The Role of Information Technology and Employee Engagement in Enhancing Knowledge Management in the Pharmaceutical Research and Development Process: Insights from Dynamic Capabilities Theory

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Abstract: This study investigates the impact of Information Technology and employee engagement on the implementation of Knowledge Management within the Research and Development processes of pharmaceutical companies. Based on Dynamic Capabilities Theory, this research examines the interaction between these factors in facilitating Knowledge Management practices. The findings indicate that while both Information Technology and employee engagement significantly enhance Knowledge Management implementation, the latter has a more pronounced effect. Engaged employees are crucial for identifying opportunities and driving strategic initiatives, whereas Information Technology supports information processing and decision making. This study highlights the complex interaction between technology and human creativity, demonstrating that the future of Knowledge Management in Research and Development relies not only on advanced systems but also on the active and committed individuals who utilize them.

Keywords: knowledge management; information technology; employee engagement; research and development; innovation; human resources; pharmaceutical industry; dynamic capabilities theory

1. Introduction

Over the past three decades, Knowledge Management has become an essential component of modern management philosophy, particularly in the context of an increasingly competitive environment [1,2]. Organizations are recognizing the substantial benefits of effective Knowledge Management and are focusing on optimizing knowledge acquisition, sharing, and utilization [3,4]. Consequently, many organizations are evolving into knowledge-intensive entities, underscoring the necessity for deliberate and systematic Knowledge Management practices [5–7].

In parallel, the rapid advancement of science and technology compels organizations to adopt new methods for optimizing the development of their products and services [8,9]. As a result, organizations striving for survival and success in the highly competitive modern environment are continually seeking ways to enhance their Research and Development (R&D) processes. This enhancement aims to achieve desired outcomes, such as reducing product development time and improving product quality. This trend is particularly pronounced in critical sectors of the economy and high-tech, knowledge-intensive industries, including telecommunications, electronics, software development, renewable energy, nanotechnology, biotechnology, and pharmaceuticals [10–15].

Previous research has demonstrated the significant advantages of applying Knowledge Management in the R&D processes, highlighting its role in enhancing product development and organizational outcomes [16–20]. Additionally, factors such as Information Technology...
and employee engagement have been identified as having a substantial positive impact on the effective implementation of Knowledge Management in R&D settings [21–25]. While this literature provides a foundational understanding, it predominantly focuses on isolated impacts within uniform contexts and lacks comprehensive analysis across varied geographies or under different theoretical frameworks.

This study seeks to address these gaps by conducting a field research investigation, with its primary objective being to explore the synergistic effects of Information Technology and employee engagement on Knowledge Management within the Greek pharmaceutical industry’s R&D processes, a sector characterized by rapid innovation and complex dynamics. Grounded in Dynamic Capabilities Theory, this research aims to clarify how these factors interact dynamically to promote an environment supportive to knowledge creation and application. This theory is particularly pertinent as it emphasizes an organization’s ability to sense opportunities and threats and to maintain competitiveness through the reconfiguration and combination of resources and capabilities, which are essential for analyzing the complex dynamics in the pharmaceutical sector. Thus, the central research question guiding this study is as follows:

*How do Information Technology and employee engagement interact to foster an environment conducive to effective Knowledge Management in the pharmaceutical industry’s R&D processes?*

In addressing this question, the research also explores secondary goals, such as understanding the broader implications of these interactions and proposing further research directions to investigate the scalability of these strategies across different organizational contexts.

This approach not only deepens our understanding of Knowledge Management in complex settings but also enhances the generalizability of Knowledge Management strategies across different geographies and theoretical perspectives, providing a robust framework for utilizing Information Technology and employee engagement in knowledge-intensive industries.

The structure of this paper is as follows: Section 2 examines the existing literature, providing a foundation for a detailed understanding of Dynamic Capabilities Theory, Knowledge Management in R&D, and the roles of Information Technology and employee engagement in implementing Knowledge Management. Section 3 outlines the research methodology employed, emphasizing the robustness and precision of the empirical approach taken. In Section 4, the findings are detailed, showcasing the interaction between Information Technology and employee engagement in enhancing Knowledge Management. Section 5 synthesizes the research insights, offering a discussion on the theoretical contributions and practical implications and suggesting paths for future research into the field.

2. Literature Review

This section provides a comprehensive overview of the key theories and concepts relevant to this study. It explores Dynamic Capabilities Theory, the role of Knowledge Management in R&D, and the impact of Information Technology and employee engagement on Knowledge Management implementation.

2.1. Dynamic Capabilities Theory

Dynamic Capabilities Theory, as proposed by Teece et al. [26], focuses on how firms can achieve and sustain a competitive advantage in dynamic environments through their ability to sense opportunities and threats, seize opportunities, and maintain competitiveness through the reconfiguration, combination, and protection of resources and capabilities.

This theory is particularly relevant to the current research as it provides a robust framework for understanding the interactions between Information Technology and employee engagement in the implementation of Knowledge Management within the R&D process. Advanced Information Technology systems help organizations gather and process information, enabling them to sense market trends and technological advancements. Engaged
employees contribute significantly to this sensing capability by sharing insights, feedback, and innovations.

Information Technology infrastructure supports swift decision making and the implementation of strategies to seize opportunities. Highly engaged employees are more likely to embrace and drive strategic initiatives, ensuring successful execution. Furthermore, Information Technology facilitates the reconfiguration of processes and systems to adapt to new challenges and opportunities. Engaged employees are more adaptable and willing to acquire new skills, aiding in the transformation process.

Dynamic Capabilities Theory naturally integrates Information Technology and employee engagement, recognizing both as crucial enablers that enhance the firm’s capabilities in sensing, seizing, and transforming opportunities and threats. Effective Information Technology systems improve data collection, communication, and process optimization. Meanwhile, engaged employees are more proactive, innovative, and committed to the organization’s goals, playing a significant role in sensing new opportunities, participating in decision making, and adapting to changes.

Using Dynamic Capabilities Theory, this study explores how Information Technology systems enhance the organization’s ability to manage knowledge and support dynamic capabilities by enabling quick adaptation and continuous improvement in the R&D process. It also examines how engaged employees contribute to knowledge sharing, innovation, and adaptation to new processes or technologies, ultimately supporting the effective implementation of Knowledge Management in the R&D process. This framework is particularly relevant in the pharmaceutical sector, where the rapid advancement of science and technology necessitates continuous adaptation and innovation.

2.2. Knowledge Management in Research and Development

Organizations in today’s highly competitive environment continuously strive to avoid crises by acquiring and maintaining their competitive advantages [27]. This effort is particularly evident in high-tech and knowledge-intensive industries, such as the pharmaceutical sector. The competitive landscape of these industries is characterized by rapid change and significant uncertainty, necessitating continuous improvement in their R&D capabilities. As a result, organizations in such dynamic environments recognize that the successful implementation of R&D is a critical challenge requiring focused attention [28,29].

For over four decades, research has identified various factors contributing to the effective and successful implementation of an organization’s R&D process [30–34]. The inherently knowledge-intensive nature of this process has led researchers to emphasize Knowledge Management as a crucial tool for achieving this objective [16,17,35,36]. Consequently, the R&D process is central to the application of Knowledge Management, serving as a primary source of knowledge creation and dissemination [37,38]. From this perspective, the primary objective of applying Knowledge Management in the R&D process is to facilitate the development of new products. Achieving this goal typically necessitates the integration of diverse knowledge from both the internal and external environments of the organization [36,39,40]. Ensuring the effective flow of necessary knowledge across all the structures and activities of the R&D process is essential. Therefore, the successful implementation of Knowledge Management is crucial in accomplishing these outcomes [41].

A comprehensive review of the pertinent literature identified several significant studies that emphasize the critical role of Knowledge Management in R&D across diverse industries and organizational contexts. Frameworks specifically tailored to R&D settings were developed by Kerssens-Van Drongelen et al. [42], Suh et al. [43], and Park and Kim [44,45]. These frameworks addressed aspects ranging from knowledge acquisition and application to generational changes in R&D processes, such as the KNOWVATION model for 4th generation R&D. Similarly, Armbrecht Jr et al. [46] explored Knowledge Management practices in nineteen leading firms and identified six foundational principles essential to Knowledge Management in R&D.
The impact of Knowledge Management on innovation and productivity was another focus area. Ferraris et al. [17] and Mete and Belgin [19] demonstrated how Knowledge Management orientation and performance could enhance innovation and efficiency, particularly in small- and medium-sized enterprises (SMEs) and Turkish R&D companies. Mendoza et al. [18] reported increased productivity in US government R&D centers following the implementation of Knowledge Management practices.

Studies that examined the dissemination and integration of knowledge within organizations include those by Brachos et al. [47], who looked at knowledge dissemination across 72 companies, and Kraaijenbrink [48], who found that Knowledge Management success in 58 high-tech firms depended significantly on knowledge integration and process interactions. Pitt and MacVaugh [49] highlighted practical Knowledge Management mechanisms that operate across organizational levels.

Lastly, the roles of tacit knowledge and organizational learning in R&D were explored by Roy and Mitra [50] and Sonmez Cakir et al. [51], who linked these elements to the quality performance of public R&D labs in India and the success of service quality and product innovation in Information Technology firms, respectively.

Table 1 provides a comprehensive summary of key research on the application of Knowledge Management in R&D processes. The findings from these studies clearly demonstrate that effective Knowledge Management significantly enhances the efficiency, innovation capabilities, and overall performance of R&D processes. However, there is a need for further examination through various theoretical frameworks and across different organizational contexts to solidify these insights and identify potential variations.

Table 1. Representative studies on the use of Knowledge Management in R&D processes.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Main Findings</th>
<th>Methodology</th>
<th>Theoretical Framework</th>
<th>Sector(s)</th>
<th>Geographic Region(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[43]</td>
<td>Effective Knowledge Management significantly enhances the efficiency and innovation capabilities of R&amp;D processes.</td>
<td>Multiple case studies</td>
<td>Knowledge-Based View</td>
<td>High-tech and pharmaceutical</td>
<td>Asia–Pacific</td>
</tr>
<tr>
<td>[45]</td>
<td>Specific requirements for Knowledge Management systems are crucial variables in designing effective Knowledge Management systems, which serve as building blocks for integrating R&amp;D management and Knowledge Management.</td>
<td>Chronological review</td>
<td>Evolutionary ecology perspective</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[49]</td>
<td>Effective Knowledge Management enhances new product development by acknowledging multiple organizational levels and supporting both formal and informal knowledge processes.</td>
<td>Conceptual review</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[48]</td>
<td>The success of product development projects is significantly influenced by the extent to which knowledge integration and integration between knowledge processes take place.</td>
<td>Retrospective analysis</td>
<td>Evolutionary paradigm</td>
<td>High-tech</td>
<td>Netherlands</td>
</tr>
<tr>
<td>[18]</td>
<td>Knowledge Management practices lead to a significant increase in productivity, as evidenced by higher publication rates at government R&amp;D centers.</td>
<td>Quantitative analysis of publication rates</td>
<td>-</td>
<td>Government R&amp;D centers</td>
<td>United States</td>
</tr>
<tr>
<td>[50]</td>
<td>The effective management of both tacit and explicit knowledge significantly enhances the quality performance of R&amp;D laboratories.</td>
<td>Correspondence analysis (CA)</td>
<td>Knowledge conversion process</td>
<td>Various sectors</td>
<td>India</td>
</tr>
</tbody>
</table>
The type of collaborative practice adopted in a joint R&D project varies based on the knowledge required and the strategy of knowledge creation, ensuring a dynamic synthesis between tacit and explicit knowledge for innovation.

Knowledge Management orientation positively moderates the relationship between R&D internationalization and innovation performance in medium-sized companies.

There is a significant difference in efficiencies between high-performance and low-performance R&D active firms in terms of knowledge creation, information system infrastructure, knowledge culture, and knowledge worker productivity.

Knowledge management strategies and organizational innovation positively impact service quality and product innovation in Information Technology companies with R&D departments.

### 2.3. The Role of Information Technology and Employee Engagement

In the relevant literature, Information Technology and employee engagement are widely recognized as key enablers for the implementation of Knowledge Management. Notably, most studies focus on either one of these factors, with fewer examining the combination of both. When both factors are investigated, it is crucial to examine them simultaneously as complementary and supportive elements, rather than as substitutes for each other [52–57].

The examination of Information Technology and Information Systems within the context of Knowledge Management is a prevalent subject in the relevant literature, with numerous studies identifying it as a primary and significant supporting factor [58–60]. These studies explore the contribution of Information Technology both theoretically and empirically through two general approaches. The first approach emphasizes highly specialized information systems and tools proposed by authors as enablers for Knowledge Management implementation. These studies detail the operation and integration of these systems with Knowledge Management practices, focusing on specific features and providing usage examples [61–67]. The second approach examines the broader role of Information Technology by analyzing existing information systems and infrastructures, which significantly aid in Knowledge Management implementation. This approach focuses on how Information Technology supports the execution of Knowledge Management processes, particularly storage and retrieval, making it an essential factor for its implementation [68–73].

Following the examination of Information Technology, the focus shifts to employee engagement, which numerous studies also identify as a primary and crucial supporting factor in Knowledge Management [74]. These studies explore the contribution of employee engagement both theoretically and empirically, correlating employees’ tacit knowledge with their level of involvement in Knowledge Management. Specifically, they investigate how employee engagement facilitates the implementation of all Knowledge Management processes, particularly the creation, acquisition, dissemination, and use of knowledge, making it an essential factor for its application [22,75–79].
these studies suggest that both factors are critical and complementary components for effective Knowledge Management. Similar to the observations in Table 1 regarding R&D processes, additional research is also necessary here to further validate these findings and explore variations across different theoretical and organizational frameworks.

Table 2. Representative studies on the impact of Information Technology and employee engagement in Knowledge Management implementation.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Main Findings</th>
<th>Methodology</th>
<th>Theoretical Framework</th>
<th>Sector(s)</th>
<th>Geographic Region(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[52]</td>
<td>Effective Knowledge Management is achieved through the optimization of both technological and social subsystems, emphasizing the equal importance of Information Technology and employee engagement.</td>
<td>Theoretical approach</td>
<td>Sociotechnological perspective</td>
<td>Various sectors</td>
<td>United States</td>
</tr>
<tr>
<td>[55]</td>
<td>Information Technology and employee engagement, including involvement and training, are critical success factors for the implementation and success of a Knowledge Management System.</td>
<td>Field studies and statistical analysis</td>
<td>-</td>
<td>Pharmaceutical</td>
<td>Taiwan</td>
</tr>
<tr>
<td>[53]</td>
<td>Information Technology facilitates Knowledge Management by enabling and improving communication and collaboration among employees, while employee engagement is crucial for the effective implementation and sustainability of Knowledge Management initiatives.</td>
<td>Literature review</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[54]</td>
<td>Information Technology significantly enhances nurses’ explicit knowledge but does not directly improve their work engagement, highlighting the pivotal role of tacit knowledge in this process.</td>
<td>Quasiexperimental design</td>
<td>Job demands–resources model</td>
<td>Healthcare</td>
<td>Netherlands</td>
</tr>
<tr>
<td>[75]</td>
<td>Employee engagement significantly influences knowledge retention and contributes to organizational sustainability.</td>
<td>Qualitative research</td>
<td>Resource-Based View</td>
<td>-</td>
<td>India</td>
</tr>
<tr>
<td>[71]</td>
<td>Information Technology facilitates decision making but does not improve the efficacy of Knowledge Management processes or managerial productivity.</td>
<td>Empirical survey</td>
<td>-</td>
<td>Coal</td>
<td>India</td>
</tr>
<tr>
<td>[58]</td>
<td>Information Technology and Artificial Intelligence significantly enhance the efficiency of Knowledge Management practices by enabling faster information retrieval, real-time decision making, and improved process tracking.</td>
<td>Systematic literature review</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[68]</td>
<td>The implementation of Information Technology enhances the efficiency of Knowledge Management in supply chains by improving the transfer and distribution of information, and fostering better cooperation among supply chain members.</td>
<td>Literature review</td>
<td>-</td>
<td>Supply chain</td>
<td>-</td>
</tr>
<tr>
<td>[69]</td>
<td>Information Systems play a crucial role in the production of tacit knowledge within knowledge-based firms by fostering the adoption of shared mental models that align with organizational goals.</td>
<td>Theoretical approach</td>
<td>SECI model (Socialization, Externalization, Combination, and Internalization)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[76]</td>
<td>Employee engagement, driven by factors such as teamwork, rewards, learning, performance management, and empowerment, significantly enhances Knowledge Management performance in organizations.</td>
<td>Structural Equation Modeling</td>
<td>Resource-Based View; Positive Reinforcement Theory; Job Characteristics Theory; Self-Determination Theory; Goal-Setting Theory</td>
<td>Knowledge services</td>
<td>Sri Lanka</td>
</tr>
</tbody>
</table>

3. Research Method

This study employs an empirical research methodology to investigate the impact of Information Technology usage and employee engagement on the implementation of Knowledge Management in pharmaceutical R&D. The chosen approach integrates rigorous hypothesis testing grounded in a comprehensive literature review and a robust theoretical
framework, enabling a structured exploration of how these factors interact within this specific industry. This design was selected to facilitate a detailed examination of the empirical evidence against an established theory, thereby enriching the understanding of Knowledge Management dynamics in a highly specialized context. By detailing the study population and the census approach and carefully outlining the instruments and procedures for data collection, the methodology ensures that each component contributes effectively to the overall data integrity and analysis reliability. Statistical methods were chosen for their robustness in addressing the complexity of the relationships modeled, ensuring that the analysis could handle the effect of Information Technology and employee engagement on Knowledge Management. This empirical framework, depicted in Figure 1, is pivotal in not only addressing the study’s research question but also in providing actionable insights that are validated through rigorous data collection and analytical techniques.

Figure 1. Empirical research design.
Based on the literature review and the theoretical framework provided in Section 2, the following research hypothesis has been developed for statistical testing:

*The degree of Information Technology usage and employee engagement influences the implementation of Knowledge Management in pharmaceutical R&D.*

The study population consists of pharmaceutical companies engaged in R&D activities in Greece. Given the availability of a reliable consolidated list of such companies and the relatively small population size, a census approach was adopted instead of sampling, ensuring comprehensive coverage of all relevant enterprises. Seven directories were sourced to compile the initial list, which included a total of 143 pharmaceutical companies. After initial telephone communication to verify their engagement in R&D and exclude those solely involved in commercial or import activities, the final sample was refined to 101 pharmaceutical companies.

Data collection involved distributing a questionnaire to the general managers of these companies. Initially designed for postal surveys, the questionnaire was subsequently adapted for online distribution to increase accessibility and the ease of response. Follow-up telephone calls were made to enhance the response rate, resulting in the collection of 66 completed questionnaires, yielding a high response rate of 65.3%. This rigorous approach ensured that the data obtained was both representative and comprehensive for the purposes of the study.

The development and validation of the questionnaire involved several critical steps, with initial designs focusing on the key themes of Knowledge Management implementation in R&D, particularly around the use of Information Technology and employee engagement. The questionnaire primarily comprised multiple-choice questions to facilitate quick and straightforward responses and included standardized scale items to measure attitudes and perceptions. The specific scales employed in this study were carefully selected to align with the core constructs of the research. The Technology Acceptance Model [80] was used to measure users’ acceptance of Information Technology systems because of its robust framework in evaluating how perceptions of usability and utility can predict actual Information Technology use, directly linking Information Technology usage with operational efficiency in pharmaceutical R&D. The Utrecht Work Engagement Scale [81] was chosen to assess employee engagement due to its comprehensive approach in measuring vigor, dedication, and absorption; factors crucial to understanding how engagement influences knowledge sharing and utilization in R&D contexts. Finally, the Knowledge Management Assessment Tool [82] was utilized to evaluate various aspects of Knowledge Management practices, including the creation, storage, and dissemination of knowledge, which are pivotal for innovation and competitive advantage in pharmaceutical companies. These scales are integral to quantitatively capturing the interdependencies between technology use, employee motivation, and effective Knowledge Management.

To ensure the questionnaire’s effectiveness and appropriateness, a preliminary pilot study was conducted with a sample of eight professionals from pharmaceutical R&D. This pilot phase was instrumental in assessing the clarity and interpretability of the scale items within the specific context of the study. Feedback from participants highlighted areas where additional instructions or clarifications were needed to ensure respondents understood and could accurately respond to the scale questions. Based on this feedback, modifications were made to the presentation and formatting of the questions rather than the content of the scale items themselves. Instructions were clarified, and layout adjustments were implemented to enhance the readability and ease of response, ensuring that the final questionnaire was user-friendly while still adhering to the rigorous standards of the standardized scales used.

To ensure quality control, the collected data underwent a preliminary analysis to check for completeness and consistency. A few discrepancies or incomplete responses were addressed during this process.

This thorough and systematic methodological approach ensured the collection of high-quality, reliable data for subsequent analysis and interpretation.
4. Results

This section presents the findings from the analysis conducted in this study. The results cover the sample profile, hypothesis testing, and validation of multiple linear regression assumptions.

4.1. Sample Profile

This study’s sample comprises 66 pharmaceutical companies operating in Greece. Of these, 37 are of Greek origin, while 29 are multinational corporations. The distribution of company sizes based on the number of employees is as follows: 1 company employs 1–9 individuals, 20 companies have 10–49 employees, 32 companies employ 50–249 individuals, 11 companies have 250–749 employees, and 2 companies have more than 750 employees. In terms of annual turnover, 5 companies report a turnover of 0–2 million euros, 17 companies fall within the 2–10 million euros range, 23 companies have a turnover of 10–50 million euros, 14 companies generate 50–200 million euros, and 7 companies exceed 200 million euros in turnover.

The sample also includes a diverse range of pharmaceutical categories and types. In terms of drug categories, 63 companies produce prescription medications, while 34 companies manufacture over-the-counter drugs. Regarding the types of drugs produced, 36 companies focus on original chemical drugs, 20 on original biological drugs, 41 on generics, and 6 on biosimilars. This diverse sample provides a comprehensive overview of the pharmaceutical industry in Greece, encompassing various company sizes and types of pharmaceutical products.

4.2. Hypothesis Testing

In this subsection, we test the research hypothesis, which examines the statistically significant effects of Information Technology usage and employee engagement on the implementation of Knowledge Management in the R&D process of pharmaceutical companies. A multiple linear regression analysis is conducted (KM = α + β₁ IT + β₂ ENG) with the following variables:

- Independent Variable 1 (predictor): Degree of Information Technology Usage [IT].
- Independent Variable 2 (predictor): Degree of Employee Engagement [ENG].
- Dependent Variable (outcome): Degree of Knowledge Management Implementation in the R&D Process of Pharmaceuticals [KM].

Table 3 presents the key results of the multiple linear regression models used to test the research hypothesis. In the first model, only the “Degree of Information Technology Usage” is inserted as the sole predictor, while in the second model, the “Degree of Employee Engagement” is also added.

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Standard Error of the Estimate</th>
<th>Durbin-Watson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.563</td>
<td>0.317</td>
<td>0.306</td>
<td>0.51617</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.737</td>
<td>0.543</td>
<td>0.528</td>
<td>0.42572</td>
<td>2.163</td>
</tr>
</tbody>
</table>

From Table 3, it is evident that the independent variable “Degree of Information Technology Usage” explains a significant proportion (31.7%) of the variability in the dependent variable “Degree of Knowledge Management Implementation in the R&D Process of Pharmaceuticals” in Model 1.

With the addition of the second independent variable, “Degree of Employee Engagement”, the model improves further, explaining an additional 22.6%, bringing the total to 54.3% of the variability in the dependent variable “Degree of Knowledge Management Implementation in the R&D Process of Pharmaceuticals” in Model 2.
Furthermore, the ANOVA results (see Table 4) demonstrate that both Model 1 (\(F = 29.711 \ *, \ p < 0.001\)) and Model 2 (\(F = 37.381 \ ***, \ p < 0.001\)) significantly improved the predictive ability of the outcome.

**Table 4.** ANOVA results of multiple linear regression.

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regression</td>
<td>7.916</td>
<td>1</td>
<td>7.916</td>
<td>29.711</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>17.052</td>
<td>64</td>
<td>0.266</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>24.968</td>
<td>65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Regression</td>
<td>13.550</td>
<td>2</td>
<td>6.775</td>
<td>37.381</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>11.418</td>
<td>63</td>
<td>0.181</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>24.968</td>
<td>65</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5 presents the parameter results for the multiple linear regression model under investigation.

**Table 5.** Results of multiple linear regression parameters.

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
<th>95% Confidence Interval for B</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower Bound</td>
<td>Upper Bound</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>2.557</td>
<td>0.292</td>
<td>8.741</td>
<td>0.000</td>
<td>1.972</td>
</tr>
<tr>
<td></td>
<td>IT</td>
<td>0.438</td>
<td>0.080</td>
<td>0.563</td>
<td>5.451</td>
<td>0.277</td>
</tr>
<tr>
<td>2</td>
<td>(Constant)</td>
<td>1.583</td>
<td>0.298</td>
<td>5.314</td>
<td>0.000</td>
<td>0.987</td>
</tr>
<tr>
<td></td>
<td>IT</td>
<td>0.213</td>
<td>0.077</td>
<td>0.274</td>
<td>2.752</td>
<td>0.058</td>
</tr>
<tr>
<td></td>
<td>ENG</td>
<td>0.457</td>
<td>0.082</td>
<td>0.556</td>
<td>5.575</td>
<td>0.293</td>
</tr>
</tbody>
</table>

Based on the above results, the linear function is formulated as follows:

\[ KM = 1.583 + 0.213 \, IT + 0.457 \, ENG \]

As indicated by the \(t\)-test criterion, both the value of \(\beta_1\) (\(t = 2.752 \ ***, \ p < 0.01\)) and the value of \(\beta_2\) (\(t = 5.575 \ ***, \ p < 0.001\)) differ significantly from 0. Consequently, it is evident that both independent variables, “Degree of Information Technology Usage” and “Degree of Employee Engagement”, make significant contributions to the predictive model of the dependent variable “Degree of Knowledge Management Implementation in the R&D Process of Pharmaceuticals”.

When comparing the contributions of the two independent variables based on the \(t\)-test criterion and the standardized beta coefficients, it is evident that the “Degree of Employee Engagement” has a greater impact than the “Degree of Information Technology Usage.” The results of the hypothesis testing lead to the rejection of the null hypothesis (H0) at a 99% confidence level, confirming the alternative hypothesis (HA). Therefore, there is a statistically significant effect of both the “Degree of Information Technology Usage” and the “Degree of Employee Engagement” on the implementation of Knowledge Management in the R&D process within pharmaceutical companies.

Figure 2 depicts the relationships between the independent variables (predictors) and the dependent variable (outcome) as determined by Model 2 of the multiple linear regression analysis. The arrows indicate the direction of influence, with the standardized coefficients (Beta values) showing the relative strength of each relationship.
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Figure 2. Relationship between IT, ENG, and KM in Model 2.

Alongside the analysis of the above findings, all assumptions for applying multiple linear regressions were tested and validated. The two independent variables are continuous ratio variables, showing variability and independence from each other and from other external variables. The dependent variable values are also independent. The check for outliers revealed a minimal number of standardized residuals exceeding the typical thresholds, considered normal. Influential case analysis showed no issues, with all Cook’s distance, Mahalanobis Distance, Standardized DFBETA, and Centered Leverage Value metrics well below their respective thresholds. Multicollinearity was not a concern, as the VIF values were below 10, and the tolerance values were above 0.2. The model demonstrated linearity and homoscedasticity, with the residuals being independent, as indicated by the Durbin–Watson statistic being close to two. Additionally, the normality check for residuals showed no issues, confirming the assumptions for a robust multiple linear regression analysis.

5. Conclusions

This study explored the two main potential enablers of Knowledge Management implementation in the pharmaceutical R&D process, as identified in the existing literature: (a) Information Technology and (b) Employee Engagement. The findings confirmed that both factors significantly enhance the degree of Knowledge Management implementation.

5.1. Theoretical Contribution

Notably, employee engagement was found to have a significantly greater impact than Information Technology. While Information Technology inspires an organization’s focus on knowledge, employees are essential for the practical implementation of Knowledge Management due to their tacit knowledge. This tacit knowledge, crucial for the organization, is not easily codified, understood, disseminated, or utilized. Consequently, although Information Technology can facilitate Knowledge Management, it cannot ensure its success without the active participation and understanding of the organization’s employees, who must recognize its benefits and be willing to engage in its implementation.

Interpreting the study’s results through the lens of Dynamic Capabilities Theory provides further insights into the relative contributions of Information Technology and employee engagement to Knowledge Management implementation in the R&D process. The greater impact of employee engagement highlights the importance of human factors in the dynamic capabilities framework. Engaged employees facilitate the sensing of opportunities and threats through their tacit knowledge and insights and play a crucial role in seizing these opportunities by driving and embracing strategic initiatives. Their adaptability and willingness to acquire new skills are essential for the reconfiguration and transformation processes emphasized by Dynamic Capabilities Theory. On the other hand, Information Technology enhances these capabilities by providing the necessary infrastructure for information gathering, processing, and swift decision making. However, as the study indicates, Information Technology alone cannot substitute the invaluable contribution of engaged employees. Together, Information Technology and employee engagement synergistically enhance the firm’s ability to sense, seize, and transform opportunities and threats, under-
scoring their complementary roles in achieving a sustainable competitive advantage in the dynamic environment of pharmaceutical R&D.

5.2. Managerial Implications

The managerial implications of this study are profound for pharmaceutical companies seeking to optimize their R&D processes through effective Knowledge Management. Managers should prioritize fostering a culture of high employee engagement, recognizing that the human element is paramount in the successful implementation of Knowledge Management practices. This involves investing in training and development programs to enhance employees’ skills and knowledge-sharing capabilities, and creating an environment that encourages collaboration and innovation. Additionally, while Information Technology remains a critical enabler, it should be viewed as a tool that supports and amplifies the efforts of engaged employees, rather than a standalone solution. Managers must ensure that Information Technology systems are user-friendly and smoothly integrated into daily workflows to support efficient information-gathering and decision-making processes.

By balancing investments in both Information Technology infrastructure and human capital, pharmaceutical companies can better utilize the dynamic capabilities necessary to remain competitive in their fast-paced industry. This dual focus will not only enhance the implementation of Knowledge Management but also drive continuous improvement and innovation in R&D activities. Furthermore, leaders should implement regular feedback mechanisms that allow employees to voice their ideas and concerns about Knowledge Management practices, thereby reinforcing their engagement and contribution to organizational goals. Strategic alignment of these initiatives with organizational objectives and the clear communication of their benefits will further ensure that employees are not only ready but also eager to adopt and support these changes. This proactive approach in managing both technology and human resources is crucial for developing a responsive and adaptable R&D environment, positioning pharmaceutical companies at the forefront of innovation and operational excellence.

5.3. Limitations and Future Directions

The study has several limitations that should be acknowledged. Firstly, the sample size, although comprehensive within the context of Greek pharmaceutical companies, may not be representative of the global pharmaceutical industry. This limits the generalizability of the findings to other geographical regions and industries. Additionally, the cross-sectional nature of the study means that causality cannot be inferred, which restricts the ability to determine the long-term impacts of Information Technology and employee engagement on Knowledge Management implementation. Moreover, the reliance on self-reported data through questionnaires may introduce bias, as respondents might overestimate their engagement or Information Technology usage due to social desirability or other factors. A further limitation arises from the fact that the study explored only one research hypothesis, potentially overlooking other relevant aspects or interactions within the domain of Knowledge Management, Information Technology, and employee engagement.

Future research should consider using mixed methods, including qualitative approaches such as interviews or focus groups, to gain deeper insights into Knowledge Management practices. By integrating qualitative data, researchers can better understand the complexities of employee engagement and the practical utilization of Information Technology in R&D processes. Furthermore, expanding the scope to include other enablers or barriers to Knowledge Management, such as organizational culture or leadership styles, could provide a more holistic understanding. Investigating the interaction between Information Technology and employee engagement over different stages of the R&D process could produce valuable insights for dynamically optimizing Knowledge Management practices. Additionally, examining multiple research hypotheses that explore various aspects of these interactions could reveal complex dynamics not captured by this initial study. This could include studies that look at different sectors within the pharmaceutical industry or
other knowledge-intensive industries to enhance the robustness and applicability of the findings. Finally, employing a longitudinal study design would help clarify the causality and long-term effects of the studied variables on Knowledge Management success.

Ultimately, this study highlights the complex interaction between technology and human creativity, showing that the future of Knowledge Management in R&D depends not just on advanced systems, but on the active, committed individuals who use them.

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