks, trade names and commercial designations, which shows indications of source and designations of origin, and finally protection against unfair competition. Also, intellectual property rights incompasses a set of signs transmitting information to consumers, in particular about the products and services offered on the market, and that the protection aims to prevent unauthorized use of these signs which would be likely to mislead the consumer, and to prevent abusive practices.
There is many consequences when firms don't protect their intellectual property rights leading them to loss their competitive advantage that reduce their market value. Also, they will have difficulty attracting talent and lack of influence in negotiations. Other risks are related to erosion of brand reputation and limited growth opportunities. Therefore, these risks inhibit innovation ecosystems; rather than exposition to risks related to trade secrets and legal battles. Thus, firms must strenghten their R&D activities, motivating their empoyees to create new ideas, suggest new solution, solve problems, through a reward system, tolerate learning from mistakes and protect legaly this creativity and new knowledge trough intellectual property rights (Yu et al., 2022). Therefore, the following hypotheses are proposed:
H 4: Patents and intellectual property rights included in SC have a positive impact on innovation.

1.2.5. Innovation and performance

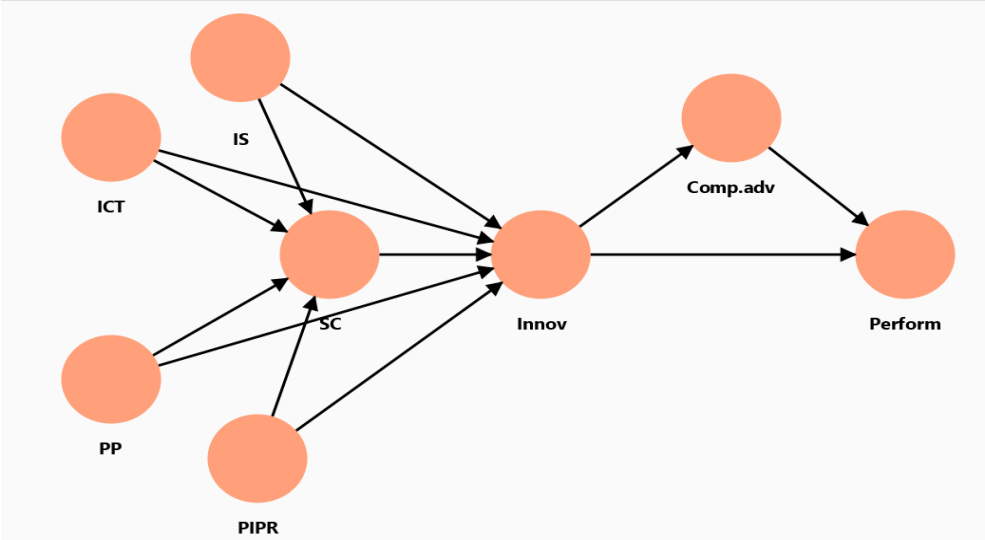
Since innovation is materialized in new goods that satisfy customers need and improve their satisfaction, the market share increase, sales and profit level rise too. Therefore, innovation is a driver of firm performance through competitive advantage related to high quality product for example. By offering products and services characterized by greater value than competing products in the market, firms acquire a greater reputation indeed to better financial results. Accordingly, the following hypothesis is postulated:
H5: Innovation has a positive impact on firm performance.

2. Model analysis and Methodology of research

2.1. Model analysis

Based on the set of hypotheses presented above, we propose the following research model including eight latent variables, namely structural capital (SC); informations systems (IS); ICT; processes and procedure (PP); patents and intellectual property rights (PIPR); innovation (Innov); competitive advantages (Comp.Adv); and performance (Perform).

Figure 1. Analysis Model



Source: own production

2.2. Participants and data collection

This study is based on quantitative data using surveys and analyzing several studies conducted on the subject. This research was conducted from December 2023 to June 2024. The sample consists of public, private, and mixed Algerian firms located in different wilayas of Algeria, and belonging to several activity sectors (52% industry, 38% services, 10% agriculture). The questionnaire was tested by five managers, and two academics (university teachers) before prescribing it. Some questions have been rephrased to improve their understanding and make it easier to answer. Also, participants were given the necessary information about the research project before distributing the questionnaire. 100 questionnaires were used out of 560 questionnaires distributed face to face and by email, representing a response rate of 17,86%. Most respondents are senior executives and senior managers (58%) given that they are the best informed about strategic issues. Also, to boost the response rate, we sought to build personal relationships with some firms and executives, knowing the difficulties in reaching the executive population (Cycyota,2002).

2.3. Measurement of constructs

To measure the set of latent variables we have related each variable with a number of items. Each item presents an ordinal modalities of response using the Likert scale of five points ranging from 1 “Strongly disagree” to 5 “Strongly agree”. The following table presents the constructs of the latent variable and the manifest variables of the measurement model.

Table 1.Items of latent variables

Latent Variable	Items (Manifest Variables)
Structural Capital (SC)	1. R&D activities are supported by allocating a specific budget. 2. Our firm is completely ready to invest in the development of its structures 3. Our firm adopts the most recent technological and technical developments in the field of communication to facilitate communication and information exchange 4. Our firm has an efficient and easy-to-use information system

	5. Our firm relies heavily on ICT to improve operations for creating and sharing new knowledge 6. Our firm strongly supports new ideas that can be registered as invention patents and licenses to store knowledge 7. Our firm protects its trademark and roots it in the minds of its customers 8. Our firm adopts clear strategies and procedures to protect its intellectual property rights 9. Processes, practices, manuals, and databases encompass much of the firm knowledge
Information Systems (IS)	1. Feasibility of data gathering 2. Information is provided on time (at the right time) 3. Providing information useful to internal management 4. Relevance to the end users 5. The information used in my work is characterized by high-precision 6. The use of the electronic information system helps reduce erroneous information 7. I can acquire clear and understandable information for my work 8. The information produced by the information system is complete 9. Our IS provides the statistics necessary for decision-making in the different functions 10. The information produced by the information system is detailed to help me make relevant decisions
ICT	1. Our enterprise invests in using recent and developed ICT 2. ICT improves internal communication 3. ICT improves external communication 4. ICT improves collaboration 5. ICT facilitates teamwork 6. ICT improves the sharing of knowledge
Processes and procedures (PP)	1. Our internal processes facilitate the employee work 2. Operations and methodologies are clearly defined to simplify employee work 3. Manuals are developed to reflect the characteristics of each job 4. Overall employees know the procedures of their work.
Patents & Intellectual Property Rights (PIPR)	1. Our creations, inventions, and industrial designs are legally protected 2. Our firm protects its trademarks, and trade names 3. Our firm protects commercial designations 4. Our firm protects signs transmitting information to customers to prevent unauthorized use.
Innovation (Innov)	1. The culture of innovation is a priority in our company policy 2. Our company has adopted changes in its products and/or services according to new technological developments 3. Our company has adopted innovations in its production processes 4. Our company has adopted innovations in its raw materials used in production

	5. Our company has adopted an expansion in its marketing channels through the use of media and social networks 6. Our company has adopted changes in its organizational structures to strengthen its control systems 7. Our company adopts cutting-edge technologies which constitute a means of competitiveness in its sector of activity 8. Our company adopts ICT to strengthen its innovation process by providing creative and innovative working methods 9. The company is interested in new creative ideas expressed by its employees and takes them into account when designing its products and/or services, 10. The company is interested in the opinions, complaints, and suggestions of its customers and suppliers and takes them into account to develop its products and/or services (after-sales service).
Competitive Advantages (Comp.Adv)	1. Our product prices are competitive. 2. We compete based on high-quality level. 3. Our products are highly reliable. 4. Our products are very durable. 5. Our products are needed. 6. The delivery of customer orders on time. 7. We provide dependable delivery 8. To customer demand for new features, we respond well. 9. We introduce new products to the market first. 10. Our time-to-market is shorter than the industry average.
Performance (Perform)	1. Annual sales have increased during the last three years. 2. Annual profits have increased during the last three years 3. Market share has increased during the last three years 4. The percentage of Return on Investment has increased during the last three years 5. The total trend of the company's performance has improved 6. Our products and services are characterized by high quality compared to our competitors 7. New products and services are widely accepted by our customers

Source: own production

3. Results and discussion

According to the PLS approach, the reliability test results are presented in the following table. The PLS (Partial Least Squares Regression) approach is a data analysis method invented in 1983 by Herman & Svante Wold. PLS regression maximizes the variance of the predictors of the variable. More precisely, PLS regression seeks latent variables, linked to X and Y, used to express the regression of Y on these variables (Tenenhaus, 1998). This analysis of the reliability of manifest variables led us to exclude some manifest variables from our research model. The only "performance" variable was unchanged. Also, the loadings of the manifest variables after modification are greater than 0.50 and are therefore considered good to be retained.

Convergent validity measures the internal consistency of a measure and the degree to which manifest variables adequately represent the latent variable. The check of convergent validity is done in two stages:

- The link between the latent variable and each of its indicators must be

significant. The student's t-test showed that factorial contributions are significant at the level p = 0.001.

- The rho-c value must be greater than 0.50 (C. Fornell and D. Larcker, 1981). This means that the average variance shared between the latent variable and its indicators is greater than 50%. When the rho-c value is greater than this level, the variance explained by the items is greater than the variance due to measurement errors. According to the results presented below, this condition is widely verified. The minimum value of the rho-c is equal to 0.886.

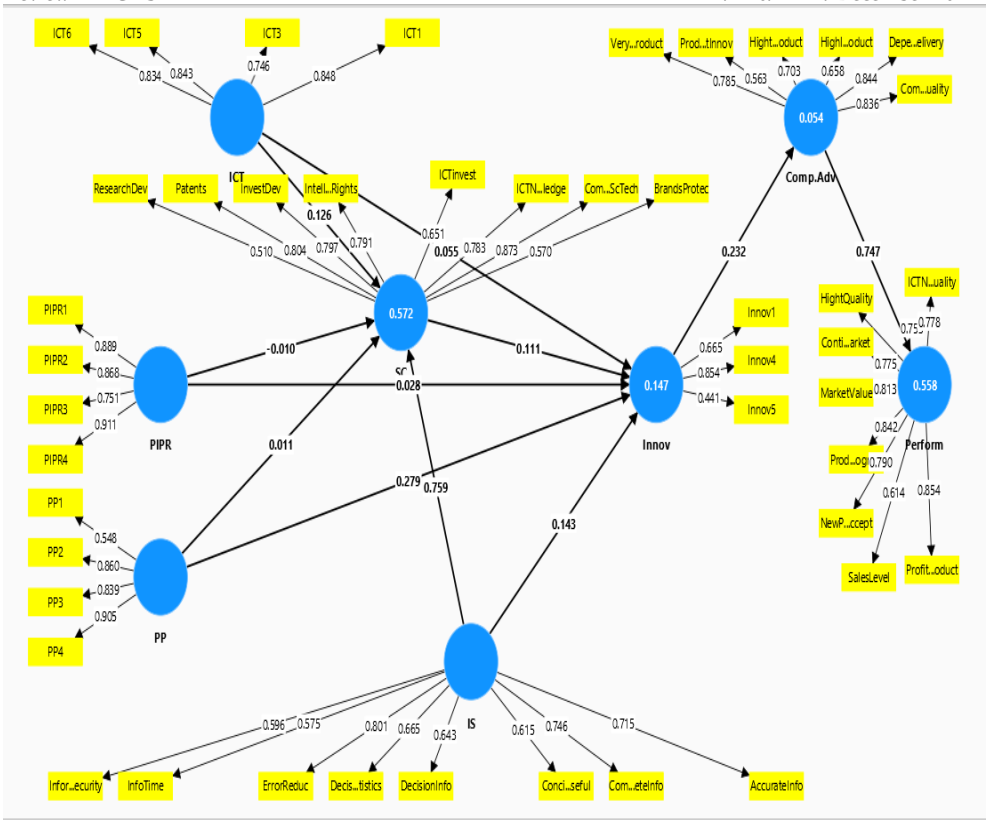
Furthermore, the evaluation of internal consistency reliability by the Jöreskog rho-a coefficient gives excellent values that exceed 0.850 for all dimensions. In other words, our manifest variables measure well the latent variables they are supposed to represent.

Also, Cronbach Alpha is greater than 0.800 in overall variables. This coefficient, which varies between 0 and 1, constitutes an index of "consistency" of the measurement scale (a synthetic index of the consistency of the manifest variables used to measure each latent variable). It is easily calculated in the SPSS and constitutes in some way a synthesis of the correlations between the different items that make up the scale. Cronbach's alpha is sufficiently satisfactory to calculate a score corresponding to the scale comprising 1 and 0.8. According to Evrard et al., (1993), a minimum coefficient of 0.6 is sufficient in exploratory studies. This condition is satisfied.

Testing the internal model, by the "path coefficients" examination resulting from the PLS approach, will allow us to validate or invalidate our research hypotheses. The study of the correlations between the latent variables, presented below, gives us insight into the quality of the causal model.

The values of R square show that structural capital is strongly impacted by its components, namely information systems and ICT. However, PP and PIRP are not. Also, innovation is weakly impacted by SC, PIRP, PP, ICT. Thus, our hypotheses are validated. Innovation impact positively the performance through competitive advantages. Thus, our last hypothesis is validated. The following figure show the main results.

Figure 2. Final Analysis Model



Source: own production by Smart PLS 4

Conclusion

Our study aimed to analyze the relationship between structural capital and its components on the innovation capabilities of the firm and then its impact on performance level. The results obtained show that the sample of algerian enterprises analyzed have a low level of innovation despite the positif role of information systems and ICT in terms of improving collaboration, teamwork, exchange of information, make-decision, and external communication. However, these companies must motivate their employees to be innovative by financial stimulations, motivation, and boosting them to learn and think to suggest new ideas and solutions for problems.

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