

**RESEARCH PAPER****Unlocking Technological Innovation: The Synergy of Knowledge-Based HR Practices, Pi-Shaped Skills, and Employee-Led Innovation in the Pharmaceutical Industry of Developing Economy****¹Dr. Naveed Mushtaq, ² Illsa Saleem and ³ Dr. Muhammad Saqib Nawaz**

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Corresponding Author: ilsasaleem819@gmail.com**ABSTRACT**

This study examines the interplay among knowledge-based HR practices, pi-shaped skills, innovative employee behavior, and innovative outcomes, addressing the gap in understanding their intricate relationships. The rapid pace of technological advancements has catalyzed technological and non-technological innovations. Firms have realized the importance of employee innovative behavior as central to achieving higher firm innovations, which could be shaped through knowledge-based HR practices and specialized skills such as pi-shaped skills. Yet, the relationship between knowledge-based HRM practices and pi-shaped skills, which shape employee innovative behavior and innovation outcomes, remains relatively unexplored. This quantitative study employed a comprehensive knowledge-based framework in light of KBV theory. Data were collected from the pharmaceutical industry of a developing economy. A dual mediation approach was used to examine mediating effects of pi-shaped skills and employee innovative behavior. Partial least squares structural equation modeling (PLS-SEM) tested the hypotheses. Findings reveal that dual mediation facilitated by pi-shaped skills and employee innovative behavior, along with knowledge-based HRM practices, enhances innovative behavior and innovation outcomes. Pharmaceutical management should adopt knowledge-based HRM practices to nurture pi-shaped skills and employee innovative behavior, fostering innovative competencies.

KEYWORDS Knowledge-Based HR Practices, Pi-Shaped Skills, Employee Innovative Behavior, Product Innovation, Process Innovation, Marketing Innovation, Service Innovation**Introduction**

Knowledge and technology are essential pillars of modern society. Their integration can foster innovation and raise economic development (Scuotto et al., 2024; Haukipuro et al., 2024; Xu et al., 2024; Aripin, Fitrianti, & Fatmasari, 2023). Studies (Rosari et al., 2024; Truong, Nguyen, & Vrontis, 2024; Yulfiswandi, & Alvin, 2024; Phonthanukitithaworn et al., 2023; Marco-Lajara, et al, 2023; Shehzad et al., 2023) stress that businesses cannot achieve long-term success without nurturing intellectual capital and stimulating employee creativity. Some scholars (Ali et al., 2021; Elayan et al., 2022; Henri Hussinki et al., 2017) link higher productivity and inventive capacity to workers' creativity. These studies highlight the importance of these factors in enhancing business productivity and innovation (Utami et al., 2024; Akhtar et al., 2024; Rosari et al., 2024; Chou et al., 2018; Dedahanov et al., 2017). Few authors emphasize how Pi-shaped skills developed from KBHRP contribute to innovative performance and reshape worker behavior to transform input into output more efficiently (Al-Qaralleh & Atan, 2021; Hayajneh et al., 2022). The pharmaceutical industry, requiring multitasking and adaptability, benefits from Pi-shaped skills, allowing professionals to manage workload, prioritize tasks, and allocate resources effectively (Mehralian et al., 2013; Amin & Aslam, 2017). Strong interpersonal skills in Pi-shaped professionals are crucial for this sector. KBHRP rests on employees' knowledge and innovative performance (Ghlichlee,

Mohammadkhani, & Hatami, 2024; Alkhalaf, & Badewi, 2024; Escribá-Carda, Canet-Giner, & Balbastre-Benavent, 2023; Al-tal & Emeagwali, 2019). Prior research focused on KBHRP and employee innovative behavior but lacks insight into these variables (Jiang et al., 2023; Than et al., 2023; Abrar et al., 2021). Further study is needed on knowledge-based compensation, performance assessment, and recruitment and selection (Abrar et al., 2021). This study analyzes how KBHRP can create Pi-shaped skills and innovative behavior, driving product, process, marketing, and service innovation.

Accordingly, this investigation examines how KBHRP enhances product, process, marketing, and service innovation via Pi-shaped skills and employee innovative behavior. The research explores: To what extent do Pi-shaped skills (π) and Employee Innovative Behavior (EIB) influence technical (Product, Process) and non-technical (Marketing, Service) innovation? We propose links between KBHRP, π , EIB, ProI, PrIn, MI, and SIn, tested via a survey of Pakistani pharmaceutical companies.

Literature Review

KBHRP and pi-shaped skills (π)

In this era, organizations understood how employee skills are valuable and a source of competitive edge for organization (Elayan et al., 2022). By utilizing their most precious assets, managers create a positive workplace culture (Elayan et al., 2022). Modern businesses follow closely integrated people-centric and knowledge-oriented HR policies (Lopez - Cabrales et al., 2009), where motivated and talented workers are paid for knowledge contributions and exhorted to increase their knowledge. Previously most work related KBHRP to human capital or innovation (Henri Hussinki et al., 2017; Noopur & Dhar, 2019), and this study assumes KBHRP approaches encourage and develop pi-shaped skills (Elayan et al., 2022). Employees are urged to grow, discover the latest skills, improve current ones, and cooperate, while performance reviews and pay are distributed according to knowledge development and organizational input (Elayan et al., 2022; Henri Hussinki et al., 2017). KBHRP like training and development assists employees in seeking knowledge, learning how to acquire knowledge, and improving their knowledge and command of skills vertically and horizontally (Abrar et al., 2021; Al-Qaralleh & Atan, 2021). H1: KBHRP is positively associated with pi-shaped skills (π).

KBHRP and Employee Innovative Behavior

HRM consists of functions such as “recruitment and selection, training and development, performance assessment, and compensation” (Lopez - Cabrales et al., 2009), which, if implemented successfully, enhance employee innovative behavior and provide innovation. Recruitment and selection attract employees with knowledge or abilities that best fit the position, while training, development, performance, and compensation train, motivate, and get the best out of them (Abrar et al., 2021; Hussinki et al., 2017). Knowledge-based approaches foster creativity, learning, and productive behavior in organizations (Metaxiotis et al., 2005; Abrar et al., 2021), and employee innovative behavior—idea development, promotion, and implementation—requires knowledge, skill, and innovators (Scott & Reginald, 1994; Noopur & Dhar, 2019). KBV theory links KBHRP to employee innovative behavior, as knowledge-based training enhances creativity through knowledge acquisition, information distribution, and interpretation (Hassan et al., 2021). H2: KBHRP is positively associated with employee innovative behavior.

Pi shaped skills(π) and employee innovative behavior (inter- mediation)

In the current digital and globalized era, organizations must be agile to gain a competitive edge and be innovative to sustain in a competitive world (Prieto & Pérez-Santana, 2014; Urbancova, 2013), making a technical workforce and innovative thinkers a

key resource (Kocoglu et al., 2012). Prior studies show a relationship between innovation and employee innovative behavior, which includes creation, acceptance, execution, and assimilation of novel ideas (Dedahanov et al., 2017; Scott & Reginald, 1994). This study focuses on skill and competence, introducing Pi-shaped skills as a predictor to influence employee innovative behavior, where horizontal skills like creativity, critical thinking, and open-mindedness drive innovation (Madhavan & Grover, 1998; Carmeli et al., 2006; Reznick et al., 1997). AMO theory links Pi-shaped skills to innovative behavior by providing training (A), motivation (M), and opportunity (O) to enhance skills and foster creativity (Hughes, 2007).

H3: pi shaped skills (π) are positively associated with employee innovative behavior

Nowadays innovation has drastically changed; it is necessary for an organization's survival, not just part of strategy (Orfila-Sintes & Mattsson, 2009), yet product and service innovation is rare, and marketing and process innovation are more unusual (Demirkan & Welser, 2016). Innovative performance encompasses technical (product and process) and non-technical (marketing or service) innovation, influenced by human abilities, management, and HRM techniques (Hagedoorn & Cloudt, 2003; Meissner & Shmatko, 2019; Kianto et al., 2017). Pi-shaped skills influence innovative performance, as employees with depth and breadth, multidisciplinary skills, learning capabilities, communication, and critical thinking provide innovation, competitive advantage, and the ability to combine theoretical and practical knowledge (Elayan et al., 2022; Vojak & Price, 2013; Lee & Choi, 2003; Madhavan & Grover, 1998; Johannessen & Olaisen, 1999; Demirk & Spohrer, 2015). Knowledge-based theory rationalizes the positive relation between Pi-shaped skills and technical/non-technical innovation, as employees' skills enhance product or process innovation and drive innovative triggers (Lopez - Cabrales et al., 2009; Christa & Kristinae, 2021).

H4-H7: pi-shaped skills are associated positively with product, process, marketing, and service innovation respectively.

Employee innovative behavior and technical or non-technical innovation

Every innovation, whether technical or non-technical, requires ideas, which employees create, re-adjust, and execute (Gumusluoglu & Ilsev, 2009), providing the base for innovative performance and resulting in product, process, marketing, or service innovation (Rangus & Černe, 2019; Dedahanov et al., 2017). Workforce innovative behavior encourages innovation by recognizing external customer problems, developing solutions, and interpreting ideas to enhance learning and innovation (Alareefi et al., 2019; Muñoz-Pascual, 2020; Luoh et al., 2014; Nayir et al., 2014). Under the KBV perspective, employee innovative behavior triggers technical and non-technical innovation, as knowledge integration empowers employees to expose their innovative style and capabilities, ultimately leading to organizational innovation (Shahzad et al., 2017).

H8-H11: Employee innovative behavior is positively associated with product, process, marketing, and service innovation respectively.

Pi-shaped skills & employee innovative behavior as a mediator between KBHRP and technical and non-technical innovation

KBHRP are necessary for innovation (Minbaeva, 2013) such as technical innovation or non-technical innovation (Al-tal & Emeagwali, 2019). KBHRP such as knowledge-based recruitment, recruit employees based on their knowledge, and skills (Abrar et al., 2021), and knowledge-based training and development keep on updating their knowledge and it allows an employee to acquire knowledge from all departments while utilizing their domain (Kianto et al., 2017). Knowledge-based compensation drives workers to develop and use

their skills to develop innovative ideas that allow them to outperform rivals (Henri et al., 2015). Innovation depends on knowledge-based practices (Minbaeva, 2013) according to KBV theory, Knowledge can provide the organization with a competitive advantage (Urbancova, 2013) Knowledge-based HR procedures that involve the production, creation, and sharing of knowledge (Abrar et al., 2021) enhance employees to develop pi-shaped skills that will enhance the organization's innovative performance (Elayan et al., 2022). KBHRP will enhance the execution of innovative ideas by employees (Lopez-Cabrales et al., 2009) that will boost innovation within the organization (Henri Hussinki et al., 2017; Kianto et al., 2017; Mahmood et al., 2015)

Based on the above literature we proposed the following hypothesis

H12-H15: pi-shaped skills(π) mediate the positive relationship between KBHRP and product, process, marketing, and service innovation respectively.

H16-H19: Employee innovative behavior mediates the positive relationship between KBHRP and product, process, marketing, and service innovation respectively.

H20-H23: There is a dual mediation of pi-shaped skills (π) and employee innovative behavior between KBHRP and and product, process, marketing, and service innovation respectively.

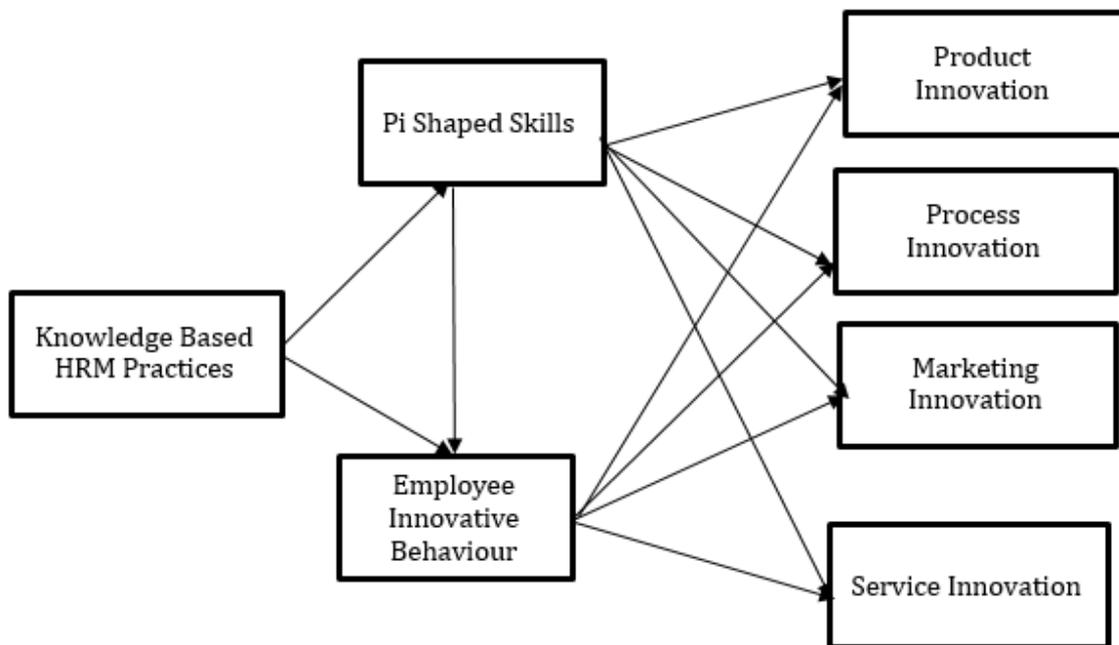


Figure 1 Research Framework

Material and Methods

All measurement tools were adapted from earlier studies to align with research requirements, validated by five academics, and piloted with 50 participants using a 5-point Likert scale and cross-sectional survey. KBHRP was measured with 13 items across four dimensions (Kianto et al., 2017), π -shaped skills with 5 items (Elayan et al., 2022), employee innovative behavior with 6 items (Scott), product innovation with 8, process innovation with 4 (Škerlavaj et al., 2010), marketing innovation with 1 (Nasution et al., 2011), and service innovation with 9 items (Yen et al., 2012). This ensured the robustness of the proposed model before final data collection.

Data Collection

Pharmaceutical firms were considered appropriate for this study due to fierce rivalry and sophisticated, innovative jobs. Pakistan's pharmaceutical industry has seen significant growth, and information was gathered from its personnel. The population comprised all 526 Pakistani pharmaceutical companies listed by the federal bureau statistics Islamabad, Pakistan, and using Krejcie & Morgan (1970), the ideal sample size was 226, raised to 317 to reduce sample attrition. A total of 160 responses were received via online survey, targeting HR managers and executives who support employee innovation and develop Pi-shaped skills. Pi-shaped skills enable HR professionals to design talent management strategies combining vertical expertise and horizontal knowledge, fostering employee innovation through training, performance assessment, and compensation. Data collection involved sharing survey links via WhatsApp and email, with follow-ups every two weeks over two months, requiring strong commitment and time dedication from the researcher.

Data Coding

After the completion of data collection data coding was done. Most of the data was preceded as we had closed-ended statements. Each of the surveys was checked at least two times to ensure correctness before the data was entered into an Excel sheet.

Missing value treatment

Since no missing data exceeded the 1% threshold for each item, the missing data were handled using the mean replacement procedure in SPSS before being included in the Smart PLS model estimation by SEM. Mean replacement is the suggested method for handling these missing data (Hair, et al., 2016).

Outlier Treatment Surveys

Since the measurement items were rated on a Likert scale of five points, no observation could be single-variate classified as an outlier. All of the items are within the prescribed range of 1-5, according to the descriptive statistics of the items. All of the items' kurtosis and skewness fell within the allowed range indicating that they are all normally distributed. SPSS was used to identify the outliers in the dataset and all responses fell within acceptable ranges, i.e., between 1 and 5. The results showed no outliers.

Data Analysis Approach

To determine the theoretical model fit and to check how the explanatory variable influences the dependent variable statistical techniques were used. To achieve this goal two of the statistical methods were utilized. Firstly, SPSS was utilized to interpret preliminary data. Secondly, we have used SEM with confirmation factor analysis to test the hypotheses.

Results and Discussion

Descriptive Statistics

In the first stage, we assessed the normality of data using descriptive statistics. The mean values were found greater than 3.66 and less than 4.12 while the standard deviation was greater than 1.168 and less than 0.900. According to (Hair et al., 2009) data is viewed as normal if the skewness and kurtosis are within a limit of -2 to +2 and -7 to +7, respectively. According to Sekaran (2003), all the variables had normal distributions as kurtosis and

skewness values below the cutoffs of absolute values of 3 and 1, respectively. To demonstrate a normal univariate distribution, values for asymmetry and kurtosis between -2 and +2 are deemed acceptable (Henseler & Fassott, 2010).

Common Method Variance

Common method variance (CMV) is the extent to which actual correlations are misrepresented due to using the same measurement method, such as a survey, to evaluate each variable. As data were collected from one participant per survey, preventive measures were taken, including using previously established measurement scales (Ylitalo, 2009) and ensuring participant confidentiality (Tehseen et al., 2017). Convenience sampling may still allow common method bias (CMB) (Jordan & Troth, 2020), which is a concern in self-surveys (Podsakoff & Organ, 1986). To reduce CMB, respondents were reassured about data security, and Harman's single-factor test showed a single factor explained only 44.6%, below the 50% threshold, indicating no CMB (Podsakoff & Organ, 1986). Table 1 Shows total variance explained.

Table 1
Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% Of Variance	Cumulative %	Total	% Of Variance	Cumulative %
1	21.968	45.767	45.767	21.443	44.673	44.673
2	2.822	5.879	51.646			
3	1.878	3.912	55.558			
4	1.785	3.718	59.276			
5	1.562	3.254	62.530			
6	1.396	2.908	65.438			
7	1.246	2.596	68.034			
8	1.147	2.389	70.423			
9	1.119	2.330	72.754			
10	1.033	2.152	74.905			

PLS-SEM

The partial least square structural equation model also known as path modeling is mainly used for data analysis in different management research. PLS consists of two important stages, Firstly the item data is utilized to examine the underlying construct score. Secondly, the path coefficient of the hypothesized model, outer loading, and formative and reflective constructs' weight are examined.

Measurement Model

This research examined separate estimates for each construct and used a repeated indicator approach to examine lower and higher order constructs concurrently (Chin, 2010; Hair et al., 2012). Since constructs precede the items, the model is reflective, where modifications to constructs impact the measures. The model was estimated using PLS path modeling to reduce theoretical complexity (Wetzels et al., 2009), with Smart PLS 3.0 (Sarstedt et al., 2014) employing path weighting and nonparametric bootstrapping with 5000 replications to calculate standard errors (Shrout & Bolger, 2002; Hair et al., 2012).

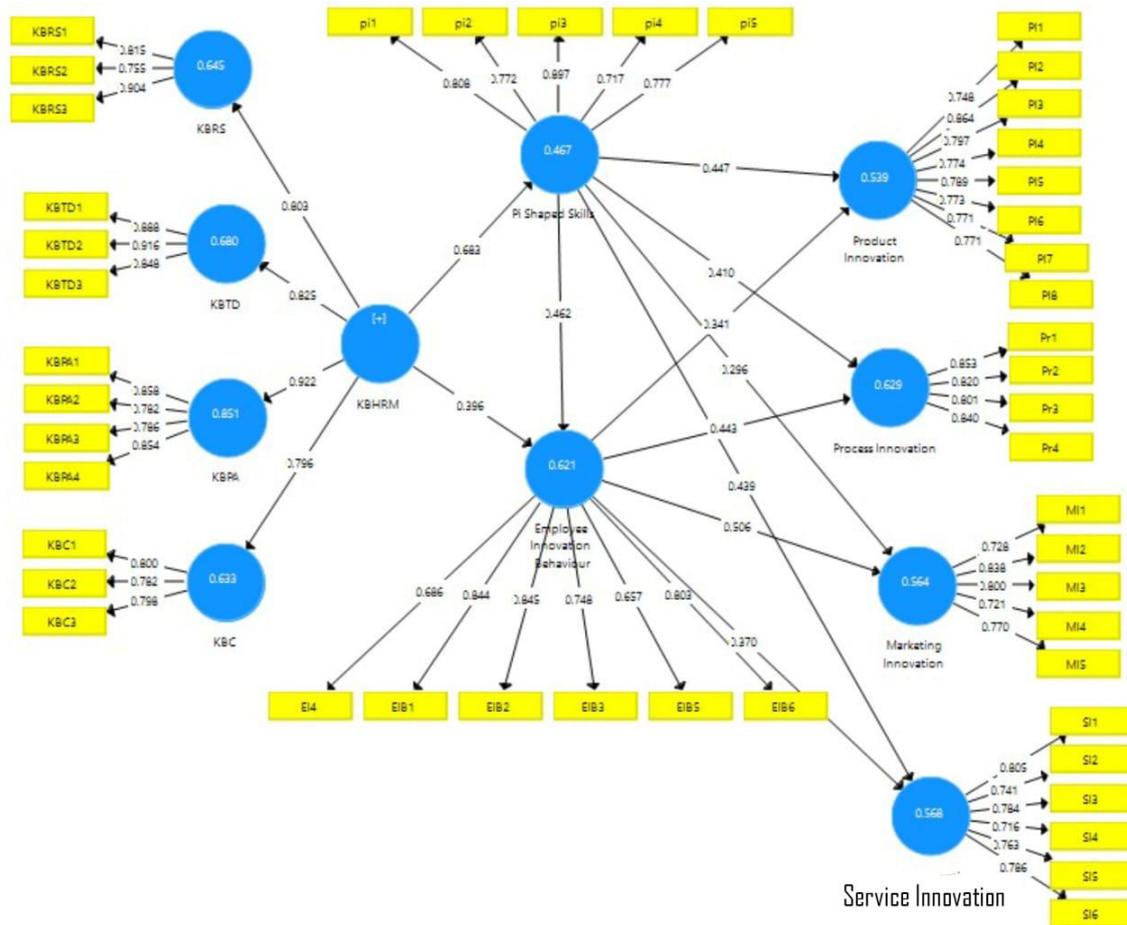


Figure No 2 Measurement Model

Construct Reliability and Validity

Reliability of Reflective Constructs

Construct reliability is defined as the extent to which the items set measuring underlying constructs are consistent. Cronbach Alpha, Composite reliability, and indicator reliability are three of the measures to examine construct reliability.

Composite Reliability

Composite reliability (CR) indicates internal consistency or reliability, measuring how accurately a latent variable reflects its underlying construct (Chin, 2010). Table 2 shows that the CR of every construct is above the 0.70 threshold, indicating satisfactory reliability.

Reflective Construct Validity

The validity of the constructs is defined degree to exactness with which a set of measurement model items set depicts the underlying constructs. Content validity, Convergent Validity, and discriminant validity are three of the measures to assess the validity of latent variables.

Content Validity

Content validity is based on subjective judgment about whether a measurement appears to measure its intended construct. While face validity is not a rigorous statistical

assessment, it is valuable in early research stages, and the research measuring items were altered based on earlier studies and experts' reviews for Pakistani content (Hair et al., 2017).

Convergent Validity

In Smart PLS, convergent validity is measured by analyzing the relation between latent variables and their corresponding indicators. AVE shows the variance acquired by the indicators and values above 0.5 are satisfactory, while CR indicates reliability and consistency, with values above 0.7 acceptable (Fornell & Larcker, 1981; Chin, 2010). In this study, all scales' CR and AVE met the cutoff values, showing strong association with indicators. The diagonals of the correlation matrix were used to calculate the square root of AVE, and inter-construct correlation coefficients were lower than the AVE square root (Fornell & Larcker, 1981).

Table Table 2
Factor Loadings, CR & AVE

	Loading	(CR)	(AVE)
EIB1	0.844	0.895	0.589
EIB2	0.845		
EIB3	0.748		
EIB 4	0.686		
EIB 5	0.657		
EIB 6	0.803		
KBHRP		0.926	0.543
KBHRP-KBRS1	0.815		
KBHRP-KBRS2	0.755		
KBHRP-KBRS3	0.904		
KBHRP-KBTD 1	0.888	0.915	0.782
KBHRP-KBTD 2			
KBHRP-KBTD 3	0.848		
KBHRP-KBPA1	0.858	0.892	0.674
KBHRP-KBPA2	0.782		
KBHRP-KBPA3	0.786		
KBHRP-KBPA4	0.854		
KBHRP-KBC 1	0.800	0.836	0.629
KBHRP-KBC 2	0.782		
KBHRP-KBC 3	0.798		
MI1	0.728	0.881	0.597
MI2	0.838		
MI3	0.800		
MI4	0.721		
MI5	0.770		
pi (π 1)	0.808	0.896	0.634
pi (π 2)	0.772		
pi (π 3)	0.897		
pi (π 4)	0.717		
pi (π 5)	0.777		
Pro11	0.853	0.898	0.718
Pro12	0.820		
Pro13	0.801		
Pro14	0.840		
PrIn1	0.748	0.928	0.619
PrIn2	0.864		
PrIn3	0.797		
PrIn4	0.774		
PrIn5	0.789		
PrIn6	0.773		
PrIn7	0.771		
PrIn8	0.805		
SIn1	0.805	0.895	0.587
SIn2	0.741		

SIn3	0.784
SIn4	0.716
SIn5	0.763
SIn6	0.786

Discriminant Validity

Discriminant validity is important in SEM using the PLS approach, ensuring constructs measure different notions. The Fornell & Larcker Criterion confirms discriminant validity when values exceed intercorrelations with other constructs (Fornell & Larcker, 1981; Chin, 2010). Additionally, the HTMT correlation ratio was applied, with values below the 0.850 cutoff (Henseler et al., 2015), supporting discriminant validity (Hair et al., 2017). Table 3 and Table 4 show Fornell & Larcker Criterion and HTMT criterion.

Table 3
Constructs' Discriminant Validity (Fornell and Larcker)

	EIB	KBRS	KBTD	KBPA	KBC	MI	Pi(π)	ProI	PrIn	SIn
EIB	0.767									
KBRS	0.532	0.827								
KBTD	0.529	0.607	0.884							
KBPA	0.668	0.616	0.691	0.821						
KBC	0.651	0.534	0.456	0.712	0.793					
MI	0.724	0.443	0.435	0.703	0.707	0.773				
Pi	0.733	0.481	0.413	0.643	0.763	0.667	0.796			
ProI	0.743	0.510	0.448	0.658	0.686	0.843	0.734	0.847		
PrIn	0.668	0.471	0.563	0.706	0.653	0.755	0.696	0.742	0.787	
SIn	0.692	0.429	0.438	0.590	0.610	0.772	0.710	0.754	0.723	0.766

Table 4
HTMT (Heterotrait-Monotrait)

	EIB	KBRS	KBTD	KBPA	KBC	MI	Pi	ProI	PrIn	SIn
EIB										
KBRS	0.654									
KBTD	0.615	0.734								
KBPA	0.792	0.760	0.809							
KBC	0.824	0.714	0.574	0.788						
MI	0.846	0.557	0.508	0.845	0.769					
Pi	0.842	0.567	0.467	0.754	0.854	0.784				
ProI	0.854	0.617	0.520	0.780	0.882	0.824	0.849			
PrIn	0.742	0.561	0.634	0.804	0.804	0.861	0.781	0.832		
SIn	0.792	0.511	0.507	0.692	0.767	0.814	0.817	0.726	0.833	

Assessment of Structural Model.

The following criteria are considered to evaluate the structural model

Coefficients of Determinants (R²)

The coefficient of determination (R²) is a significant measure in SEM using PLS, explaining the variance of the structural model and its predictive potential (Quinino et al., 2013). Higher R² values indicate stronger fit and understanding of variable relationships, and the proposed model shows acceptable predictive accuracy within threshold values (Piepho, 2019).

Predictive Relevance (Q²)

The Q² score assesses the model's endogenous construct prediction and evaluates structural model prediction accuracy, with higher values indicating better prediction (Akteer

et al., 2011). In Smart PLS, Q² CV is calculated via blindfolding, and values above zero show predictive significance.

Multi Collinearity

Multicollinearity refers to the presence of interdependence among predictor variables in a multiple regression model. High multicollinearity can cause unstable and unreliable coefficient estimates. To indicate the presence of multicollinearity the values of the variance inflation factor (VIF) are analyzed, which is substantially less than the cut-off value of five for the reflective variables. Hence, the test of collinearity is satisfactory.

Evaluation of the internal model and the testing Process

Direct Effects

The hypothetical relationships among variables were examined after establishing the goodness of the outer model using the PLS Algorithm in Smart PLS 3.0, with path coefficients and p-values assessed via bootstrapping. H1: KBHRP practices impact Pi-shaped skills ($\beta=0.683$, $t=8.730$, $p<0.001$), and H2: KBHRP practices affect employee innovative behavior ($\beta=0.396$, $t=3.893$, $p<0.001$). H3: Pi-shaped skills influence employee innovative behavior ($\beta=0.462$, $t=4.030$, $p<0.001$); H4-H7: Pi-shaped skills impact product ($\beta=0.447$, $t=2.678$, $p<0.05$), process ($\beta=0.410$, $t=2.879$, $p<0.001$), marketing ($\beta=0.296$, $t=2.087$, $p<0.05$), and service innovation ($\beta=0.439$, $t=3.694$, $p<0.001$). H8-H11: Employee innovative behavior affects product ($\beta=0.341$, $t=2.006$, $p=0.045$), process ($\beta=0.443$, $t=3.346$, $p<0.001$), marketing ($\beta=0.506$, $t=3.890$, $p<0.001$), and service innovation ($\beta=0.370$, $t=2.882$, $p<0.05$). Direct Effects are shown in Table 5 below.

**Table 5
Direct Effects**

	Hypothesis is	Original Sample	T statistics	P values
H1	KBHRP>PrIn	0.683	8.730	0.000
H2	KBHR->EIB	0.396	3.893	0.000
H3	Pi->EIB	0.462	4.030	0.000
H4	Pi->PrIn	0.447	2.678	0.008
H5	Pi->ProI	0.410	2.879	0.004
H6	Pi->MI	0.296	2.087	0.037
H7	Pi->SIn	0.439	3.694	0.000
H8	EIB->PrIn	0.341	2.006	0.045
H9	EIB->ProI	0.443	3.346	0.001
H10	EIB->MI	0.506	3.890	0.000
H11	EIB->SIn	0.370	2.882	0.004

*P<0.10; ** p<0.05;***p<0.01; NS:Not Significant

Evaluating the mediating impact of Pi shaped Skills and Employeeinnovative behavior

Grounded in the theoretical context, the mediating effect of Pi-shaped skills and employee innovative behavior (EIB) was examined between KBHRP and product, process, marketing, and service innovation using Smart PLS 3. Pi-shaped skills significantly mediate KBHRP's effect on product ($\beta=0.305$, $t=2.632$, $p<0.01$, H12), process ($\beta=0.280$, $t=2.850$, $p<0.01$, H13), marketing ($\beta=0.202$, $t=1.918$, $p<0.01$, H14), and service innovation ($\beta=0.300$, $t=3.517$, $p<0.001$, H15). EIB significantly mediates KBHRP's effect on product ($\beta=0.315$, $t=1.859$, $p<0.10$, H16), process ($\beta=0.175$, $t=2.430$, $p<0.05$, H17), marketing ($\beta=0.201$, $t=2.594$, $p<0.01$, H18), and service innovation ($\beta=0.147$, $t=2.099$, $p<0.05$, H19). Joint mediation of Pi-shaped skills and EIB between KBHRP and product ($\beta=0.108$, $t=1.860$, $p<0.10$, H20), process ($\beta=0.140$, $t=2.418$, $p<0.05$, H21), marketing ($\beta=0.160$, $t=2.378$,

p<0.05, H22), and service innovation ($\beta=0.117$, $t=2.295$, $p<0.05$, H23) is statistically significant. Indirect Effects are shown in Table 6 below.

Table 6
Indirect Effects

	Hypothesis is	Original Sample	T values	P values
H12	KBHRP->Pi->PrIn	0.305	2.362	0.00
H13	KBHRP->Pi->ProI	0.280	2.850	0.00
H14	KBHRP->Pi->MI	0.202	1.918	0.056
H15	KBHRP->Pi->SIn	0.300	3.517	0.00
H16	KBHRP-EIB->PrIn	0.135	1.859	0.064
H17	KBHRP->EIB->PrIn	0.175	2.430	0.015
H18	KBHRP->EIB->MI	0.201	2.594	0.010
H19	KBHRP->EIB->SIn	0.147	2.009	0.036
H20	KBHRP->Pi->EIB->PrIn	0.108	1.860	0.074
H21	KBHRP->Pi->EIB->ProI	0.140	2.418	0.016
H22	KBHRP->Pi->EIB->MI	0.160	2.378	0.018
H23	KBHRP->Pi->EIB->SIn	0.117	2.295	0.022

*P<0.10; ** p<0.05; *** p<0.01; NS: Not Significant

Conclusion

This research finding suggests that under the KBV and AMO framework, KBHRP play an important role in enhancing innovative performance in the organization while developing Pi-shaped skills and enhancing employee innovative behavior (EIB). Additionally, KBHRP confining KBRS, KBTD, KBPA, and KBC exert a positive influence on product innovation (PI), process innovation (PrI), service innovation (SI), and marketing innovation (MI) while considering the mediating role of EIB and Pi shaped skills.

As a pharmaceutical business in Pakistan has limited development in Pi-shaped skills and knowledge-based HR procedures that restrict its impact on innovative performance. In Pakistan, most organizations don't have data data-driven culture that's why this study enlightens the importance of culture driven by data and encourages it to be studied further.

Recommendations

This study adds to the existing body of knowledge in six distinct ways. First, by identifying the research gap between KBHRP in recruitment and selection, training and development, performance assessment, compensation, and pi-shaped skills. Second, this study has operationalized pi-shaped skills as a predictor for employee innovative behavior and product innovation, process innovation, marketing innovation, and service innovation and an outcome of KBHRP (Elayan et al., 2022).

Third, by exploring and revealing the mechanical process by which product innovation, process innovation, marketing innovation, and service innovation are achieved, we advanced the theoretical development of the recently presented and intricate theme of KBHRP. Previous research on pi-shaped skills was primarily conceptual (Nurius, & Kemp, 2019; Vojak, & Price, 2013).

Fifth this study has explored employee innovative behavior as the mediator between KBHRP and innovative performance such as product innovation, process innovation, marketing innovation, and service innovation. Sixth, KBV, and AMO are supported by the proposed and examined empirical model richly and comprehensively. Hence, having pi-shaped people are a valuable competitive differentiation for businesses (Distanont & Khongmalai, 2020).

This paper provides human resource managers with practical insights, highlighting the need for highly skilled workers in a competitive, globalized, and technologically

advanced environment, and suggests adopting KBHRP to enhance innovative performance. KBHRP empowers employees to recognize opportunities, improve skills, and develop Pi-shaped skills while fostering innovative behavior through knowledge acquisition, distribution, interpretation, and compensation. These concepts are particularly pertinent to Pakistan's pharmaceutical industry, encouraging self-improvement, learning, skill sharing, and innovative behavior.

Our research has certain flaws, to be sure. The sample size may limit the generalizability of the results to some extent as it is small compared to the overall population of the Pakistani pharmaceutical business. We have collected cross-sectional data that are likely to suppress causation so future research can collect data through longitudinal studies, and time lag sources to overcome this problem. As we only gathered information from pharmaceutical firms, our conclusions might not apply to companies that operate in different contexts or sectors. This study has measured the impact of pi-shaped skills on employee innovative behavior and product, process, marketing, and service innovation. Further exploring pi-shaped skills' relevance with frugal innovation will provide a productive avenue. The connection between a company's business analytics capabilities, KBHP, and a data-driven culture should therefore be considered to be studied further (Elayan et al., 2022).

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