Management Strategies and Engineering Sciences 2023; 5(3):11-26.

Designing an Information Technology Strategic Plan (ITSP) in Knowledge-Based Industries of the Country Considering the Current National Economy

Nasir Roshan Ghiyas[1], Kiamars Fathi Hafashjani[2]*, Fazlollah Jamalo[2], Nasrin Akhondi[4], Ashraf Shahmansoury[2]

1. PhD student, Department of Industrial Management, South Tehran Branch, Islamic Azad University, Tehran, Iran.
2. Assistant Professor, Department of Industrial Management, South Tehran Branch, Islamic Azad University, Tehran, Iran.
3. Associate Professor, Department of Statistics, South Tehran Branch, Islamic Azad University, Tehran, Iran.

*** Corresponding author email address**: fathikiamars@yahoo.com

Received: 2023-06-05 **Reviewed:** 2023-06-15 **Revised:** 2023-07-28 **Accepted:** 2023-08-20 **Published:** 2023-09-10

Abstract

This paper aims to design an Information Technology Strategic Plan (ITSP) in the knowledge-based industries of the country, considering the current state of the national economy. The research is applied in nature and uses a mixed-methods approach (qualitative-quantitative) for data collection. The statistical population in the qualitative section includes 15 experts in knowledge-based pharmaceutical industries and academic experts. In the quantitative section, the participants consist of professionals and specialists working in the country's pharmaceutical industries, stakeholders from the public, and leading academic figures in the field. Ultimately, after distributing 106 instruments, the sample size of this study consists of 96 experts who were available and willing to participate, selected through a combination of non-probability purposive sampling (judgmental) and snowball sampling methods. The data collection tools were interviews in the qualitative phase and a researcher-made questionnaire in the quantitative phase. The validity and reliability of the questionnaire were confirmed. For data analysis, grounded theory, interpretive structural modeling (ISM) in the MicMac foresight matrix, and structural equation modeling (SEM) using AMOS software were employed. The results led to the identification of 18 components, including IT strategy evaluation; IT strategy formulation; IT strategy implementation; defining the organization's vision and goals; determining the organization's critical performance indicators; analyzing the organizational environment; strategic marketing orientation frameworks; IT strategic orientation frameworks; organizational strategic orientation frameworks; challenges related to organizational size; challenges related to the utilization of IT; challenges related to the type of industry; mechanisms for utilizing the internet infrastructure to provide organizational services anytime and anywhere; mechanisms for rapidly developing services and products for customers; mechanisms for addressing organizational needs in a competitive environment; enhancing IT governance; improving IT architecture; and implementing an IT infrastructure library. According to the reachability matrix calculations in interpretive structural modeling, the intervening conditions of the IT strategic plan (challenges) have the greatest influence, as their relative influence was calculated to be 100% (6 out of 6). In contrast, the outcomes and effects of the IT strategic plan (results) were determined to be 50% (3 out of 6). In fact, the relative influence and relative dependence for the contextual conditions of the IT strategic plan (enablers) and the mechanisms of the IT strategic plan (strategies) were measured to be exactly the same at 83%.

Keywords: Information Technology; Strategic Plan; Knowledge-Based Industries; Pharmaceutical Industries; Interpretive Structural Modeling (ISM).

How to cite this article:

Roshan Ghiyas N , Fathi Hafashjani K, Jamalo F, Akhondi N, Shahmansoury A. (2023). Designing an Information Technology Strategic Plan (ITSP) in Knowledge-Based Industries of the Country Considering the Current National Economy. Management Strategies and Engineering Sciences, 5(3), 11-26.

1. Introduction

Knowledge management plays a pivotal role in driving innovation by facilitating the flow of information within and between organizations. As emphasized by Aalbers and Whelan (2021), industries such as the German automotive sector have embraced digitally enabled collaborative innovation to optimize both online and offline interactions. This reflects a broader trend where innovation is not only confined to physical spaces but is increasingly happening through digital platforms that support remote collaboration. Collaborative innovation, as highlighted by Alaffad and Masrom (2018), is particularly crucial in sectors like the aviation industry in the UAE, where knowledge management frameworks are tailored to enhance innovation by integrating diverse expertise across organizations.

In knowledge-based industries, such as biopharmaceuticals and information technology, the ability to absorb and apply external knowledge is paramount to maintaining competitive advantage. According to Albort-Morant, Leal-Rodríguez, and Marchi (2018), absorptive capacity—the firm's ability to recognize, assimilate, and apply external knowledge—along with relationship learning mechanisms, is a critical driver of green innovation performance. In Brazil, innovation and competence building have been central to the biopharmaceutical industry's ability to compete on a global scale (Alves, Vargas, & Britto, 2016). This underscores the importance of developing internal capabilities while also fostering collaborations that extend beyond organizational boundaries.

The role of collaborative innovation is not limited to high-tech or knowledge-intensive industries. As Amirova, Sargina, and Khasanova (2021) point out, even in traditional sectors such as mining, consumer innovation management is crucial for navigating the complexities of modern economic landscapes. Similarly, in China, An et al. (2021) highlight the significance of knowledge pricing in open innovation environments, where social dual innovation balance serves as a critical perspective in understanding how knowledge can be commoditized and applied to drive industrial innovation.

Sustainability challenges, particularly those related to environmental concerns, are reshaping how industries approach innovation. Andersen and Wicken (2020) argue that the natural environment has become a significant driver of innovation, particularly in industries that are heavily reliant on natural resources. The automotive, mining, and energy sectors, for example, are increasingly focused on developing sustainable solutions that not only comply with regulatory standards but also enhance long-term competitiveness. These sectors must balance the need for technological advancement with the imperative to minimize environmental impact, a challenge that requires new forms of collaboration and knowledge sharing.

The banking industry, although traditionally seen as a conservative sector, has also been affected by the growing importance of knowledge creation processes. Arijitsatien and Ractham (2017) explore how knowledge creation processes in the Thai banking industry have a direct impact on organizational performance, demonstrating the cross-sectoral relevance of knowledge management and innovation. Asheim, Grillitsch, and Trippl (2017) further elaborate on how regional innovation dynamics are shaped by the combinatorial knowledge bases that arise from interactions between industries, academia, and government institutions.

Knowledge management and innovation are deeply intertwined, with firms increasingly recognizing that the ability to leverage external knowledge sources can significantly impact innovation outcomes. Bawa (2023) notes that firms that effectively manage their knowledge resources are better positioned to enhance their innovation performance. This is particularly true in industries where rapid technological change requires constant adaptation and learning. For instance, in the biopharmaceutical industry, external knowledge sourcing is a critical factor in the innovation process, as firms must continuously incorporate new scientific discoveries into their product development pipelines (Bukstein, Hernández, & Usher, 2019).

Chen and Kim (2023) highlight the relationship between industrial policy and exploratory innovation in China's high-tech sectors, demonstrating that government interventions can play a pivotal role in shaping the innovation landscape. External knowledge sourcing, whether through formalized collaborations or more informal networks, is essential for firms operating in both rural and urban areas. Dotzel and Faggian (2019) emphasize that businesses in rural areas, often thought to be less innovative, can achieve significant innovation outcomes through strategic partnerships and external knowledge acquisition.

The rise of artificial intelligence (AI) and other advanced technologies has further complicated the innovation landscape, necessitating new learning and development tools. Drewniak and Posadzińska (2020) argue that AI companies, in particular, need to focus on building their innovative potential by leveraging new knowledge management tools and frameworks. This aligns with the findings of D'Itria (2023), who explores how European fashion ecosystems are fostering sustainable innovation through a quadruple helix model that involves collaboration between academia, industry, government, and civil society.

In industries where the pace of technological change is particularly rapid, such as aerospace and pharmaceuticals, knowledge dynamics are critical to maintaining a competitive edge. Gao et al. (2015) explore how synergy innovation has shaped China's aerospace industry, while Fu, Wu, and Shan (2022) examine the evolutionary path of pharmaceutical clusters in China. Both studies highlight the importance of collaborative innovation in driving industrial development and ensuring long-term competitiveness.

The service sector, while often overlooked in discussions of technological innovation, also plays a crucial role in shaping industrial dynamics. Gallouj (2019) argues that service innovation trajectories are as varied and complex as those in the manufacturing sector, with significant implications for how industries approach both technological and non-technological forms of innovation. This is particularly relevant in industries where customer-facing innovation, such as digital services or eco-friendly product offerings, is critical to maintaining competitiveness.

Firms operating in traditional industries, such as mining and manufacturing, are also increasingly adopting collaborative innovation practices to enhance their innovation outcomes. Glushak et al. (2016) discuss how industrial enterprises are utilizing network models to manage innovation processes more effectively, while Lazarenko et al. (2020) explore strategic directions for local innovation ecosystems in the mining industry. Both studies underscore the importance of knowledge management and collaboration in driving industrial innovation, particularly in sectors that are typically slow to adopt new technologies.

The role of intermediaries in facilitating innovation has also gained attention in recent years. Go (2022) examines the role of innovation intermediaries in the Philippine rice industry, demonstrating how these actors can help bridge the gap between academia and industry. Similarly, in South Africa, Marule (2022) highlights the role of technology commercialization in operationalizing industrial policies and driving innovation across sectors.

As industries become increasingly interconnected, the ability to manage knowledge across organizational and sectoral boundaries becomes critical. Heil and Bornemann (2017) emphasize the role of industry and resource alignment in fostering collaborative innovation, particularly in sectors where knowledge exploration is a key component of the innovation process. Hohberger (2014) also explores how firms can search for emerging knowledge through collaborative and geographically proximate networks, further emphasizing the importance of external knowledge sources in driving innovation.

In conclusion, knowledge management and collaborative innovation are critical drivers of industrial competitiveness in today's rapidly evolving economy. Whether through formalized partnerships, government interventions, or the adoption of new technologies, industries across the globe are increasingly recognizing the importance of leveraging external knowledge to enhance their innovation outcomes. As the examples from sectors as diverse as biopharmaceuticals, aerospace, mining, and services demonstrate, the ability to manage and apply knowledge effectively is essential to maintaining long-term competitiveness in the global economy. Therefore, this paper aims to design an Information Technology Strategic Plan (ITSP) in the knowledge-based industries of the country, considering the current state of the national economy.

2. Methodology

Considering that the present study focuses on designing an Information Technology Strategic Plan (ITSP) in the country's knowledge-based industries, the research method is applied in terms of purpose, mixed-method (qualitative-quantitative) in terms of data type, and descriptive-correlational in terms of data collection method and the nature of the research.

The study population can be divided into three main groups: the first group includes prominent academic experts; the second group consists of professionals and specialists working in the country's pharmaceutical industries (including Dr. Abidi Pharmaceutical Group; Caspian Tamin Pharmaceutical Group; Vitabiotics Iran; Tolid Daru Pharmaceutical Group; Barekat Pharmaceutical Group; Nano Alvand Pharmaceutical Group; TIPICO Pharmaceutical Investment Organization; Exir Pharmaceutical Group; and Daroupakhsh Factories) (industry experts); and the third group comprises customers and independent researchers (public stakeholders). The sampling method in this study is a combination of non-probability purposive sampling (judgmental) and snowball sampling. Due to the nature of the sampling method, the final sample size will be determined by the accessible experts willing to cooperate.

The data collection tool for the qualitative section was a semi-structured interview. The interviewees included 15 experts from knowledge-based industries in the pharmaceutical sector and academic experts in fields such as innovation management, industrial management, information technology management, and industrial engineering, who are experts in research. These interviews were conducted as in-depth interviews in the spring of 2022.

Qualitative data analysis was based on document analysis and semi-structured interviews using the multi-grounded theory method. At this stage, 15 interviews were conducted on the topic of information technology in the country's knowledge-based industries. The results from the three stages of coding were processed using MAXQDA software, and the findings are presented below. After finalizing the research variables and categories, statistical analyses and interpretive structural modeling (ISM) were performed. Finally, the relationships between variables were confirmed using structural equation modeling (SEM) with the Amos software.

The localization tool for the research components was evaluated by a group of professors and experts. In the next phase, to test the simplicity and clarity of the questions, as the localization tool was intended to be distributed among experts, a portion of the localization tools was distributed among part of the study population. After reviewing their feedback and obtaining final approval from the advisors and supervisors, the localized research tool was distributed.

The research validation for designing the research model was achieved using a coding frequency matrix in the Maxqda software, which was used to analyze the qualitative data obtained from interviews with the experts.

3. Findings

The qualitative analysis (multi-grounded theory) for designing the Information Technology Strategic Plan (ITSP) in the country's knowledge-based industries, specifically for the pharmaceutical sector, included the theory development stage based on inductive coding, conceptual refinement, and pattern coding to familiarize with the research data. In the qualitative section of the study, opinions from 15 experts in the knowledge-based pharmaceutical industries and academic experts were collected through in-depth interviews conducted in the spring of 2022. In this stage, key research concepts were extracted from the qualitative methodology, focusing on variables and categories emphasized by the experts. Below are some outputs from the in-depth interviews with the experts.

The overall structure of the in-depth interview, as displayed in the document browser of MAXQDA software, shows that the causal conditions of the IT strategic plan (influencing); the core category of the IT strategic plan (phenomenon); the contextual conditions of the IT strategic plan (enabling); the intervening conditions of the IT strategic plan (challenging); the mechanisms of the IT strategic plan (strategies); and the outcomes and effects of the IT strategic plan (results) represent the main concepts of the study. The theory validation stage primarily involves analyzing the codes and how different codes are combined and integrated to form the basic categories. Finally, in the theory enrichment stage, concepts related to designing the IT strategic plan in the country's knowledge-based industries were integrated and refined using MAXQDA software.

Ultimately, the theory extracted from the multi-grounded theory method for designing the IT strategic plan (ITSP) in the country's knowledge-based industries explains that the ITSP is designed based on the causal conditions of the IT strategic plan (influencing); the core category of the IT strategic plan (phenomenon); the contextual conditions of the IT strategic plan (enabling); the intervening conditions of the IT strategic plan (challenging); the mechanisms of the IT strategic plan (strategies); and the outcomes and effects of the IT strategic plan (results). In essence, the concept of "causal conditions of the IT strategic plan (influencing)" encompasses categories such as defining the organization's vision and objectives, determining the organization's critical performance indicators, and analyzing the organizational environment. The concept of "core category of the IT strategic plan (phenomenon)" includes categories such as IT strategy evaluation, IT strategy formulation, and IT strategy implementation. The concept of "contextual conditions of the IT strategic plan (enabling)" involves categories such as strategic marketing orientation frameworks, IT strategic orientation frameworks, and organizational strategic orientation frameworks. The concept of "intervening conditions of the IT strategic plan (challenging)" includes categories such as challenges related to organizational size, challenges related to the level of IT utilization, and challenges related to industry type. The concept of "mechanisms of the IT strategic plan (strategies)" includes categories such as mechanisms for utilizing internet infrastructure to provide organizational services at any time and place, mechanisms for rapid development of services and products for customers, and mechanisms for addressing organizational needs in a competitive environment. The concept of "outcomes and effects of the IT strategic plan (results)" includes categories such as enhancing IT governance, improving IT architecture, and implementing the IT infrastructure library.

After finalizing the variables and categories of the research model, statistical analyses and interpretive structural modeling (ISM) were conducted using the MicMac foresight matrix to establish the relationships between variables.

Based on the qualitative analysis findings, the design of the IT strategic plan for the country's knowledge-based industries was approached using interpretive structural modeling (ISM). The ISM method can rank and prioritize the elements of the IT strategic plan in the country's knowledge-based industries using the structural self-interaction matrix (SSIM) technique for the foresight of related concepts. In other words, this matrix is formed to analyze the relationship between elements and to show the interactions between them using the following four symbols: one-way relationship from row i to column j (V); one-way relationship from column j to row i (A); two-way relationship between i and j (X); no relationship between i and j (O).

Table 1: Structural self-interaction matrix for the foresight of related concepts (main variables)

Variable Comparison	1	2	3	4	5	6
1. Causal Conditions of IT Strategic Plan (Influencing)	1	X	V	A	A	V
2. Core Category of IT Strategic Plan (Phenomenon)	-	1	X	A	V	V
3. Contextual Conditions of IT Strategic Plan (Enabling)	-	-	1	X	X	V
4. Intervening Conditions of IT Strategic Plan (Challenging)	-	-	-	1	X	X
5. Mechanisms of IT Strategic Plan (Strategies)	-	-	-	-	1	X
6. Outcomes and Effects of IT Strategic Plan (Results)	-	-	-	-	-	1

Based on the relationships between the research model concepts in the structural self-interaction matrix for the foresight of related concepts, the IRM reachability matrix was organized for foresight, which illustrates the power of influence and the degree of dependence:

Table 2: IRM Reachability Matrix for Foresight of Related Concepts (Main Variables)

Matrix Reachability in ISM	1	2	3	4	5	6	Absolute Influence IRM	Relative Influence IRM
Causal Conditions of IT Strategic Plan (Influencing)	1	1	1	0	0	1	4	67%
Core Category of IT Strategic Plan (Phenomenon)	**1**	**1**	**1**	**0**	**1**	**1**	**5**	**83%**
Contextual Conditions of IT Strategic Plan (Enabling)	0	1	1	1	1	1	5	83%
Intervening Conditions of IT Strategic Plan (Challenging)	1	1	1	1	1	1	6	100%
Mechanisms of IT Strategic Plan (Strategies)	1	0	1	1	1	1	5	83%
Outcomes and Effects of IT Strategic Plan (Results)	0	0	0	1	1	1	3	50%
Absolute Dependence IRM	4	4	5	4	5	6	-	-
Relative Dependence IRM	67%	67%	83%	67%	83%	100%	-	-

According to the reachability matrix calculations in interpretive structural modeling, the "intervening conditions of the IT strategic plan (challenging)" holds the most significant power of influence since its relative influence power is calculated to be 100% (6 out of 6). Meanwhile, the "outcomes and effects of the IT strategic plan (results)" was determined to have 50% (3 out of 6). In fact, the relative influence power and the relative degree of dependence for both the "contextual conditions of the IT strategic plan (enabling)" and the "mechanisms of the IT strategic plan (strategies)" were measured to be exactly the same, at 83%. Following the reachability matrix in interpretive structural modeling, the power-dependence chart for the foresight of related concepts is presented

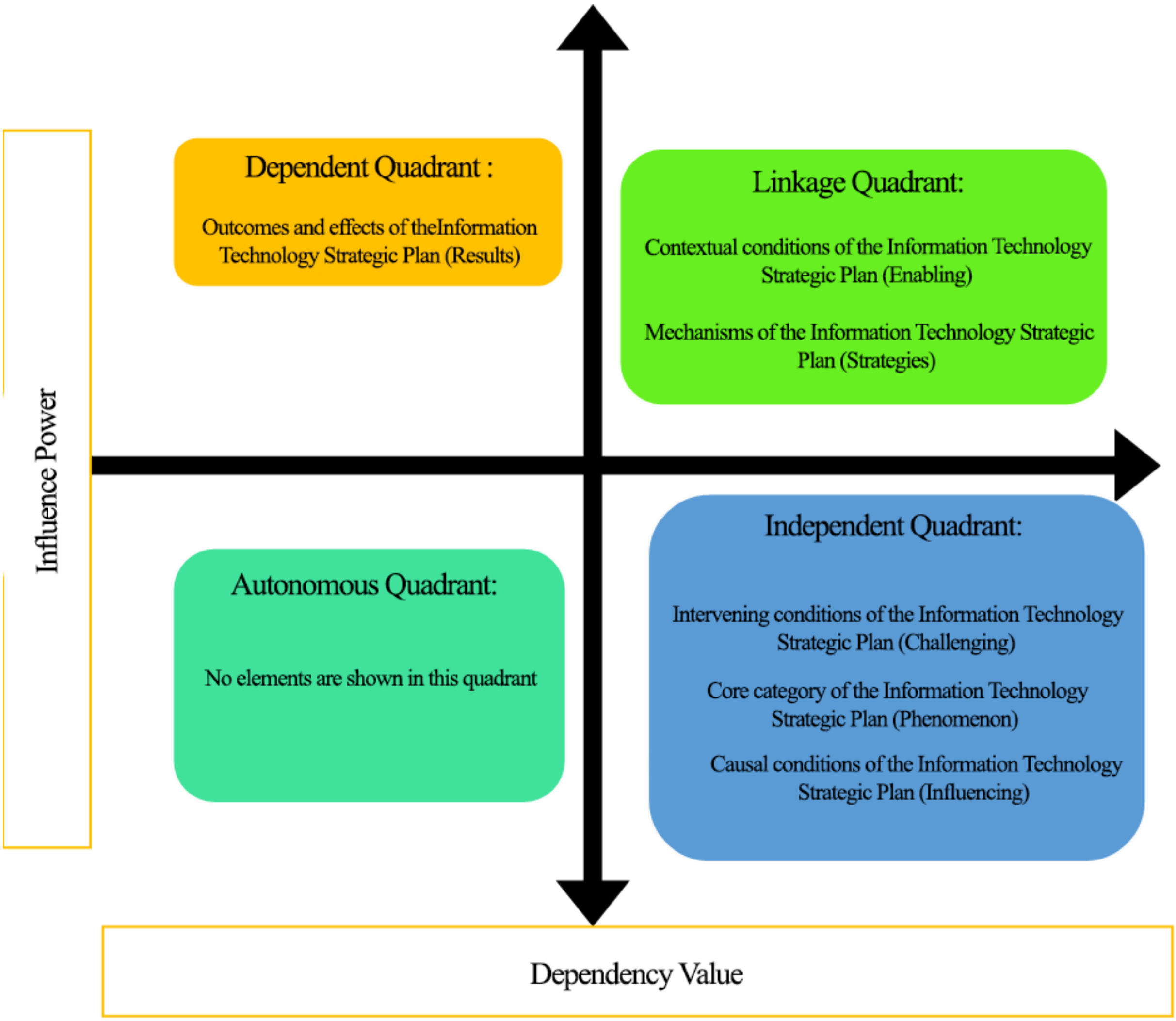

Figure 1: Power-Dependence Matrix in Interpretive Structural Modeling

According to the power-dependence chart for foresight of related concepts, the "outcomes and effects of the IT strategic plan (results)" has the highest level of dependence, with a relative dependence of 100% (6 out of 6), placing it in the "dependent" quadrant (high dependence, low influence). Meanwhile, the relative dependence of the "causal conditions of the IT strategic plan (influencing)," "core category of the IT strategic plan (phenomenon)," and the "intervening conditions of the IT strategic plan (challenging)" was determined to be 67% (4 out of 6), placing them in the "independent" quadrant (low dependence, high influence). In contrast, the "contextual conditions of the IT strategic plan (enabling)" and the "mechanisms of the IT strategic plan (strategies)" with a relative influence of 83% and a relative dependence of 83% are placed in the "linkage" quadrant (high dependence, high influence). Notably, no variable falls into the "autonomous" quadrant (low dependence, low influence). Based on these findings, structural equation modeling was conducted.

In the fourth step, based on the adjusted reachability matrix, the levels of each variable are determined by calculating the total input, output, and common variables in each iteration. If the output variable equals the common variable in an iteration, that iteration is considered the i-th level. In the next iteration, the row and column of that variable are removed from the matrix, and the calculations are repeated. The results are presented in the following:

Table 3: Criteria for Level 1

Label	Output	Input	Commonality
C1	C1, C2, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18	C1, C2, C3	C1, C2
C2	C1, C2, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18	C1, C2, C3	C1, C2
C3	**C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18**	**C3**	**C3**
C4	C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C13, C14, C15, C16, C17, C18	C4, C5, C6, C7, C8, C9, C10, C11, C13, C14, C15, C16, C17
C5	C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C13, C15	C4, C5, C6, C7, C8, C9, C10, C13, C15
C6	C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C13, C15	C4, C5, C6, C7, C8, C9, C10, C13, C15
C7	C4, C5, C6, C7, C8, C9, C10, C11, C13, C14, C15, C16, C17	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C13, C15	C4, C5, C6, C7, C8, C9, C10, C13, C15
C8	C4, C5, C6, C7, C8, C9, C10, C11, C13, C14, C15, C16	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C13, C15	C4, C5, C6, C7, C8, C9, C10, C13, C15
C9	C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C13, C15, C18	C4, C5, C6, C7, C8, C9, C10, C11, C13, C15
C10	C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C13, C15	C4, C5, C6, C7, C8, C9, C10, C13, C15
C11	C4, C9, C11, C13, C14, C15, C16, C17	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C13, C15	C4, C9, C11, C13, C15
C12	C12	C1, C2, C3, C4, C5, C6, C9, C10, C12, C15, C17, C18	C12
C13	C4, C5, C6, C7, C8, C9, C10, C11, C13, C14, C15, C16	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C13, C14, C15, C16, C17, C18	C4, C5, C6, C7, C8, C9, C10, C11, C13, C14, C15, C16
C14	C4, C13, C14, C16	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C13, C14, C15, C17, C18	C4, C13, C14
C15	C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C13, C15, C17, C18	C4, C5, C6, C7, C8, C9, C10, C11, C13, C15, C17, C18
C16	C4, C13, C16	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C13, C14, C15, C16, C17, C18	C4, C13, C16
C17	C4, C12, C13, C14, C15, C16, C17, C18	C1, C2, C3, C4, C7, C11, C15, C17, C18	C4, C15, C17, C18
C18	C4, C9, C12, C13, C14, C15, C16, C17, C18	C1, C2, C3, C15, C17, C18	C15, C17, C18

Table 4: Criteria for Level 2

Label	Output	Input	Commonality
C1	C1, C2, C4, C5, C6, C7, C8, C9, C10, C11, C14, C15, C17, C18	C1, C2, C3	C1, C2
C2	C1, C2, C4, C5, C6, C7, C8, C9, C10, C11, C14, C15, C17, C18	C1, C2, C3	C1, C2
C3	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C14, C15, C17, C18	C3	C3
C4	C4, C5, C6, C7, C8, C9, C10, C11, C14, C15, C17	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C14, C15, C17, C18	C4, C5, C6, C7, C8, C9, C10, C11, C14, C15, C17
C5	**C4, C5, C6, C7, C8, C9, C10, C11, C14, C15**	**C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C15**	**C4, C5, C6, C7, C8, C9, C10, C15**

Table 5: Criteria for Level 3

Label	Output	Input	Commonality
C1	C1, C2, C5, C6, C7, C8, C9, C10, C11, C15, C17, C18	C1, C2, C3	C1, C2
C2	C1, C2, C5, C6, C7, C8, C9, C10, C11, C15, C17, C18	C1, C2, C3	C1, C2
C3	C1, C2, C3, C5, C6, C7, C8, C9, C10, C11, C15, C17, C18	C3	C3
C5	C5, C6, C7, C8, C9, C10, C11, C15	C1, C2, C3, C5, C6, C7, C8, C9, C10, C15	C5, C6, C7, C8, C9, C10, C15
C6	**C5, C6, C7, C8, C9, C10, C11, C15**	**C1, C2, C3, C5, C6, C7, C8, C9, C10, C15**	**C5, C6, C7, C8, C9, C10, C15**
C7	C5, C6, C7, C8, C9, C10, C11, C15, C17	C1, C2, C3, C5, C6, C7, C8, C9, C10, C15	C5, C6, C7, C8, C9, C10, C15

C8	C5, C6, C7, C8, C9, C10, C11, C15	C1, C2, C3, C5, C6, C7, C8, C9, C10, C15	C5, C6, C7, C8, C9, C10, C15
C9	C5, C6, C7, C8, C9, C10, C11, C15	C1, C2, C3, C5, C6, C7, C8, C9, C10, C11, C15, C18	C5, C6, C7, C8, C9, C10, C11, C15
C10	C5, C6, C7, C8, C9, C10, C11, C15	C1, C2, C3, C5, C6, C7, C8, C9, C10, C15	C5, C6, C7, C8, C9, C10, C15
C11	C9, C11, C15, C17	C1, C2, C3, C5, C6, C7, C8, C9, C10, C11, C15	C9, C11, C15
C15	C5, C6, C7, C8, C9, C10, C11, C15, C17, C18	C1, C2, C3, C5, C6, C7, C8, C9, C10, C11, C15, C17, C18	C5, C6, C7, C8, C9, C10, C11, C15, C17, C18
C17	C15, C17, C18	C1, C2, C3, C7, C11, C15, C17, C18	C15, C17, C18
C18	C9, C15, C17, C18	C1, C2, C3, C15, C17, C18	C15, C17, C18

In the fifth step, using the levels obtained from the criteria, the ISM interaction network is drawn. If there is a relationship between two variables, i and j, it is represented by a directed arrow. The final diagram, created after removing transitive states and using the obtained levels, is shown in Figure 2.

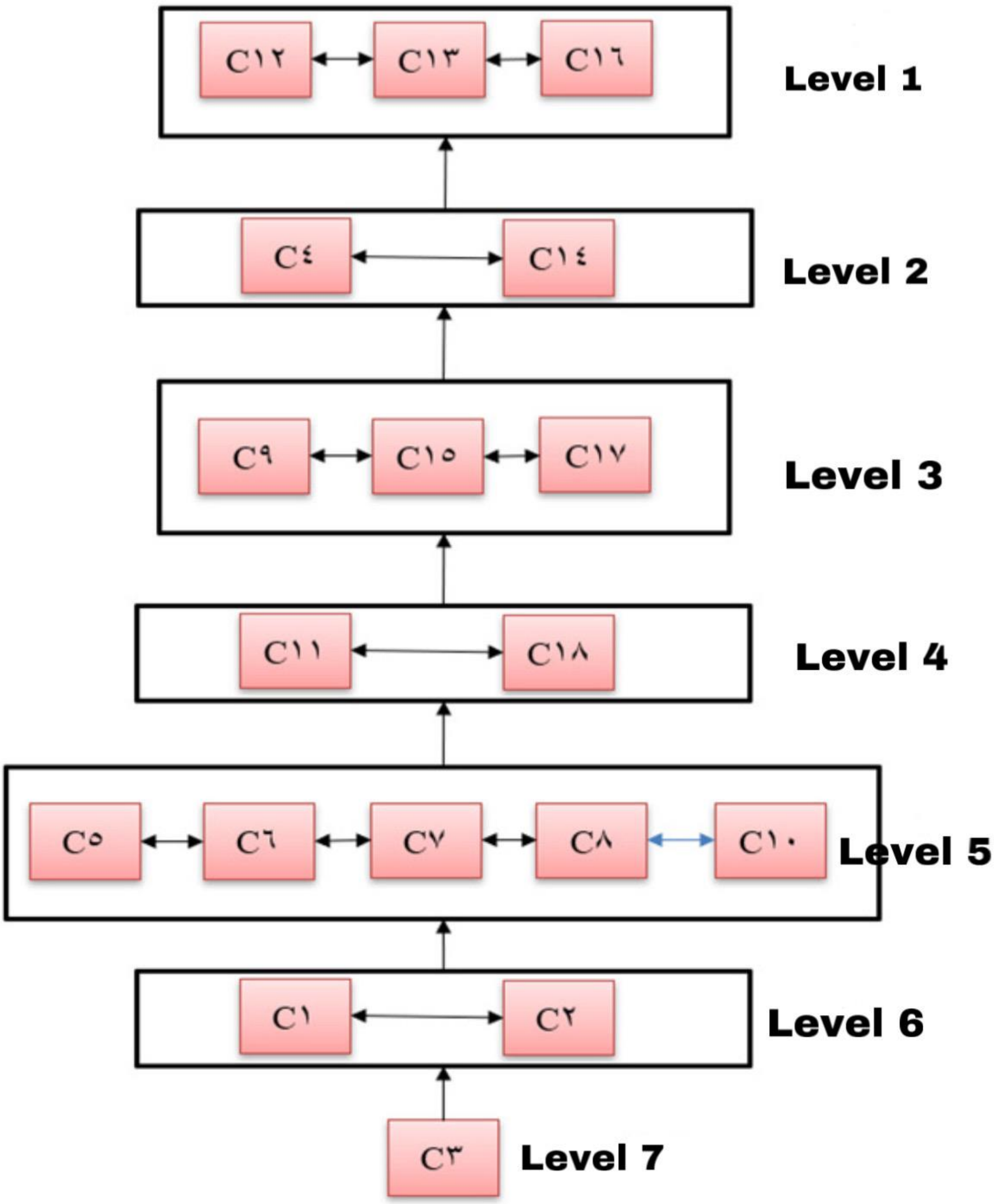

Figure 2: ISM Model of the Research

Furthermore, the research model can be presented based on influence and dependence power, as illustrated in Figure 3. The X-axis represents the level of dependence, while the Y-axis represents the level of influence. Accordingly, variables C4, C5, C6, C7, C8, C9, C10, C13, and C15 are linkage variables, characterized by high dependence and high driving power. In other words, these variables are highly influential and susceptible to changes within the system, meaning any small alteration in these variables leads to significant system changes.

Variables C1, C2, and C3 are independent variables, marked by low dependence and high driving power. These variables have a high impact but are less affected by the system. On the other hand, variables C11, C12, C14, and C16 are dependent variables, with strong dependence and weak driving power. These variables are primarily influenced by the system but have little influence on it. Variables C17 and C18 are autonomous variables with low dependence and low driving power, indicating their weak connections to the system.

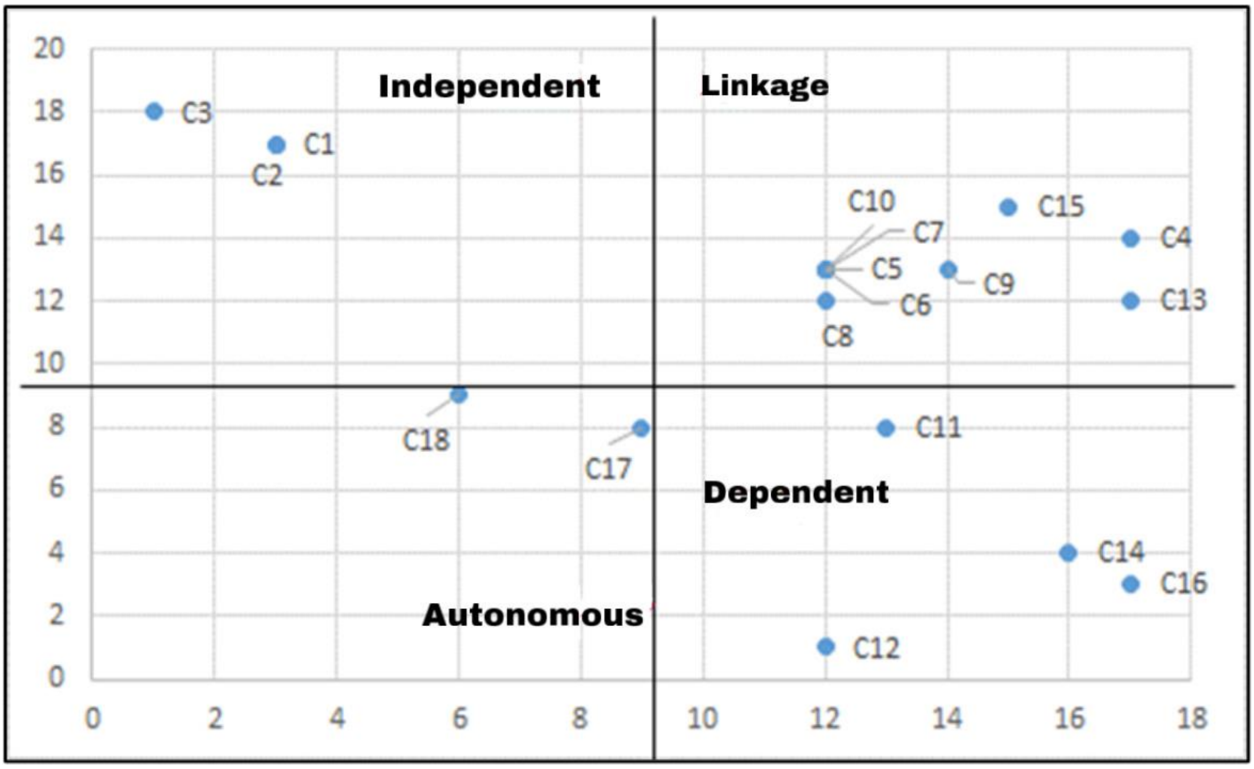

Figure 3: Influence-Dependence Matrix

Finally, structural equation modeling was employed to examine and confirm or reject the established relationships. One of the key indicators for confirming the relationships in the structural model is the significance of the path coefficients. The significance of path coefficients complements the magnitude and direction of the beta coefficient in the model. If the obtained value exceeds the minimum statistic at the desired confidence level, the relationship or hypothesis is confirmed. At significance levels of 90%, 95%, and 99%, this value is compared with the minimum t-statistic of 1.64, 1.96, and 2.58, respectively.

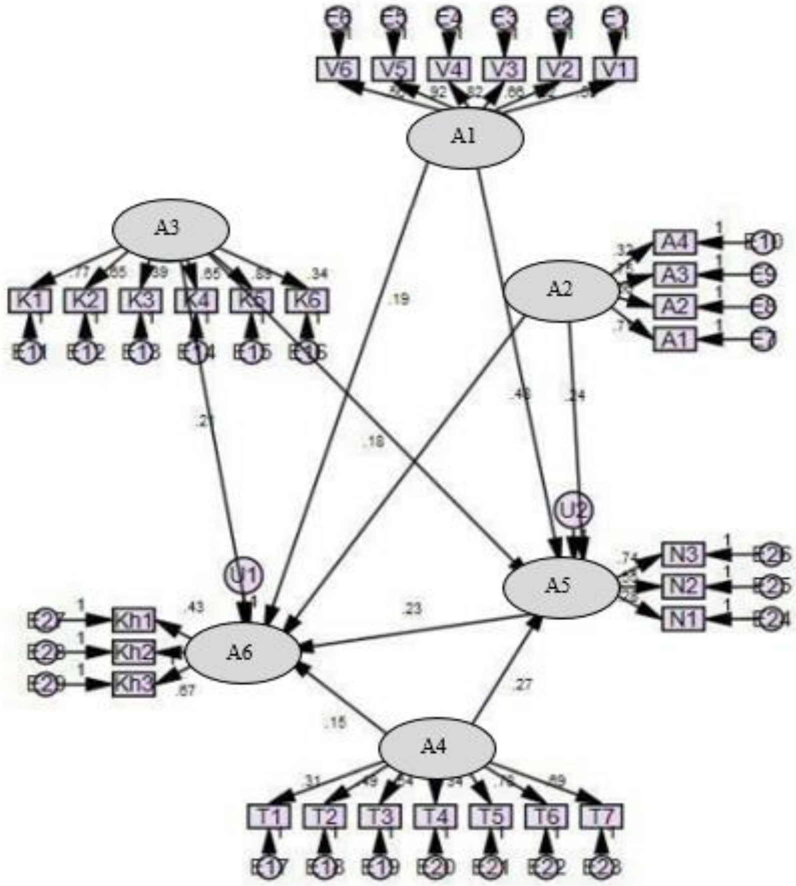

Figure 4: Significance of Path Coefficients Discussion and Conclusion

The findings of this study highlight several key components essential for the successful implementation of an Information Technology Strategic Plan (ITSP) in knowledge-based industries, with specific attention to the pharmaceutical industry. The analysis identified 18 significant components that influence the development and execution of ITSP, including IT strategy evaluation, formulation, and implementation; organizational vision and objectives; critical performance indicators; and external and internal challenges. The results underscore the importance of aligning IT strategy with organizational goals and the necessity for robust mechanisms to overcome industry-specific challenges. These findings align with the broader literature on the intersection of knowledge management and innovation, particularly in industries where the rapid pace of technological advancement demands continual adaptation (Amirova, Sargina, & Khasanova, 2021; An et al., 2021).

A critical finding from this study is the influence of external factors, such as industry size and the level of IT integration, on the development and success of IT strategies. The results show that the greatest influence on ITSP comes from external challenges, including organizational size, industry type, and technology adoption. This is consistent with the findings of Chen and Kim (2023), who reported that the relationship between industrial policy and exploratory innovation is strongly influenced by external factors, particularly in high-tech sectors. Furthermore, the identification of mechanisms for rapid service and product development aligns with Albort-Morant et al. (2018), who identified absorptive capacity as a critical driver of innovation performance, particularly in industries reliant on continuous external knowledge inflow.

The strategic use of IT within organizations is highlighted as a key driver of innovation and organizational success. The results support the view that IT governance and architecture must be improved to ensure the strategic alignment of IT with overall organizational goals (Aalbers & Whelan, 2021; Alaffad & Masrom, 2018). This is in line with previous studies, which emphasize the importance of IT infrastructure in facilitating knowledge flow and supporting innovative processes within organizations (Popescu et al., 2019). The findings suggest that IT can act as both an enabler and a barrier, depending on how well it is integrated into the organizational structure and strategy. Firms that can effectively manage their IT infrastructure and utilize it as a tool for innovation will have a significant competitive advantage in the knowledge-based economy.

A particularly interesting result is the identification of the highest leverage components in the development of ITSP, including IT strategy formulation and execution. These components were found to have a strong influence on the overall success of IT implementation, a finding that mirrors the work of Fu, Wu, and Shan (2022), who demonstrated that in the pharmaceutical industry, innovation is heavily reliant on the alignment of strategy with organizational objectives. Additionally, the results point to the importance of environmental factors in shaping the success of ITSP, with external pressures such as regulatory requirements and market competition driving the need for more agile and adaptive IT strategies. These findings align with the broader literature on innovation ecosystems, where external factors such as policy frameworks and market dynamics play a critical role in shaping organizational innovation (Andersen & Wicken, 2020; D'Itria, 2023).

One of the key contributions of this study is the identification of mechanisms for leveraging internet infrastructure to provide services and products in a more flexible and responsive manner. This finding is consistent with previous research, which has shown that digital platforms and online collaboration tools are essential for enabling knowledge sharing and collaborative innovation (Aalbers & Whelan, 2021; Alaffad & Masrom, 2018). In knowledge-intensive industries, such as pharmaceuticals and biotechnology, the ability to quickly adapt to changing market conditions and deliver new products and services is critical for maintaining competitiveness (Freitas & Fontana, 2017). This study contributes to this body of knowledge by providing a detailed framework for how IT can be used strategically to enhance innovation and organizational performance.

Another important finding is the role of organizational vision and goals in driving IT strategy. The results show that organizations that have a clear vision and well-defined objectives are more likely to successfully implement IT strategies that support innovation. This is consistent with the work of Grinza and Quatraro (2019), who demonstrated that organizations with a strong strategic vision are better able to align their IT initiatives with broader organizational goals, leading to more effective innovation outcomes. Furthermore, the identification of critical performance indicators as a key component of ITSP aligns with previous research, which has shown that organizations that effectively measure and monitor their performance are better able to adapt to changes in the external environment and improve their innovation outcomes (Dotzel & Faggian, 2019).

The results also highlight the challenges associated with the size of the organization and the level of IT adoption. Larger organizations, in particular, face significant challenges in integrating IT across their various departments and business units. This finding aligns with the literature on organizational size and complexity, which has shown that larger organizations often struggle with the coordination and alignment of IT initiatives (Bukstein, Hernández, & Usher, 2019). However, the study also suggests that organizations that can overcome these challenges by leveraging IT strategically can gain a significant competitive advantage, particularly in knowledge-based industries.

This study is not without limitations. First, the sample size, although adequate for the purposes of this research, may limit the generalizability of the findings. The focus on the pharmaceutical industry, while providing valuable insights into this sector, may not fully capture the nuances of IT strategy in other knowledge-based industries such as biotechnology or aerospace. Furthermore, the use of qualitative data from a limited number of experts could introduce bias, as the perspectives of these individuals may not fully represent the diversity of views within the industry. Future research should seek to expand the sample size and include participants from a broader range of industries to enhance the generalizability of the findings.

Another limitation is the cross-sectional nature of the study, which provides a snapshot of the current state of IT strategy in knowledge-based industries but does not capture how these strategies evolve over time. Longitudinal studies would be valuable in understanding how IT strategies adapt to changes in the external environment, such as new regulatory requirements or technological advancements. Additionally, the reliance on self-reported data, particularly in the qualitative interviews, may introduce bias, as participants may overestimate the success of their IT initiatives or underreport challenges.

Given the limitations of this study, several avenues for future research emerge. First, future studies should aim to conduct longitudinal research to explore how IT strategies evolve over time in response to changing market conditions and technological advancements. This would provide valuable insights into the dynamic nature of IT strategy and how organizations can remain agile in a rapidly changing environment. Additionally, future research should examine the role of government policy and regulatory frameworks in shaping IT strategy, particularly in industries such as pharmaceuticals, where regulatory compliance is a critical factor in innovation.

Future research should also focus on exploring the relationship between IT strategy and organizational culture. While this study identified organizational vision and goals as key drivers of IT strategy, the role of culture in shaping IT adoption and integration was not explored in depth. Research in this area could provide valuable insights into how organizations can foster a culture of innovation and IT adoption that supports long-term competitiveness. Moreover, future studies could investigate the impact of emerging technologies, such as artificial intelligence and blockchain, on IT strategy in knowledge-based industries.

Another important area for future research is the exploration of the role of external partners, such as suppliers and customers, in shaping IT strategy. While this study focused primarily on internal factors, the literature suggests that external collaborations are increasingly important for driving innovation, particularly in industries that rely on complex supply chains (Freitas & Fontana, 2017). Future research could explore how organizations can effectively manage these external relationships to enhance their IT strategy and drive innovation.

For practitioners, this study offers several important insights into how organizations can strategically implement IT to drive innovation and enhance performance. First, organizations should focus on aligning their IT strategy with their overall organizational vision and objectives. This requires a clear understanding of the organization's goals and a commitment to using IT as a strategic tool to support these goals. Organizations should also invest in improving their IT governance and architecture to ensure that IT is fully integrated into their business processes and that it supports innovation across all levels of the organization.

Second, organizations should be proactive in addressing the external challenges that influence IT strategy, such as regulatory requirements and market competition. This requires ongoing monitoring of the external environment and the development of agile IT strategies that can quickly adapt to changes. Organizations should also focus on building their absorptive capacity, as the ability to recognize and assimilate external knowledge is critical for driving innovation performance.

Finally, organizations should leverage digital platforms and online collaboration tools to enhance knowledge sharing and innovation. As the findings of this study suggest, organizations that can effectively use these tools to collaborate with external partners and share knowledge across organizational boundaries are better positioned to innovate and remain competitive in the knowledge-based economy. Practitioners should invest in digital infrastructure and training to ensure that employees are equipped to fully utilize these tools and contribute to the organization's innovation efforts.

References

Aalbers, R., & Whelan, E. (2021). Implementing digitally enabled collaborative innovation: A case study of online and offline interaction in the German automotive industry. Creativity and Innovation Management, 30(2), 368-383. https://doi.org/10.1111/caim.12437

Alaffad, A., & Masrom, A. (2018). Knowledge management framework for the collaborative innovation projects: A case of aviation industry in the UAE. International Journal of Advanced and Applied Sciences, 5(2), 76-80. https://doi.org/10.21833/ijaas.2018.02.013

Albort-Morant, G., Leal-Rodríguez, A., & Marchi, V. (2018). Absorptive capacity and relationship learning mechanisms as complementary drivers of green innovation performance. Journal of Knowledge Management, 22(2), 432-452. https://doi.org/10.1108/jkm-07-2017-0310

Alves, N., Vargas, M., & Britto, J. (2016). Innovation and competence building in the Brazilian biopharmaceutical industry. https://doi.org/10.5151/engpro-1enei-038

Amirova, N., Sargina, L., & Khasanova, A. (2021). Consumer innovation management in the mining industry economy. E3S Web of Conferences, 278, 03034. https://doi.org/10.1051/e3sconf/202127803034

An, X., Qi, L., Zhang, J., & Jiang, X. (2021). Research on the evolutionary game of knowledge pricing in an open innovation environment: From the perspective of social dual innovation balance. Asia Pacific Journal of Marketing and Logistics, 34(7), 1392-1415. https://doi.org/10.1108/apjml-05-2021-0320

Andersen, A., & Wicken, O. (2020). Making sense of how the natural environment shapes innovation, industry dynamics, and sustainability challenges. Innovation and Development, 11(1), 91-117. https://doi.org/10.1080/2157930x.2020.1770975

Arijitsatien, C., & Ractham, V. (2017). The effects of knowledge creation process upon the organizational performance: A study of Thai banking industry. International Journal of Culture and History (Ejournal), 3(4), 236-242. https://doi.org/10.18178/ijch.2017.3.4.106

Asheim, B., Grillitsch, M., & Trippl, M. (2017). Introduction: Combinatorial knowledge bases, regional innovation, and development dynamics. Economic Geography, 93(5), 429-435. https://doi.org/10.1080/00130095.2017.1380775

Bawa, S. (2023). Impact of knowledge management on firms' innovation performance. Technology and Investment, 14(4), 293-328. https://doi.org/10.4236/ti.2023.144018

Bukstein, D., Hernández, E., & Usher, X. (2019). Assessing the impacts of market failures on innovation investment in Uruguay. Journal of Technology Management & Innovation, 14(4), 137-157. https://doi.org/10.4067/s0718-27242019000400137

Chen, P., & Kim, S. (2023). The relationship between industrial policy and exploratory innovation – Evidence from high-tech enterprise identification policy in China. Kybernetes, 53(5), 1636-1652. https://doi.org/10.1108/k-12-2022-1699

D'Itria, E. (2023). Fostering fashion ecosystems: A quadruple helix-based model for European sustainable innovation. Systems, 11(9), 478. https://doi.org/10.3390/systems11090478

Dotzel, K., & Faggian, A. (2019). The impact of external knowledge sourcing on innovation outcomes in rural and urban businesses in the U.S. Growth and Change, 50(2), 515-547. https://doi.org/10.1111/grow.12289

Drewniak, Z., & Posadzińska, I. (2020). Learning and development tools and the innovative potential of artificial intelligence companies. European Research Studies Journal, 23(2), 388-404. https://doi.org/10.35808/ersj/1599

Freitas, I., & Fontana, R. (2017). Formalized problem-solving practices and the effects of collaboration with suppliers on a firm's product innovation performance. Journal of Product Innovation Management, 35(4), 565-587. https://doi.org/10.1111/jpim.12432

Fu, L., Wu, F., & Shan, Z. (2022). Evolutionary path and innovative development of pharmaceutical industrial cluster—a case study of Shijiazhuang, China. International Journal of Environmental Research and Public Health, 19(5), 2928. https://doi.org/10.3390/ijerph19052928

Gallouj, F. (2019). Beyond technological innovation: Trajectories and varieties of services innovation. In Trajectories and varieties of innovation (pp. 129-145). https://doi.org/10.4324/9781315864228-7

Glushak, N., Glushak, O., Shuklina, Z., & Gerashchenkova, T. (2016). Innovative methods of industrial enterprises management based on the universal network model. SHS Web of Conferences, 28, 01041. https://doi.org/10.1051/shsconf/20162801041

Go, K. (2022). Enabling innovation in the Philippine rice industry: The roles and key capabilities of innovation intermediaries. STI Policy and Management Journal, 7(1). https://doi.org/10.14203/stipm.2022.315

Grinza, E., & Quatraro, F. (2019). Workers' replacements and firms' innovation dynamics: New evidence from Italian matched longitudinal data. Research Policy, 48(9), 103804. https://doi.org/10.1016/j.respol.2019.05.013

Heil, S., & Bornemann, T. (2017). Creating shareholder value via collaborative innovation: The role of industry and resource alignment in knowledge exploration. R&D Management, 48(4), 394-409. https://doi.org/10.1111/radm.12258

Hohberger, J. (2014). Searching for emerging knowledge: The influence of collaborative and geographically proximate search. European Management Review, 11(2), 139-157. https://doi.org/10.1111/emre.12031

Lazarenko, Y., Garafonova, O., Margasova, V., Tkalenko, N., & Grigashkina, S. (2020). Exploring strategic directions for the local innovation ecosystem development in the mining industry. E3S Web of Conferences, 174, 02001. https://doi.org/10.1051/e3sconf/202017402001

Marule, N. (2022). The role of technology commercialisation in the operationalisation of innovation and industrial policies in South Africa. Triple Helix Journal, 9(2), 119-137. https://doi.org/10.1163/21971927-bja10013

Popescu, D., Ceptureanu, S., Alexandru, A., & Ceptureanu, E. (2019). Relationships between knowledge absorptive capacity, innovation performance, and information technology: Case study—The Romanian creative industries SMEs. Studies in Informatics and Control, 28(4), 463-476. https://doi.org/10.24846/v28i4y201910