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Understanding the Relationship between Knowledge Management and Pharmaceutical Innovation Empirical Study

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Abstract. Purpose This research aims to understand the role of knowledge management (KM) approaches in pharmaceutical innovation; a comprehensive investigation using a multidisciplinary approach toward the integrative concepts of KM has been carried out. Consequently, this research recognizes to what extent pharmaceutical organizations in the UK successfully apply the KM. Design/methodology/approach The questionnaire survey method was deployed to collect data from pharmaceutical organizations in the UK. Many statistical procedures have been undertaken—exploratory factor analysis (EFA). One sample - T-test analysis and AMOS. Multiple regression analysis, path analysis, and SPSS were used. Findings – Two Proposed models were examined. The empirical assessment's overall result was significant, reflecting the appropriateness of the proposed model. All the constructs revealed a high level of internal consistency reliability. A good model fit was found for the measurement model using several fit indicators such as GFI, AGFI, and RMR. The findings also reveal that Knowledge management has a significant and positive impact on all innovation dimensions. It is also found that KM processes have a mediate effect on the relationship between knowledge management enablers and pharmaceutical innovation, Originality/value – This study is probably one of the critical studies that propose and examine the fit model as an integrative perspective for implementing KM in pharmaceutical organizations in the UK. It gives a guide for organizations to accomplish innovation through KM.

Keywords. Knowledge management, knowledge management processes, knowledge management, infrastructure, pharmaceutical innovation.

1.Introduction

The pharmaceutical industry's future is not as stable or secure as before. Significant economic, cultural, and technological challenges affect the drug industry’s fortunes; coping with these trends has become imperative. Unlike other sectors, the pharmaceutical industry extensively depends on drug innovation and research & development (R&D). Despite the highly growing investment in research and development, the actual data in the pharmaceutical industry shows that the total investment in drug R&D (PhRMA) was around $83 billion in 2019, while it was $5 billion in 1980 and $38 billion in 2000. However, its productivity is still weak [1], which reduces the annual number of approved drugs. Considering that pharmaceutical companies are now not dominating the R&D market like before, for many reasons, the increase of new Contract Research Organizations (CROs) as research businesses has become the leading supplier of innovation in pharmaceutical manufacturing. That has put pressure on the knowledge-creation processes in drugs (R&D). Thus, it must be considered to take crucial steps toward improving the drug innovation processes.

Additionally, there is a trend toward pharma consolidation. Those synergies often manifested in the form of mergers and acquisitions. Thus, fewer and bigger companies are developing. However, this increase in size is just increasing marketing power more than actual innovation itself. Also, the big pharmaceutical companies no longer sustain R&D productivity and internal research but only focus on marketing products that are in- licensed from biotech companies; for example, Pharma's output's lack of scientific productivity has increased over the past decade. Yet the processes it uses to discover and develop new products remain the same. Accordingly, there are no critical reasons for improving productivity suddenly [2]. Keeping into account that the pharmacy industry is concerned with human health, which is heavily investigated and regulated by governmental organizations. As a result, there is a need for more knowledge processing and management of the pharmaceutical industry recently are multiplied [3].

Due to critical challenges, most pharmaceutical businesses have also been compelled to increase their operational effectiveness in relation to product time-to-market, cost retention, the complexity of the drug lifecycle, and regulatory compliance. They represent one of the areas that are evolving the most quickly. Additionally, novelty and value are achieved by straddling the frontiers of science and, as a result, the biological, chemical, and medicinal functions. Further, pharmaceutical R&D is now plagued by poor information management of rigid, closed, heterogeneous, and independent sources of knowledge assets [4]. Therefore, sharing and applying the new information today within and between pharmacy sectors will be promising. Significantly, there is a demand for additional cutting-edge products that can combat today's deadly diseases (e.g., Coved 19 - Swan flue).

Meanwhile, the growing demand for personalized medicine is expected to increase the effectiveness and safety of needed drugs [5, 56]. Thus, pharmaceutical companies have become more worried about their future profits. All the previous challenges call for a new pharmaceutical organization that can generate knowledge to maximize organizational competitiveness and strategic success. This paper investigates the integrative role of KM processes and KM infrastructure in creating and sustaining pharmaceutical innovation.

2.Research Importance

Since the pharmaceutical industry's value is created by generating and synthesizing information into knowledge applicable to human health. Therefore, it is critical to improve R&D productivity and reduce product cycle time. The success of this approach depends on creating the required internal knowledge parallel with capturing it from external sources and then disseminating this knowledge among the team members and applying it to newly advanced medicine. In this context, effective knowledge management can provide significant and measurable advantages for enhancing pharmaceutical innovation.

Knowledge management promises to significantly reduce discovery and development times and costs and improve success rates. Reduction in R&D cycle time, resulting in more extended exclusivity periods and can translate into substantial increases in revenues for each new chemical entity [6]. Based on a systematic review of 137 refereed articles on the KM field revealed six empirical research themes in the pharmaceutical industry. Findings shed light on the gap between academic and KM research in the pharmaceutical industry [7]. Also, a 6-month cross-sectional study has been performed to assess pharmacists' knowledge of scientific publications in Saudi Arabia. For this purpose, a self-reported electronic survey questionnaire has been distributed to pharmacists, interns, consultants, and specialists. They conclude that Pharmacists' knowledge about writing research sections, study design, and journal indexing database for scientific publications was varied. Therefore, improving pharmacists' training and education during graduation is highly recommended to improve patients' pharmaceutical care [8]. All the previous; calls for taking up KM by the pharmacy industry to optimize pharmaceutical innovation. Thus, the purpose of this paper is responding to address this gap in the pharmaceutical industry

2.1.Reasons for being Pharmaceutical Organization as A Knowledge-Intensive Firm (KIF)

The pharmaceutical organization is a good symbol of a knowledge-intensive organization, which is needed in a booming knowledge economy. Since these companies' primary product is specified in medical discovery and development. Pharmaceutical manufacturing is unique regarding what biotech and Pharma essentially does is create and manage Knowledge [1].many reasons for being a pharmaceutical company as Knowledge intensive Firms: -

i) The pharmaceutical business is considered Knowledge intensive firm (KIF) in that high performance and progress require creating, acquiring, and using highly distributed Knowledge. The more effective pharmaceutical companies must be intensively open to information; they apply a beneficial compound, develop lots of studies, and create new knowledge about it. It is critical to managing that Knowledge as efficiently as possible since it costs so much and takes a lot of time to develop a drug. Thus, the essential ability that decides pharmaceutical manufacturers' success is creating new pharmaceutical knowledge and the duration for dissemination of such Knowledge [9, 52, 54].

ii) The pharmaceutical sector invests heavily in research; innovation and R&D keep it competitive. The successful discovery and development of new medications represent the apex of knowledge creation in this industry, serving as the principal competitive advantage and a way of recouping significant R&D expenditures and coping with steadily declining success rates. [10-12, 8, 54, 55].

iii) The pharmaceutical sector relies on intellectual property rights, notably patent rights, due to its worldwide nature and highly concentrated market share (in 2005, the US, Europe, and Japan accounted for 90% of all sales). Therefore, it is necessary to maintain a competitive position even when the global business climate evolves. As a result, strong performance cannot be assured using the traditional variables that have contributed to the UK's past success in the pharmaceutical industry. To keep their advantage over rivals, pharmaceutical businesses must put forth more effort. Because of this, the UK government and the Food & Drug Association (FAD) are looking for ways to cut costs and the fierce competition in the market, which presents significant problems for pharmaceutical firms. [13, 52, 56].

iv) Additionally, the pharmaceutical sector is distinct and has a challenging environment. It takes 10–14 years and more than $500 million to introduce one new drug to patients.[2]

2.2.Pharmaceutical Industry

The pharmaceutical industry's value has been essentially established through gathering and producing information into Knowledge relevant to human health. Improved R&D productivity and shorter product cycle times are therefore essential. [14]. The success of this approach depends on creating the required Knowledge in the organizations (internally), parallel with capturing it from external sources, then disseminating this Knowledge among the team members and applying it to newly developed medicine. In this context, an effective KM can provide significant and measurable advantages for enhancing pharmaceutical innovation. [15, 16. 54, 55].

[1] http://www.pharmaknowledge.com/KM%20in%20pharma%20-%20Query.htm

[2] The influence of the pharmaceutical industry, house of common heath committee, fourth report of sessions 2004-2005, Vol 1,22, march 2005.

2.3.Pharmaceutical Innovation

The physical product of the pharmaceutical industry - the drug- is an innovation by itself. Thus, we can define pharmaceutical innovation as a process of creating and acquiring new Knowledge and using the existing Knowledge in a new context. That leads the organization to add value by discovering new drugs or improving the current drugs. According to the literature, an ideal pharmacy industry model includes the following activities; drug discovery; drug development; process R&D; active ingredient and; drug formulation & manufacturing [17-19]. We can consider pharmaceutical innovation as a manufacturing process in which Knowledge is the basis of the drug cycle figure (1) shows

Figure 1. A knowledge-based innovation in the pharmacy industry [6]

2.4.The Pharmaceutical Industry Characteristics

Pharmaceutical sector has some unique characteristics[3] as follows.

2.4.1. Extensively Regulatory Requirements

The Food and Drug Administration (FAD), the Occupational Safety and Health Administration (OSHA), the European Agency for the Evaluation of Medicine Products (EMEA), and the Environmental Protection Agency are just a few of the regulatory bodies that all pharmaceutical businesses must abide by (EPA),. Pharmaceutical companies must follow various legally obligatory medical procedures, including Current Good Manufacturing Practices (CGMP), Good Laboratory Practices (GLP), and good clinical trials, in addition to adhering to government requirements (GCP). Numerous of these rules and regulations are intricate and open to various interpretations. FDA, for instance, outlines several requirements that pharmaceutical companies must meet to be approved (the accurate drug profiles, i.e., essential activity, dose-response, proves drug safety and effectiveness). Those regulatory constraints frequently cause significant time-market delays, reducing competitiveness and revenues [15].

2.4.2. Complex and Lengthy R&D Cycle

Drug development is a significant undertaking that typically takes 8 to 12 years and more than $350 million. Clinical development consumes over a third of the budget and more than half of the time [20]. The average recent drug approval (NDA) submission contains thousands of pages of information about 60 clinical trials. Additionally, despite thousands of novel compounds being found annually, only a tiny portion of these new compound entities reach the pre-clinical stage. Less than 10% of them end up as approved pharmaceuticals. Only those treatments that clear all of the scientific and regulatory hurdles can reach the market and start being used; therefore, it is crucial for a drug development program to identify the losers and the expedited winner. [3].

2.4.3. Long Lead Times in Demand Planning

Long lead times result in a loss of market share for the company. People cannot afford to wait for pharmaceutical products to become accessible; therefore, they must look for alternatives. Suppliers must comprehend demand and how it is met for this reason. However, because some essential active components have taken more than six months to develop, market, supply, scheduling, inventory, and deployment planning might be difficult. Due to the length of some production processes' cycle times, up to 16 months may be needed. Additionally, the flawless coordination of new

[3]www.aspentech.com (accesses in April 2010)

product introductions' packaging and labelling may help increase the time to market. [21, 22]

2.4.4. Demanding Clinical Trials Workflows

Only the pharmaceutical sector uses a three-phase clinical trial process as part of its research and development process. These phases involve ongoing work on process and product development, and production must ramp up as the necessary numbers of new chemical entities (NCEs) rise with each stage. Due to constraints for study design, the volume needed frequently increases enormously for NCEs that are "on track" for approval. To cut costs, the organization must facilitate and support this ramp-up process. The competitive climate is challenging for the pharmaceutical sector because it differs from other industries in specific ways. [23, 24]. Pharmaceutical organizations must look for novel strategies like KM to boost the likelihood of success.

3. Literature Review

3.1. Knowledge Management (KM): An Integrative Approach

According to an intensive review [25], there are two approaches to KM.

3.1.1. The First approach, KM Infrastructure

Since knowledge is seen as a strategic asset, managers need to consider the idea of knowledge enablers and barriers or the conditions that help the knowledge process and remove obstacles as much as possible. According to this methodology, managers and organizations should pay particular attention to knowledge technology, knowledge culture, and knowledge workers since they are the key facilitators for implementing KM processes. [26-29] a knowledge-friendly culture, explicit language, sustained and effective motivational methods, various routes for knowledge transfer, support from top management, a flexible knowledge structure, and appropriate technical and organizational infrastructure were counted as essential criteria. KM infrastructure was mentioned by Wickramasinghe et al. [28] as a way to support KM. They argued that it is strategically significant to establish and construct a suitable KM infrastructure explicitly. They pointed out that for any organization intending to embrace KM, KM infrastructure fully should be a crucial factor to consider. [28, 51]

A knowledge Worker (KW) is a particular kind of worker who possesses the tools of production in his mind; he is a capital asset that must increase; as a result, Ducker (1999) proposed that the job requires more of them than they require of it [30]. Peer-to-peer sharing by knowledge workers has favorably impacted innovation [31, 32]. In the same manner, Nonaka et al. (2006) recognized knowledge workers as the agents for knowledge renewable and changed [33]; On the other hand, knowledge worker contributions will expand the overall value of organizational capital. Therefore, they have been termed gold-collar workers [31].

Knowledge Culture (KC); according to the resource-based view, Knowledge culture cannot be readily produced, purchased, replaced, or copied by rivals. Knowledge culture can therefore result in competitive advantages over competitors. [34] Barney (1996) supported this idea and said, "Firms that do not have the required culture cannot engage in activities that will generate sustained superior performance." Also, Fahey and Prusak (1998) comment that “technology is only 20% of the km picture, the remaining (80%) is people, and so you have to get the culture right” [35]. Therefore, it is appropriate to use knowledge culture as a gauge of how well KM has been implemented in an organization.

Knowledge Technology (KT); Knowledge technology can improve knowledge production, transfer, and application within businesses, as well as decision-making, productivity, and time and cost savings. It can also facilitate quick searches. Fostering teamwork and putting a product cycle focus [26, [36, 37].

In comparison, most empirical studies on KM concentrate on just one strategy. This study focused on merging these two strategies, which are essential for successfully implementing KM in enterprises. The function of KM processes is also inconsistent. According to several research, KM infrastructures and processes are independent variables that influence corporate performance, and they are thus acknowledged as antecedents of organizational performance [36-38]. KM enablers are independent factors of KM processes, according to several kinds of research, which acknowledged KM infrastructure as a prerequisite of KM processes [39]. Therefore, defining the integrated KM approach's role in innovation can be difficult.

3.1.2. Second Approach: KM Processes

This approach emphasizes the creation, sharing, distribution, and use of knowledge, which is seen as a flow. According to a survey conducted among 260 firms in the UK and Europe, 73% of those surveyed defined knowledge management (KM) as "the collection of processes encompassing; the generation, diffusion, and usage of knowledge to accomplish organizational objectives" [41]. According to this approach, if firms are successful in producing new Knowledge, disseminating it within and between organizational units, utilizing it to generate new goods and services, and other activities, KM activities are viewed as a source of competitive advantage. Although KM activities span a wide range, knowledge generation, dissemination, and utilization are the most critical processes for enterprises to develop a competitive advantage [38, 41-44, 49]. Nonaka and Takeuchi's (SECI) model examined the knowledge creation process

by converting tacit to explicit knowledge in four modes: socialization, combination, externalization, and internalization. This research will focus on the socialization mode, which is the most concentrated on human aspects. Organizations may prefer the acquisition of knowledge to acquire knowledge from other sources and adapt it for their use [43]. The knowledge dissemination process is defined as" the process through which an organizational unit is affected by the experience of another" [42], and the Knowledge utilization process is defined as the process of converting innovative and creative ideas into actions, goods, and services [38, 50, 51].

3.2. Innovation

Innovation is becoming a primary element in organizations' competitive strategy. However, it is still a challenging task involving; a shorter product lifecycle, a higher rate of new product development, changes in customer needs, and the increased complexity domain [45]. The Organization for Economic Co-operation and Development is the source of the commonly used definition of innovation (OECD). It describes innovation as releasing new or significantly better goods or procedures. Organizations are becoming more conscious nowadays that KM's main objective is improving innovation capacity. Numerous studies have acknowledged that businesses will become more innovative if they can change the environment by producing new knowledge, successfully sharing it, and incorporating it into their processes [33]. Many innovations are addressed in the literature; some authors addressed innovation as new or significantly improved products or processes developed for the market [46, 45]. This research will address innovation as R&D, process, and product innovation as core distinctive for pharmaceutical companies. Process & (R&D) innovation refers to; technical, physical, and knowledge-based activities. And product development refers to; the development of new products or improvements on existing products [47, 53].

4.The Proposed Model and Research Hypotheses

The proposed model aims to answer the question; can KM drive the organization's innovativeness? Therefore, this model comprises three main dimensions; KM infrastructure, KM processes, and innovation. This research investigates the relationship between knowledge infrastructures (K worker, K culture, K technology) and KM processes (K capture, K dissemination, K utilization) and their effects on the organization's innovation. As shown in figure (2)

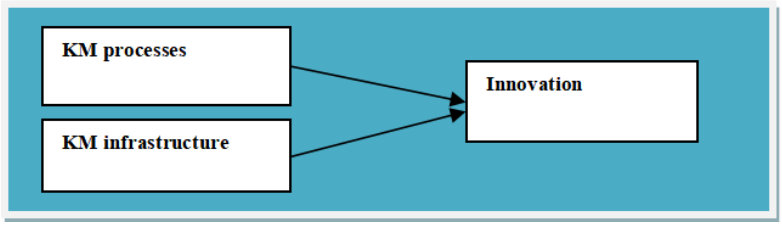

Figure 2. A simple proposed researches Model

Despite an increasing corpus of literature on innovation, the investigation of KM processes and innovation linkages is lacking. To better comprehend the connection between KM practices relating to human resources and IT resources, this research will provide particular, pertinent hypotheses. Consequently, the following is the statement of the research's central hypothesis; KM can be addressed as an innovation approach.
To test this hypothesis following sub-hypotheses will be tested;

H.1. KM infrastructure has a significant effect on knowledge processes.

H.1. 1 K workers play a significant role in the KM processes

- H.1.1.1K workers play a significant role in the K generation.
  - H.1.1.1.1K worker plays a significant role in the K creation.
  - H.1.1.1.2 K workers play a significant role in K acquisition.
- H.1.1.2K worker plays a significant role in the K dissemination.
- H.1.1.3K worker plays a significant role in K utilization.

- **H.1.2 K technology plays a significant role in the KM processes**
- H.1.2.1 K culture has a significant impact on the K generation.
  - H.1.2.1.1 K culture has a significant impact on K creation.
  - H.1.2. 2 K culture has a significant impact on K acquisition.
- H.1.2.2 K culture has a significant impact on K dissemination.
- H.1.2.3 K culture has a significant impact on K utilization.

H.1.3 K culture has a significant impact on the KM processes

- H.1.3.1 K culture has a significant impact on the K generation
  - H.1.31.1 K culture has a significant impact on the K creation
  - H.1.3.1.2 K culture has a significant impact on the K acquisition
- H.1.3.2 K culture has a significant impact on K dissemination.
- H.1.3.3 K culture has a significant impact on K utilization.

- **H.2. KM processes significantly impact the organization's innovativeness.**

- H.2.1 There is a positive relationship between k generation and innovation.
  - H.2.1.1 There is a positive relationship between k creation and innovation
  - H.2.1.2 There is a positive relationship between k acquisition and innovation
- H.2.2 There is a positive relationship between the k dissemination process and innovation.
- H.2.3 There is a positive relationship between k utilization and innovation

5. Methodology

5.1. Unit of Analysis and Data Collection

The research's unit of analysis has been determined to be the pharmaceutical company. There is broad acceptance among authors that the pharmaceutical organization is a highly knowledge-intensive firm (KIF) [14]. This paper focuses on understanding the integrative role of KM processes and KM infrastructure in creating pharmaceutical innovation. The most qualified respondent of our research is the human resource director, operation director, IT director, or/and general director, as they are significantly involved in the KM topic and able to provide more reliable environmental, cultural, and technological information. According to three different database sources (Wikipedia - Pharmapedia – UK pharmaceutical Directory), the researcher received 98 valid questionnaires (65 by mail and 33 via an online- survey).

5.2. Administration of the survey

The survey questionnaire was devised, drawing on an extensive literature review; the survey questionnaire was composed of eight- pages. It consisted of eight sections covering specific information about the organization and the respondents; some general information about KM in the organization; KM infrastructure; KM processes; and the organization's innovativeness. The questionnaire's preliminary versions were tested on a group of academic and KM-experienced professionals before being improved and retested before the final version was created. Two main methods[4] have been undertaken for data collection; an online survey (survey monkey) and a mail survey.

5.3. Statistical Analysis

The relationship between KM (enablers, processes) and KM performance (Innovation) will be investigated in this research. Thus, it examines the factors that can predict the successful implementation of pharmaceutical KM processes and evaluate the effects of these factors on innovation to address the following questions: -

1)What is the impact of KM enablers on the KM processes in pharmaceutical organizations?

2)What is the effect of KM processes by the main KM enablers on pharmaceutical innovation?

3)To what extent are the pharmaceutical organizations in the UK successfully applying KM/?

Four statistical approaches have been used to examine the earlier queries and assess the study hypotheses:

First: Exploratory factor analysis (EFA) has been undertaken to examine the validity of our measurements.

Second: One sample- T-test analysis has been performed to examine KM dimensions in pharmaceutical organizations.

Third: AMOS.17 has been used to explore the excellent fit of our model and to determine which one of the two proposed models are fit in explaining our research variables.

Fourth: A multiple regression analysis is a suitable tool to study the influence of several independent variables on dependent variables. The variation of a dependent variable can be explained by estimating the contributions of two or more independent variables. Therefore, multiple regression analysis is appropriate for examining how KM infrastructures and KM processes affect firms' capacity for innovation. Thus, a multiple regression method has been used to test the gathered data from the pilot survey by making the most of the above advantages of multiple regression analysis; the appropriateness of the proposed research model has been evaluated before the central study. Thus, the research model will be modified according to the multiple regression statistics. It can reduce the variance and improve our model's correctness, leading to a highly reliable model when we examine it for the central survey. Also, SPSS (version .17) was used for all analyses.

5.4. The Measurement Validation

Exploratory Factor Analysis (EFA) was conducted separately for KM enablers, KM processes, and Innovation datasets to validate the measurement of this research. The rotation method was performed as it helps to mathematically redistribute the relationships among the factors without changing the relationships between items and factors [48].

[4]The researcher used the mail survey after three months of using the on-line survey and it appears to be useless, one reason for that maybe because the individual e- mail for the HRM was not available and the link was sent to the general website of the organization.

5.4.1. First: Factor Analysis for KM Enablers

Table 1 displays the findings for both Bartlett's Tests of Sphericity (BTS) since the corresponding significance value (p=0.000) was very low and the Chi-Square was high (992.372). Thus, the data were appropriate for factor analysis. Additionally, the computed Kaiser-Meyer-Olkin (KMO) measurement of sample adequacy (MSA) is 0.640, which is sufficient as an acceptable level. Therefore, we can be sure that factor analysis is suited for KM enablers and that it can be done.

Table 1. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.640
Bartlett's Test of Sphericity	Approx. Chi-Square	992.372
	df	153
	Sig.	.000

Principal Component Analysis

The original premise of the primary components analysis is that all variance is shared. Table 2 demonstrates that for all items in a principal component analysis before extraction, the starting value of the commonality is one. However, the fraction of each variable's variation that the significant components may predict is explained by the commonalities that remain after extraction. Variables with high values are visible in the common factor space, while those with low values are less clear. Table 2 shows that the components E22 and E33 both have shallow values. As a result, the initial amount of these items may be lower than the number of components we have saved (see table 4).

Table 2. Communalities

	Initial	Extraction
E11	1.000	.477
E12	1.000	.582
E13	1.000	.604
E14	1.000	.504
E15	1.000	.740
E16	1.000	.692
E21	1.000	.673
E22	1.000	.076
E23	1.000	.531
E24	1.000	.623
E25	1.000	.534
E26	1.000	.715
E31	1.000	.715
E32	1.000	.680
E33	1.000	.185
E34	1.000	.728
E35	1.000	.671
E36	1.000	.425
Extraction Method: Principal Component Analysis.		

The eigenvalues for each linear component (factor) before extraction (the initial solution) and after rotation are listed in Table 3. SPSS found 18 linear elements in the data set before extraction. SPSS extracted six factors with eigenvalues greater than one, but only three of these components, or **56.422%** of the variance, are explained by the rotation sums of squared loadings.

Factor Rotation and factor loading

After determining that the three criteria were satisfactory, all the items' loadings within the three factors were looked t. The cut-off value for interpreting the factors was set at 0.3 or below while using the varimax technique for rotated component analysis. The variables were arranged according to how significant their factor loadings were. Table 4 below provides a summary of the findings.

As demonstrated in table 4, all elements (apart from two) were put onto the predicted factors for which they were designed. Factor loading values greater than 0.5 indicated that the item loaded on its connected construct more heavily than any other. This finding is supported by the measurement's discriminative validity. Knowledge technology and knowledge culture still lack both of their components. Reliability analyses were redone for each of the three components to ensure the accuracy of the remaining components (see Table 5).

Factor Naming and Interpretation Process

The interpretation of the three-factor solution was developed by relating them to the theoretical concepts of KM enablers; the three factors can be discussed as follows:

Factor 1: represents the respondent's opinions regarding '**knowledge technology.**' It consists of 5 items (see table 5) and fits well with the concept of knowledge technology. The values of these items are tightly grouped, with the

highest being "use the advanced k technology in the organization" (0.828) and the lowest' k technology as a searching tool' (0.702). The overall mean of this factor is (3.246).

Factor 2: represents the respondents' opinion on the '**knowledge worker,**' which consists of (6) items and fits very well with the knowledge worker (see table 5). The values of these items are tightly grouped, with the highest being "k worker has sufficient T – skills" (0.842) and the lowest "knowledge worker is a valuable resource" (0.627). The overall mean of this factor is (3.985).

Factor 3: represents the respondents' opinion regarding '**knowledge culture**' in their organizations**.** It consists of (5) items (see Table five); it fits well with the knowledge culture theory. The values of these items are tightly grouped, with the highest being "organization's members are generally trustworthy" (0.841), and the lowest "organization offers a high degree of love, care and commitment for collaboration" (0.509). The overall mean of this factor is (3.80).

Table 3. Total Variance Explained

Component	[5]Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	4.718	26.210	26.210	3.636	20.203	20.203
2	3.238	17.988	44.198	3.509	19.495	39.698
3	2.200	12.224	56.422	3.010	16.724	56.422
4	1.447	8.041	64.463			
5	1.123	6.241	70.704			
6	1.001	5.562	76.266			
7	.759	4.219	80.485			
8	.614	3.411	83.896			
9	.541	3.008	86.904			
10	.517	2.870	89.773			
11	.421	2.341	92.114			
12	.378	2.101	94.215			
13	.278	1.545	95.760			
14	.214	1.188	96.948			
15	.208	1.155	98.102			
16	.160	.889	98.991			
17	.120	.667	99.658			
18	.062	.342	100.000			
Extraction Method: Principal Component Analysis.						

Table 4. Rotated Component Matrix

	Component		
	1	2	3
E21	.817		
E26	.790		
E24	.786		
E23	.714		
E25	.712		
E22			
E15		.839	
E16		.821	
E12		.719	
E13		.673	.371
E11		.659	
E14	-.342	.622	
E34			.837
E32			.802
E31	.302		.776
E36			.573
E35	.493	.385	.529
E33			.420
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.			
a. Rotanverged in 5 iterations.			

[5] **Initial Eigenvalues** - Eigenvalues are the variances of the principal components. Because we conducted our principal components analysis on the correlation matrix, the variables are standardized, which means that the each variable has a variance of 1, and the total variance is equal to the number of variables used in the analysis, (18).

Table 5. Factor loading score and Cronbach's Alpha analysis

	Factor loading	**Cronbach alpha**
F1: knowledge technology (5 items)		.844
Our organization sufficiently uses advanced k technologies.	.817	
Our organization uses k technology as a collaboration & sharing tool.	.790	
Our organization uses k technology as a learning tool.	.786	
In our organization, there are qualified persons to manage k technology.	.714	
Our organization uses k technology as a search tool.	.712	
F2: knowledge worker (6 items)		.827
In our organization, the knowledge workers have sufficient T-shaped skills.	.839	
In our organization, the knowledge workers have the required social skills.	.821	
Our organization has clear strategies to retain experts and talented staff.	.719	
In our organization, the knowledge workers' loyalty is relatively high.	.673	
A knowledge worker is a valuable resource	.659	
In our organization, knowledge workers are managed by a special style of management	.622	
F3: knowledge culture (5 items)		.795
Our organization's members are generally trustworthy.	.837	
In our organization, there is a willingness to share knowledge across organizational units.	.802	
In our organization, employees respect Knowledge and learning.	.776	
Our organization's members are satisfied with the degree of collaboration.	.573	
Our organization offers a high degree of care, love, and commitment.	.529	

5.4.2. Second- Factor analysis for KM processes

In line with this, table 6's Bartlett's Test of Sphericity (BTS) score was high at 1426.688, and the significance value linked with it is negligible (p=0.000). The data might therefore be used for factor analysis. Additionally, Kaiser-Meyer-Olkin (KMO) reports the computed KMO to be at a level acceptable at 0.607. Consequently, factor analysis is appropriate for KM processes and can be used.

Table 6. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.607
Bartlett's Test of Sphericity	Approx. Chi-Square	1426.688
	df	276
	Sig.	.000

Table 7. Communalities

	Initial	Extraction
B11	1.000	.812
B12	1.000	.822
B13	1.000	.757
B14	1.000	.860
B15	1.000	.814
B16	1.000	.832
B21	1.000	.808
B22	1.000	.667
B23	1.000	.718
B24	1.000	.735
B25	1.000	.766
B26	1.000	.545
C1	1.000	.866
C2	1.000	.717
C3	1.000	.528
C4	1.000	.370
C5	1.000	.719
C6	1.000	.793
D1	1.000	.709
D2	1.000	.843
D3	1.000	.748
D4	1.000	.720
D5	1.000	.811
D6	1.000	.620
Extraction Method: Principal Component Analysis.		

Principal Component Analysis

Table 7 depicts the similarities before and after the extraction; it reveals no shallow values. As a result, we could save them all.

Table (8) shows the initial solution for 24 items, identified seven factors with eigenvalues of more than one, while the four factors, according to the rotation sums of squared loadings, explain 57.163 % of the variance.

Factor Rotation and factor loading

The four variables were looked ز to evaluate the factors at 0.50 or lower, the varimax technique for rotational component analysis was utilized together with a cut-off point. Table 9 below provides a summary of the findings;

Every item was loaded onto the anticipated variables for which it was intended. Each item loaded higher on its linked construct than any other because factor loadings were higher than 0.5. Each of the four components' reliability analyses has been computed; see Table (10).

Table 8. Total Variance Explained

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	4.599	19.161	19.161	3.564	14.848	14.848
2	3.728	15.535	34.696	3.516	14.648	29.496
3	3.157	13.153	47.849	3.401	14.170	43.666
4	2.236	9.315	57.163	3.239	13.497	57.163
5	1.461	6.088	63.251			
6	1.267	5.279	68.530			
7	1.046	4.358	72.887			
8	.980	4.085	76.973			
9	.825	3.438	80.410			
10	.744	3.100	83.510			
11	.690	2.874	86.384			
12	.602	2.510	88.894			
13	.461	1.920	90.814			
14	.384	1.602	92.416			
15	.363	1.513	93.928			
16	.310	1.291	95.219			
17	.236	.984	96.203			
18	.206	.860	97.063			
19	.171	.711	97.774			
20	.158	.659	98.433			
21	.147	.611	99.045			
22	.095	.395	99.440			
23	.078	.327	99.767			
24	.056	.233	100.000			
Extraction Method: Principal Component Analysis.						

Factor Naming and Interpretation Process

The interpretation of the four-factor solution was accomplished by relating them to the theoretical concepts of KM processes; the four factors can be discussed as follows:

Factor 1: represents the respondent's views on the diffusion of knowledge process. It has six components (see table 10) and meshes flawlessly with the idea of the knowledge distribution process. These questions' values are closely grouped, with "Our company can accurately distribute the right knowledge to the right people at the right time" (.924) scoring the highest and "Knowledge in pharmaceutical businesses is too deep and complex to disseminate" (.924) scoring lowest (577). The factor's total mean is (3.246).

Factor 2: indicates the respondent's views on the process of creating knowledge. It has six components and adheres to the knowledge generation idea. These items' values are closely clustered, with "our organization fosters deductive and inductive reasoning" (.844) having the highest value and "our organization provides a wonderful opportunity for us to see each other through informal conversation" having the lowest (.597). The factor's total mean is (3.55).

Factor 3: shows what the respondent thinks about the "knowledge use process." It has six things (see table 10) and fits the knowledge usage paradigm well. These items' values are closely clustered, with "our organization fosters deductive and inductive reasoning" (.844) having the highest value and "our organization provides a wonderful opportunity for us to see each other through informal conversation" having the lowest (.597). The factor's total mean is (3.69).

Factor 4: shows what the respondent thinks about "the knowledge acquisition process." It aligns with the knowledge acquisition idea and consists of 6 things (see table 10). The values of these items are closely packed, with "our organization cooperates with a research institute to obtain new information and experience" having the lowest value and "our organization subscribes to a wide range of periodicals" having the highest value (.800). (. 544). The factor's total mean is (3.71).

Table 9. Rotated Component Matrix

	Component			
	1	2	3	4
C1	.924			
C6	.863			
C5	.786			
C2	.760			
C4	.588			
C3	.577			
B16		.844		
B13		.832		
B14		.790		
B15		.687		
B11		.617	.506	
B12		.597		
D5			.808	
D6			.730	
D1		.366	.705	
D2			.617	
D3			.515	.350
D4			.513	
B24				.800
B23				.755
B25				.750
B26				.686
B22			.440	.563
B21			.432	.545
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.				
a. Rotation converged in 5 iterations.				

Table 10. Factor loading Score and Cronbach's Alpha analysis

	Factor Score	**Cronbach alpha**
F1: Knowledge Dissemination (6 items)		**.856**
Our organization can accurately disseminate the proper Knowledge at the accurate time to the right people.	**.924**	
Our management supports the dissemination of Knowledge.	**.863**	
In our organization, there are many tools to show us how to share knowledge and best practices.	**.786**	
In our organization, it is easy to access all Knowledge and best practices.	**.760**	
It is easy to know and communicate with a person with knowledge of our organization.	**.588**	
Knowledge in pharmaceutical companies is too deep and complex to disseminate.	**.577**	
F2: Knowledge creation (6 items)		**.832**
Our organization supports deductive and inductive thinking.	**.844**	
Our organization supports daily face – to face interaction between colleagues.	**.832**	
Our organization supports using interactive media tools	**.790**	
Our organization supports holding interactive seminars.	**.687**	
Our organization is creating a social environment that allows peers to spend more time together.	**.617**	
Our organization provides a good opportunity to see each other through informal communication.	**.597**	
F3: Knowledge Utilization (6 items)		**.771**
Most of the best practices in the last ten years have been reused in developing new products.	**.808**	
Most of the internal R&D results are used to develop new products.	**.730**	
Our organization encourages employees to use and apply new Knowledge.	**.705**	
Our organization encourages employees to attend seminars, symposia, conferences, etc.	**.617**	
Our organization has a system to avoid repeat mistakes.	**.515**	
In our organization, product development mainly depends on new Knowledge	**.513**	
F4: Knowledge Acquisition (6 items)		.795
Our organization subscribes to a wide range of publications.	**.800**	
Our organization can easily get new ideas from external organizations	**.755**	
Our organization is a good source of new Knowledge and best practices	**.750**	
Our customers are a good source of experiences and feedback on products.	**.686**	
Our organization has strong networks with external experts in various areas	**.563**	
Our organization cooperates with a research institute to acquire new Knowledge and expertise.	**.545**	

5.4.3. Third: Factor Analysis for Innovation

Bartlett's Test of Sphericity (BTS) was significant at 736.034, and the corresponding significance value was negligible (p=0.000), according to Table Eleven. The data might therefore be used for factor analysis. Kaiser-Meyer-Olkin (KMO) reports that the computed KMO is 0.821, which is an acceptable level; see Table (11). Factor analysis is appropriate for the innovation set as a result.

Table 11. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.821
Bartlett's Test of Sphericity	Approx. Chi-Square	736.034
	df	66
	Sig.	.000

Principal Component Analysis

- Table 12 shows that the initial commonalities for all items are one, .and the **Communalities** after extraction with only high values; therefore, we may save all of them.

Table 12. Communalities

	Initial	Extraction
F11	1.000	.578
F12	1.000	.595
F13	1.000	.588
F14	1.000	.441
F15	1.000	.603
F16	1.000	.585
F21	1.000	.542
F22	1.000	.678
F23	1.000	.763
F24	1.000	.760
F25	1.000	.605
F26	1.000	.770
Extraction Method: Principal Component Analysis.		

The initial solution for 12 items indicated two variables with eigenvalues of more than one, as shown in Table (13). These two factors account for 62.576% of the variance, per the rotation sums of squared loadings.

Factor Rotation and factor loading

The two factors were examined. To evaluate the factors at 0.50 or lower, the varimax technique for rotational component analysis was utilized together with a cut-off point. The results are summarised in Table 14 below.

Except for one item, all things were put onto the anticipated factors for which they were intended. Each item loaded higher on its linked construct than any other construct because factor loadings were higher than 0.5. Only one R&D and process innovation item has loaded with the product innovation factor. Therefore, this item has been omitted, and reliability analysis was re-calculated for each of the two components to ensure their reliability, as shown in table (15).

Table 13. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	5.961	49.676	49.676	5.961	49.676	49.676
2	1.548	12.900	62.576	1.548	12.900	62.576
3	.998	8.318	70.893			
4	.788	6.566	77.459			
5	.660	5.500	82.960			
6	.489	4.073	87.033			
7	.453	3.773	90.807			
8	.382	3.186	93.992			
9	.258	2.152	96.144			
10	.202	1.684	97.828			
11	.160	1.336	99.163			
12	.100	.837	100.000			
Extraction Method: Principal Component Analysis.						

Factor Naming and Interpretation Process

By connecting the two factors to the theoretical ideas behind KM processes, the two-factor solution might be interpreted; the four components can be stated as follows:

Factor 1: represents the respondent's opinions regarding **"R&D and Process Innovation.** "It consists of 5 items (see table 15) and fits with the R&D and process innovation concept. The values of these items are closely grouped, with the highest being "our organization encourages buying innovation" (.862) and the lowest 'our organization responds to the market high-speed (.732). The overall mean of this factor is (3.49).

Factor 2: represents the respondent's opinions regarding **"product innovation.** "It consists of 6 items (see table 15), and it fits with the concept of product innovation. The values of these items are closely grouped, with the highest being **"our organization has already developed many new products in the last ten years"** (.771) and the lowest **'our organization considers innovating new products as an important target'** (.566). The overall mean of this factor is (3.21).

Table 14. Rotated Component Matrix

	Component	
	1	2
F23	.862	
F26	.838	
F24	.805	.333
F25	.750	
F21	.732	
F12		.771
F13		.761
F11	.302	.698
F16	.429	.633
F14		.607
F22	.576	.588
F15	.531	.566
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
a. Rotation converged in 3 iterations.		

Table 15. Factor loading Score and Cronbach's Alpha analysis

	Factor Score	**Cronbach alpha**
F1: R&D and Process Innovation (5 items)		**0.881**
•Our organization encourages buying innovation.	.862	
•Our organization facilitates new processes to improve quality and lower costs.	.838	
•Our organization uses a lot of collaboration networks and innovative technology to drive R&D and processes.	.805	
•In our organization, the average RD expenditure is high.	.750	
•Our organization responds to the market very fast.	.732	
F2: Product Innovation (6 items)		**0.823**
•Our organization has already developed many new products in the last ten years	.771	
•Our organization fosters an environment that increases the ability to produce new products.	.761	
•Our organization has already discovered many new products in the last ten years	.698	
•Our organization already has many patents.	.633	
•Our organization has discovered many new products that the FDA has approved as a novel in the last ten years.	.607	
•Our organization considers innovating new products as an important target.	.566	

5.5.Second: One-Sample T-Test for testing the statistical significance existence of KM dimensions in pharmaceutical firms

This section determines to what extent the pharmaceutical firms in the UK successfully apply KM as part of the research objectives. The mean of the KM dimensions has been computed to determine which of the KM dimensions in terms of; KM enablers (knowledge workers – knowledge culture – knowledge technology) and the KM processes (knowledge creation – knowledge acquisition – knowledge dissemination – knowledge utilization) are satisfactory existence in the pharmaceutical firms or not. A [6]one-sample T-test was performed to investigate whether the means of KM factors (table 16) are significantly different from the mid-point 3.0. The results are presented in Table (17) below.

[6] H0: $\mu \neq 3$ and any difference is just due to sample error

Table 16. One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
KM Enablers	98	3.6635	.44229	.04468
Knowledge Worker	98	3.7441	.48702	.04920
Knowledge Technology	98	3.5482	.64305	.06496
Knowledge Culture	98	2.7282	.42862	.04341
Whole KM processes	98	2.5254	.39320	.03972
Knowledge Creation	98	2.3373	.33910	.04436
Knowledge Acquisition	98	3.7126	.66700	.06738
Knowledge Dissemination	98	3.4041	.71877	.07261
Knowledge Utilisation	98	2.8219	.38332	.04892

Table 17. One-Sample Test

Table 17 **One-Sample Test**						
	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Whole process	27.107	97	.000	2.62546	2.4332	2.8177
Creation	30.074	97	.000	2.98071	2.7840	3.1774
Acquisition	55.101	97	.000	3.71259	3.5789	3.8463
Knowledge Dissemination	47.743	97	.000	3.34112	3.2022	3.4800
Enablers	83.794	97	.000	3.67951	3.5924	3.7667
Knowledge Worker	76.187	97	.000	3.99551	3.8914	4.0996
Knowledge Technology	44.356	97	.000	3.36633	3.2157	3.5170
Knowledge Culture	26.446	97	.000	2.64939	2.4506	2.8482

The results of one sample test (see table 17) are found to be significantly different from the mid-point 3.0 ($p<0.01$). And this result confirms that all the dimensions for KM are on the positive side.

5.6.Third: Hypotheses and Model Testing Procedures

5.6.1. Hypotheses

The main research question was tested using multiple regression analysis, and the significance of the total regression model was assessed using an analysis of variance (ANOVA). The significance of R, which denotes the significance of the regression model, is tested using the F test because multiple regression analysis is used to test the null hypothesis that there is no linear relationship between the dependent and independent variables.

The result of a Multiple Regression Analysis

The central hypothesis of our research is explaining the KM and innovation relationships. **KM has a significant effect on innovation**

H1.1 KM enablers have a significant impact on innovation

H1.2 KM processes have a significant effect on innovation

The multiple linear regression equation can express the correlation between KM (enablers and processes) as independent variables and innovation as the dependable variable as follows:

Innovation = α + $\beta 1$ KM enablers + β2 KM processes + ε

The result shows for innovation, KM is essential since KM is a positively significant predictor of innovation. 73.4% of the observed variability in the innovation is explained by the two independent variables (R2= 0.739, Adjusted R2= 0.734) (see table 18)

Innovation = α + $\beta 1$ KM enablers + β2 KM processes + ε

Table 18. Model Summary [b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.860[a]	.739	.734	.23781
a. Predictors: (Constant), Whole process, Enablers				
b. Dependent variable: Innovation				

ANOVA test has been performed see Table (19).

H1: $\mu \geq 3$ and any difference is significant.

Table 19. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.237	2	7.618	134.707	.000[a]
	Residual	5.373	95	.057		
	Total	20.610	97			
a. Predictors: (Constant), Whole process, Enablers						
b. Dependent variable: Innovation						

Table (18) shows the ratio of the two mean squares (F) was 134.707 (sig = 0.000, which means P< 0.001). Then the two variables influence innovation.

To investigate the equivalent null hypothesis, whether the population as a whole exhibit a lack of a linear relationship between the dependent variable (innovation) and the independent variables (km enablers/km processes). The T-statistic has been performed, and its observed significance level. Table 20 below lists the outcomes.

Table 20. Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.121	.219		.553	.582		
	Enablers	.412	.086	.389	4.813	.000	.420	2.379
	Whole process	.586	.090	.526	6.509	.000	.420	2.379

a. Dependent variable: Innovation

The results from Table 20 indicate that we can safely reject the null hypotheses that the coefficients for independent variables and the dependents variables are zero since the results show; for enablers (B=0.389, t= 4.813, p<0.001) and for the whole processes (B= 0.526, t= 6.509, p<0.001).

Also, the result found that the multicollinearity between the independent variables was minimal, as shown in Table (20), with the values of Tolerance of .420 and VIF of 2.379, indicating that the results were reliable. Thus we can safely accept the central research hypothesis. However, the beta weights show that the KM whole process (B=0.526) is relatively stronger than KM enablers (B= 0.389) in explaining changes in pharmaceutical innovation, as shown in figure (3).

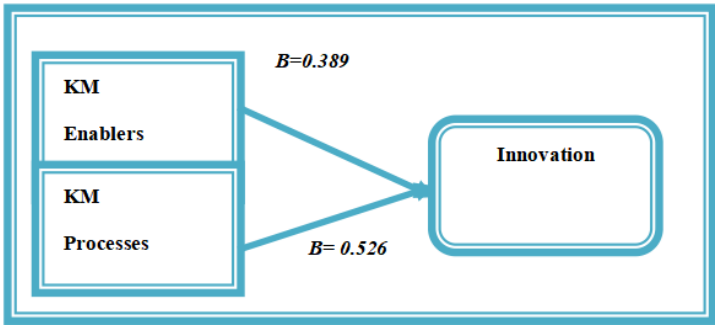

Figure 3. The simple, tested model

5.6.2. Testing the good fit of the Proposed Model

To determine the relationships of our research variables, two proposed models have been tested and compared as follows: **First model;** This model encompassed both KM enablers and KM processes as independent variables that directly affect innovation in terms of product innovation and R&D innovation. **Second model;** This model incorporated KM enablers as the independent variables that directly affect KM processes, indirectly affecting innovation. The first and second models were run as a Structural Equation Model (SEM) with Path analysis .17 to estimate which model is fitter to explain our research variables, and the result is explained below:

Result 1: The Most Fit model

Table (21) summarizes the various goodness-of-fit statistics.

In relation to the outcomes of the first and second models. The result demonstrates how superior the second model is. As a result, the second model is more accurate and more suited to explaining the research variables than the first model due to its higher (GFI, AGFI, NFI, CFI) and lower (RMR and RMSE) values (see table 21).

Table 21. Goodness of fit comparison between the two models

The goodness of fit measures	Criteria	First model	Second Model
Chi-Square	Smaller is better if p<0.05	Chi2= 414.117 Df=43 P=.000	Chi-square = 94.493 Df=10 P=.000
GFI	≥0.9	.666	.988
AGFI	≥0.8	.395	.889
Comparative fit index (CFI)	≥0.9	.353	.994
Incremental Fit Index (IFI)	≥0.9	.378	.994
Normal Fit index (NFI)	≥0.9	.353	.979
Root mean square residual (RMR)	Smaller is better	.104	.011
Root mean Square Error (RMSE)	≤ 0.05	.298	.060
		Poor FIT	**Good Fit, Better Model**

Table 22. Squared Multiple Correlations

Knowledge Enablers	KM Processes	Estimate R2	Innovation	Estimate R2
	Creation	.426	Product Innovation	.439
	Acquisition	.253		
	Dissemination	.202	R&D Innovation	.458
	Utilization	.186		

Results 2: Testing the Hypothesized Causal Relationships

Figure (4) has outlined primary testable hypotheses related to KM processes that are affected by KM enablers and their effects on pharmaceutical innovation. Arrows represent the direct theorized relationships and the influence's direction.

Figure (5), which depicts the path coefficient value for each path and the degree of each direct influence, is the result of the path analysis used to examine the data. The assumptions generated by the model have been tested using the structural equation-modeling program (SEM). We conducted a route analysis using the maximum likelihood estimates (MLE) method, using the factor scores as single-item indicators.

Table (22) shows our model's multiple square regressions between our predictor and criterion variables.

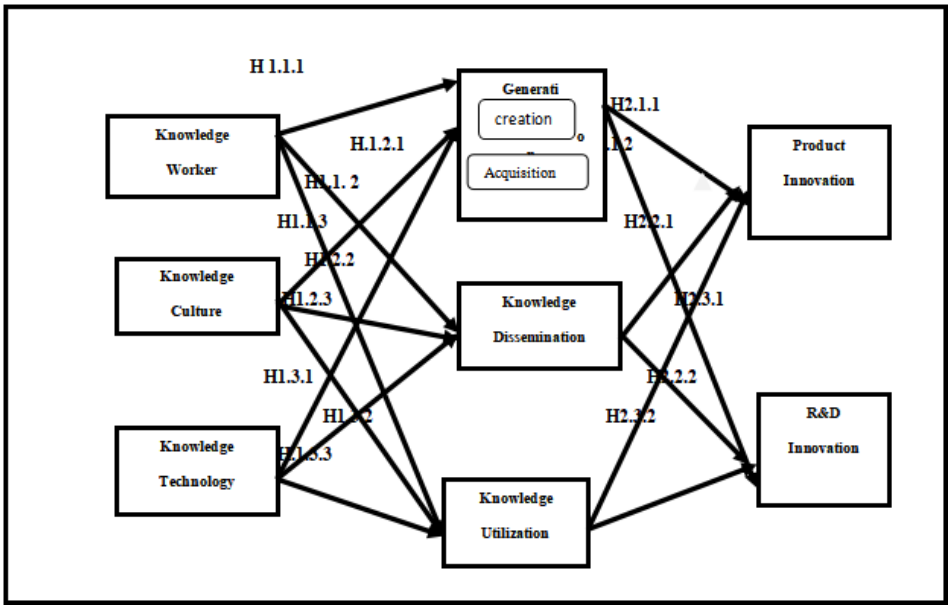

Figure 4. Hypothesized Relationships **between the Implication Variables**

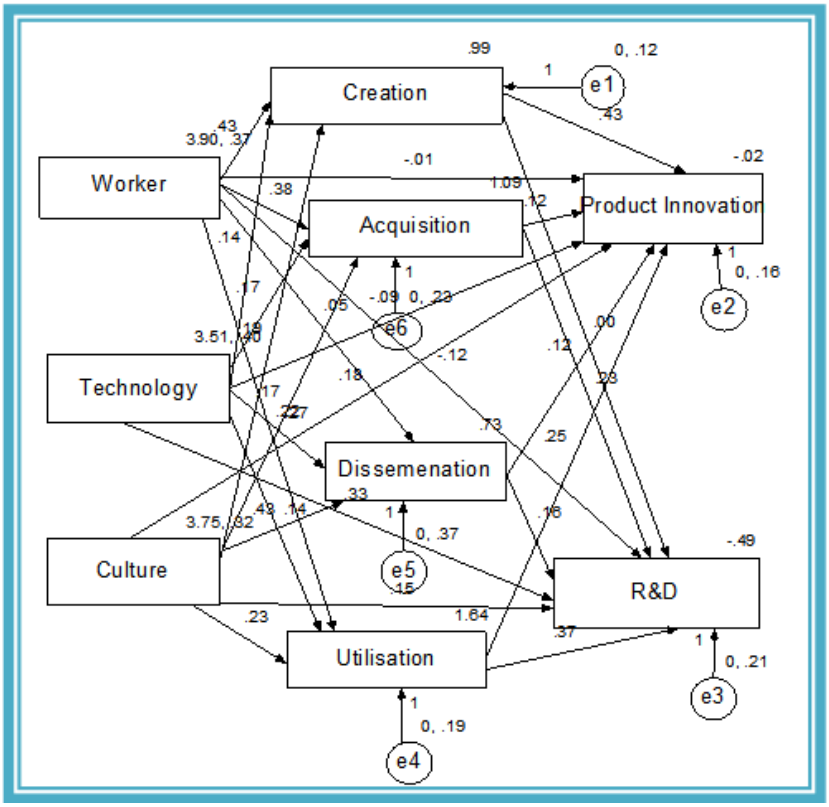

Figure 5. Results of Path Analysis

The relevance of each causal path in the second model is summarized in Table (23), along with the regression weight for all of the causal paths.

Table 23. Standardized Regression Weights: (Group number 1 - Default model)

Criterion variable		Predictor variables			Hypotheses Relationship	Standardized Coefficient
Creation	<---	Worker			H1.1.1.1	.580***
Acquisition	<---	Worker			H1.1.1.2	.427***
Dissemination	<---	Worker			H1.1.2	.047ns
Utilization	<---	Worker			H1.1.3	.278**
Creation	<---	Technology			H1.2.1.1	.187**
Acquisition	<---	Technology			H1.2.1.2	.199**
Dissemination	<---	Technology			H1.2.2	.257**
Utilization	<---	Technology			H1.2.3	.186**
Creation	<---	Culture			H1.3.1.1	.233**
Acquisition	<---	Culture			H1.3.1.2	.177**
Dissemination	<---	Culture			H1.3.2	.366***
Utilization	<---	Culture			H1.3.3	.271**
Product Innovation	<---	Creation			H2.1.1.1	.368***
Product Innovation	<---	Acquisition			H2.1.1.2	.121ns
R&D	<---	Creation			H2.1.2.1	.000ns
R&D	<---	Acquisition			H2.1.2.2	.203**
Product Innovation	<---	Dissemination			H2.2.1	.157ns
R&D	<---	Dissemination			H2.2.2	.178**
Product Innovation	<---	Utilization			H2.3.1	.229**
R&D	<---	Utilization			H2.3.2	.291***
Product Innovation	<---	Worker			-------	-.012ns
R&D	<---	Worker			-------	-.116ns
Product Innovation	<---	Technology			-------	-.102ns
R&D	<---	Technology			-------	.337***
Product Innovation	<---	Culture			-------	.195**
R&D	<---	Culture			-------	.138ns

**** Significant at 0.01** Significant at 0.05, ns not significant*

The overall causal impacts were calculated because the KM's effects on innovation could be direct, indirect, or both. As indicated in Table, the total results are the sum of the direct and indirect effects (24).

Table 24. Standardized Direct, Indirect and Total Effects (Group number 1 - Default model)

Criterion Variable	Predictor variable	Direct Effect		Indirect Effect	Total Effect	
[7]K Generation	K worker	1.007		.000	.869	
	K technology	.386		.000	.386	
	K culture	.410		.000	.410	
K Dissemination	K worker	.047		.000	.047	
	K technology	.257		.000	.275	
	K culture	.366		.000	.366	
K Utilization	K worker	.278		.000	.278	
	K technology	.186		.000	.186	
	K culture	.271		.000	.271	
Product innovation	K worker	-.012		.336	.324	
	K technology	-.102		.176	.074	
	K culture	.195		.227	.422	
	K Generation	.489		.000	.489	
	K dissemination	.157		.000	.157	
	K utilization	.229		.000	.229	
R&D and process innovation	K worker	-.116		.176	.060	
	K technology	.337		.140	.477	
	K culture	.138		.180	.318	
	K Generation	.203		.000	.203	
	K dissemination	.178		.000	. 178	
	K utilization	.291		.000	.291	

Based on Table (22) our findings support that the KM enablers overall have a positive effect on the KM processes since KM enablers explain 42.6 percent of the k creation process, 25.3 percent of the k acquisition process, 20.2 percent of the k dissemination and 18.6 percent of the k utilization. Similarly, our results show that the KM enablers and KM processes' integration positively explained 43.9 percent of the innovative product and 45.8 percent of the R&D innovation. In particular, Table 21 shows the estimated standardized parameters for the causal paths; K worker positively affects the generation processes (H1.1.1) as it positively affects the creation process (H1.1.1.1) (Standardized Estimate=0.580, P≤ 0.001), k acquisition (H1.1.1.2) (Standardized Estimate=0.427, P≤ 0.001). It also positively affects K utilization (H1.1.3) (Standardized Estimate=0.278, P≤ 0.05). But it has no significant impact on k Dissemination (H1.1.2) (Standardized Estimate= 0.047, P> 0.50). Concerning K technology, it was found that it has a positive effect on k generation (H1.2.1) since it positively affects k creation ((H1.2.1.1) (Standardized Estimate=0.187 P ≤ 0.05) and also positively impacts k acquisition (H1.2.1.2) (Standardized Estimate=0.199, P≤ 0.05). Also, it has a significant effect on k dissemination (H1.2.2) (Standardized Estimate=0.257 P ≤ 0.05) and k utilization (H1.2.3.) (Standardized Estimate=0.186 P ≤ 0.05). In the same manner, the results show that k. culture positively affects the process of k. generation (H1.3.1). Since it positively affects k creation (H1.3.1.1) (Standardized Estimate=0.233, P≤ 0.001) and k acquisition (H1.3.1.2) (Standardized Estimate=0.177, P≤ 0.05). Also, it has a positive effect on k dissemination (H1.3.2) (Standardized Estimate=0.366, P≤ 0.001) and also on k utilization (H1.3.3) (Standardized Estimate=0.271, P≤ 0.05). Concerning KM processes, it was found that k generation has a positive impact on product innovation (H2.1.1); since k creation positively affects product innovation (H2.1.1.1) (Standardized Estimate=0.368, P≤ 0.05) and k acquisition also has a significant effect on product innovation (H2.1.1.2) (Standardized Estimate=0.223, P≤ 0.05). However, k creation has no significant impact on R&D innovation (H2.1.2.1) (Standardized Estimate=0.001, P> 0.10), but k acquisition has a significant effect on R&D innovation (H2.1.2.2) (Standardized Estimate= 0.203, P ≤ 0.5). Also, the results show that the k dissemination process has no significant effect on product innovation (H2.2.1) (Standardized Estimate=- 0.157, P> 0.10) but has a positive impact on R&D Innovation (H2.2.2) (Standardized Estimate= 0.178, P≤ 0.05). Also, the k utilization process has a positive effect on product innovation (H2.3.1) (Standardized Estimate=0.229, P≤ 0.05), it has a positive impact on R&D innovation (H2.3.2) (Standardized Estimate=0.291, P≤ 0.05). On the other hand, the results found that; k worker has a neglectable negative impact on product innovation (Standardized Estimate= - .012, P > 0.01), and also, it has a neglectable negative effect on R&D innovation (Standardized Estimate= - 0.116, P> 0.01). In the same manner, k technology has a direct neglectable negative impact on product innovation (Standardized Estimate=-0.102 P> 0.01) but has an immediate positive effect on R&D innovation (Standardized Estimate = .337, P≤ 0.001). Finally, k culture has a positive direct impact on product innovation (Standardized Estimate= 0.195, P≤0.05) and has an indirect positive effect on R&D innovation (Standardized Estimate=.138, P> 0.01). The results are summarized below (see table 25). According to the obtained results, only paths with substantial direct and indirect relationships are shown in figure (6) below.

[7] (K Generation = K Creation +K Acquisition)

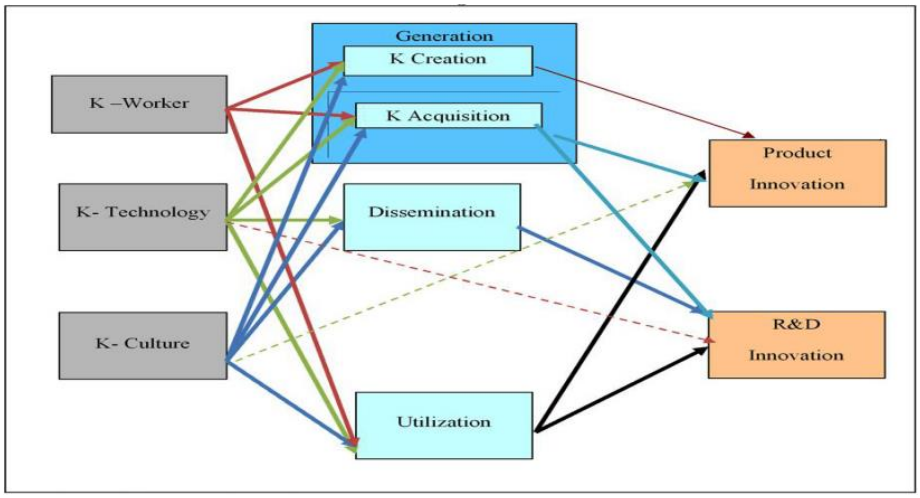

Figure 6. **the Modified Model**

The modified model of this study is shown in Figure 6, along with the proposed links between the constructs, which explain three different kinds of relationships:

- The direct relationship between enablers and process
- The direct relationship between KM processes and innovation
- The direct relationship between KM enablers and innovation

6. Pharmaceutical KM Summary and Explanation

6.1. The Effect of KM on pharmaceutical innovation

The findings reinforce the increasingly accepted view that KM significantly impacts innovation. This result is supported by regression coefficients revealing that total KM explains 72% ($P< 0.001$) of the innovation variance. However, the beta weights show that KM processes ($B=0.526$, $p \leq 0.001$) are relatively more robust than KM enablers ($B= .389$, $p \leq 0 .001$) in explaining the changes in innovation in pharmaceutical organizations.

6.2. The Relationship between KM infrastructure and KM Processes in pharmaceutical organizations

The findings support the results of all the previous studies which investigated the significant relationship between KM enablers and KM processes and found a meaningful positive relationship between them [37, 42]. The total effect of KM enablers has significance in predicting KM processes; the squared multiple correlations show that the most substantial impact of KM enablers is on the k- creation process (42.6%), followed by its effect on k- acquisition (25.3%), then its impact on the k- dissemination process (20.2%), and k- utilization process (18.6%).

6.3. The Relationship between KM Processes and innovation

According to the regression model, KM processes explain 52% of the variance of the Sustainable competitive advantages (SCA) ($B =.526$, $p\leq0.001$). Therefore, the research findings suggest that KM processes as a whole are playing a significant role in pharmaceutical innovation, more so than the role of KM enablers ($B =.389$, $p\leq0.001$)

6.4. The Direct Relationship between KM Enablers and Innovation

Besides the indirect effect of KM enablers on innovation (via its effect on KM processes), the empirical results show various direct effects of KM enablers on innovation. The findings show that the knowledge worker does not directly affect product innovation or process innovation since the standard coefficient weights are (Standardized Estimate = - .012, $P > 0.01$) and (Standardized Estimate = - 0.116, $P> 0.01$), respectively. However, this negative and insignificant direct effect is offset by the indirect positive impact of the knowledge worker on them. This result is significant in placing more attention on the role of KM processes in increasing the effectiveness of the knowledge worker; hence the use of the knowledge worker does not automatically increase pharmaceutical innovation; there will not be any innovation without the successful application of KM processes by the knowledge worker. The statistical findings also show a direct effect of knowledge technology on R&D and process innovation (Standardized Estimate = .337, $P\leq 0.001$). In contrast, knowledge technology indirectly affects product innovation since the empirical results show an insignificant negative effect on product innovation (Standardized Estimate = - 0.102 $P> 0.01$). Thus, it can be said that organizations that invest only in knowledge technology will achieve little innovation unless they use this enabler to apply KM processes. The results also record a significant direct effect of knowledge culture on product innovation (Standardized Estimate = 0.195 $P\leq0.05$), while the results show an insignificant negative impact of knowledge culture on R&D (Standardized Estimate=.138, $P> 0.01$); this result may explain why many pharmaceutical organizations have been disappeared.

7. Research Implications

7.1. Theoretical Implications

This research contributes to the KM literature by merging the research on KM processes and KM infrastructure into a unique conceptual model. This research, in this way, has incorporated a more comprehensive view of the value and impact of KM based on the RBV. This broad view of KM helps in understanding many different variables and constructs which can affect the successful application of KM in pharmaceutical organizations

7.2. Managerial Implications

7.2.1. The Main KM Enablers in Pharmaceutical Firms

However, this research accepted the crucial role of the knowledge worker in creating pharmaceutical Knowledge. It is also found that pharmaceutical organizations suffer from a turnover problem (32.7%). This result may alarm the pharmaceutical organizations that they may lose their essential Knowledge by losing their employees' brains. This result justifies the heavy dependence of most pharmaceutical organizations (80%) on external partners to support their knowledge workers. Therefore, management's high interest and commitment toward knowledge workers will affect their willingness to participate in KM initiatives. Increasing the importance of KW training is needed by focusing on KM enablers' skills. This also necessitates changing HRM standards and policies for employee recruitment, deployment, motivation, training, evaluation, and compensation.

Knowledge Culture is also an essential enabler in the pharmaceutical organization since it significantly impacts all KM processes. The research found that the lack of knowledge culture is the main barrier to the practical application of KM. There is an underestimation of knowledge culture from the pharmaceutical firms, which increases the need to place high importance on knowledge culture. Thus, the pharmaceutical organization needs to change the way of thinking to shift towards more learning, sharing, and doing culture—this needs to identify and reward those who contribute and share their knowledge with others in the organization.

The findings demonstrate that the pharmaceutical firm's use of knowledge technology critically is as a communication tool (100%), followed by using it as a searching tool (60%), while very few numbers of organizations use it as a learning tool (20%). That refers to a shortage of using knowledge of technology in the organization,

7.2.2. The Main KM Processes in the Pharmaceutical Firms

This research suggested that the pharmaceutical organization without an effective external system to acquire knowledge may lose its capability to generate new Knowledge. The findings show that knowledge acquisition is more important than the knowledge creation process as a capability for innovation. Thus, pharmaceutical firms must encourage the integration between them and make good use of the external source of Knowledge.

The knowledge utilization process, which is interested in converting innovative ideas into innovative processes and products, is essential in pharmaceutical organizations; however, the results found a knowing-doing gap. Therefore, if pharmaceutical organizations increase their interest in these processes, they will be more creative.

7.2.3. Critical Barriers to KM in the Pharmaceutical Firms

The main result of this research is that this study supplies pharmaceutical firms with the main barriers to KM. These factors, as shown in figure (7) below, are Lack of KM culture (93.9%), Lack of talented people (89.8%), Difficulties of reusing new Knowledge (75.5 %), difficulty communicating with the person who knows (64.3%), Lack of social contact (52%), and Shortage of advanced technology (14.3%). Therefore, if pharmaceutical companies excel in these critical areas, KM is believed to have succeeded.

7.2.4. Pharmaceutical Innovation

R&D & process innovation and product innovation have been used to evaluate pharmaceutical innovation. Pharmaceutical companies must therefore stress turning innovative and creative ideas into action because doing so may result in modifications to behaviour, practice, regulations, and innovation development. Managers can utilize a variety of technological instruments to boost the efficiency of KM initiatives, including communities of training, best practices, apprenticeships, and traineeships.

An important implication for the pharmaceutical organizations out the UK is the results from this study provide evidence that KM considers a drive for pharmaceutical innovation, especially in organizations such as (Pfizer, Roche, and Galaxy) that represent best practices and achieved many benefits from applying KM.

8. Limitations of the study

This study is dependent on UK-based pharmaceutical organizations. The pharma word, though, was in use between 1400 and 1600. The Pharma was given a standard medical description and a list of services other doctors currently provide, such as surgery and childbirth. Nowadays, there are numerous settings where pharmacists can practice,

including retail, medical facilities, hospitals and clinics, nursing homes, and the pharmaceutical sector. The drug sector is the subject of this study's KM (innovation focus), not marketing

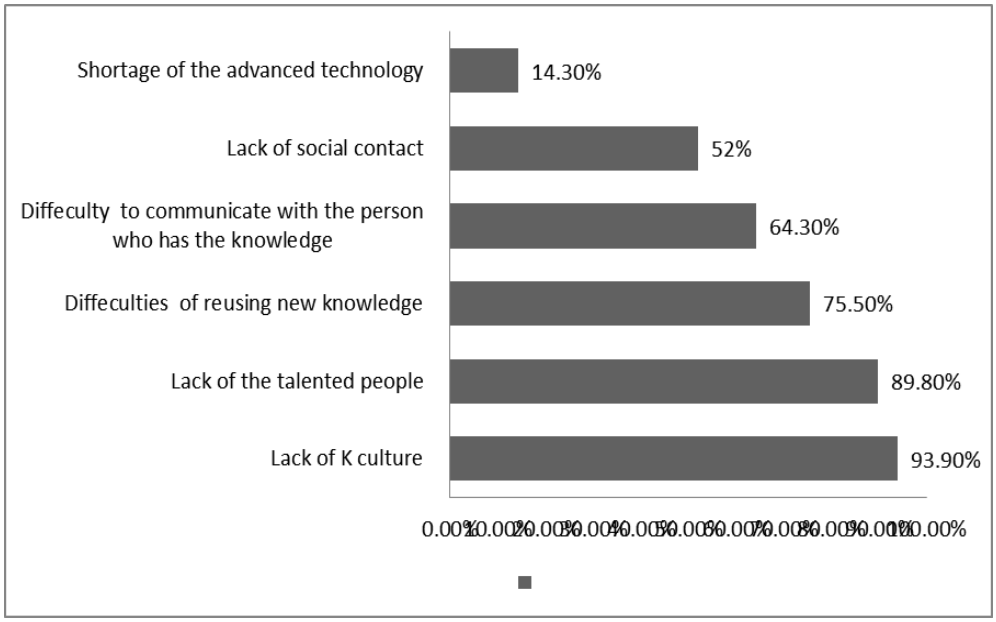

Figure 7. summarizes the relative popularity of these six barriers among survey respondents

9. Suggestions for Future Research

Future research is required in many areas, but the most important thing to remember is that knowledge management is rapidly expanding. It would therefore be beneficial for scholars to investigate and empirically evaluate how various KM approaches might be combined with other fields, such as organizational learning (OL) and intellectual capital (IC). To assist firms in adequately managing their knowledge, this might be integrated.

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