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Understanding the impact of human capital on radical and incremental innovation: the role of entrepreneurial passion and alertness

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Abstract

Purpose The present study sought to comprehend the impact of human capital on radical and incremental innovation, with a focus on examining the mediating effects of entrepreneurial passion and entrepreneurial alertness.

Design/methodology/approach The study employed a purposive sampling technique for collecting data from entrepreneurs in from different sectors of Pakistan. A sample of 382 entrepreneurs completed the survey. Data were analyzed using SPSS and AMOS. Reliability, discriminant, and convergent validity tests were conducted, and structural equation modeling was used to test the hypotheses.

Findings It was revealed that human capital has a significant impact on radical and incremental innovation. Furthermore, entrepreneurial passion and alertness significantly mediates the relationship between human capital and innovation.

Originality/value The study contributes to the emerging research on innovation in entrepreneurship. There is limited research on types of innovation and entrepreneurial alertness in Pakistan; therefore, the study adds value to the scarce empirical research on innovation and entrepreneurial alertness and passion.

Keywords Human capital, Radical and incremental innovations, Entrepreneurship, Entrepreneurial passion, Alertness

Introduction

Scholars view innovation as a dynamic competence, which allows firms to evolve their products and services [36]. Therefore, firms are striving to develop their innovation capabilities to face external turbulences and environmental factors that might have a negative impact on their performance otherwise [29]. Furthermore, human capital is regarded as a significant determinant of the innovation capabilities of a firm [81]. In particular, the question regarding the impact of human capital on incremental and radical innovation has been garnering attention [1]. Innovation is considered to play a vital role in developing the economy of a nation [27]. Both human capital and training are critical inputs of innovation as human capital strengthens a firm's capacity to create and absorb innovative knowledge [18]. Different factors, such as direct funding by the public and R&D policies, effectively improve the human capital stock resulting in an innovation boost. It has been observed that the firms that focus on their R&D departments are likely to produce more products by 34.8% compared to other firms [41]. However, organizations in emerging and developing economies, in particular, have to face significant hurdles in terms of available resources and capital. Therefore, they are unable to develop their incremental and radical

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innovation [35]. The present study focuses on the entrepreneurial landscape in Pakistan.

Looking at the entrepreneurial landscape in the context of Pakistan, several political and economic factors have been obstructing the growth of entrepreneurial firms in the country. These factors include political instability, deficient legal framework, bank loans, and grants, and red-tape-filled bureaucracy [65]. In 2023, Pakistan ranked 88 among 132 economies on the Global Innovation Index, which ranks global economies according to their innovation capabilities [89]. The report indicates that much work is being done on advancing technology and boosting innovation in Pakistan. According to a report published by the World Bank on human capital development in Pakistan, the country has reached middle-income status. However, the country needs healthy, skilled, and resilient human capital to accelerate economic growth. Currently, human capital development in the country is in a crisis [88].

As Pakistan's economy is developing, the number of jobs is not found to be enough to fulfill the requirements of the public. This has encouraged the concept of entrepreneurship in Pakistan. Entrepreneurship is essential to societal wealth and health and ensures a nation's economic growth [62]. Technology experiences revolutionary changes by implementing radical innovations. Such changes are found to be impactful in every organization in Pakistan. Radical innovation encourages a complete exit from existing practices. At the same time, incremental innovations promote simple adjustments and slight improvements in the technology of various companies [49]. In Pakistan, various firms, especially SMEs, are taking necessary steps to implement radical and incremental innovations to improve the firm's overall performance. As stated by "the World Bank/IFC's (2010) report", SMEs are present in both developed and developing countries. Still, developing countries have only a few more giant corporations than their industrialized counterparts [61]. Furthermore, human capital is linked to entrepreneurial passions and positive alertness to improve the innovation processes for the firm's overall performance [66, 71]. For this purpose, the skills and training of employees are encouraged to improve human capital [39]. Entrepreneurial passion and alertness are also crucial [91].

The importance of entrepreneurship in promoting social and environmentally sustainable development areas has been observed to positively influence women's financial inclusion, minority integration, and sustainable business ventures [6]. Data from 28 European countries highlighted the relationship between entrepreneurship and the economic development of countries, and policymakers should focus on enhancing entrepreneurs' abilities [75]. The current research study also implements a quantitative analysis to determine the impact of human capital on different types of innovations focusing on the mediating roles of entrepreneurial alertness and entrepreneurial passion in Pakistan.

The present is significant because of its exclusive focus on the context of Pakistan, which has been rarely explored in terms of its entrepreneurial potential. The existing studies on human capital and innovation focus on the context of China [56, 81] and developed economies [60], making the present study immensely significant. Bakeev et al. [9] also analyzed the association between human capital and innovation. However, the study did not specify the impact of human capital on incremental innovation and radical innovation. Kusumawijaya and Astuti [51] also analyzed the impact of human capital on innovation. However, the study did not focus on entrepreneurial alertness and passion, a gap covered by the present study. Thus, this study plays an essential role in determining the impact of human capital on different types of innovation in Pakistan, and it also covers the other observed gaps. The main objectives of this research study are to determine how human capital boosts radical and incremental innovation in the presence of entrepreneurial passion as well as entrepreneurial alertness. This research study is found to be of great significance both theoretically as well as practically. The theoretical significance of the present study lies in the improvement of literature regarding the impact of human capital on different types of innovations in the context of Asian countries. This study also provides knowledge regarding the discussed variables and adds novelty to the theoretical framework. Such work also encourages practical implications by spreading awareness about the concept of entrepreneurship and its significance. This encourages more people to take entrepreneurship seriously to improve innovations and performance. In addition, this research study is also significant at the managerial level as it encourages managers to become influential leaders to play their role in radical and incremental innovations for effective outcomes. As human capital is considered necessary, more training sessions are supported.

The current study consists of five sections. The first section of the study focuses on the research background and articulates the research problem and objectives of the study. While section two focuses on the relational literature review of the discussed variables. Section three focuses on the research methodology and section four focuses on the obtained results and analysis. Finally, section five includes the discussion, conclusion, limitations, future research indications, and implications.

Literature review

Human capital theory

The primary intention of the human capital theory was to arrive at a method for determining the value of the human capital investments made by an employee [13]. Human capital was first conceptualized by Becker [13], who defined it as the knowledge and abilities that individuals acquire due to their education, training, and various other experiences, such as working in the field. In Becker's definition of human capital, there are two distinct conceptualizations of human capital attributes: human capital investments and the consequences of those investments, and task-related human capital as opposed to non-task-related human capital. Both of these conceptualizations are distinct from one another. The acquisition of information and abilities can be the product of formal education and practical experience, but this is not a given. Human capital characteristics are essential for two reasons: (1) they make it possible to separate causes and effects logically, and (2) they provide a basis for the theoretical derivation of the connection between human capital and innovative accomplishments of employees in any firm. The learning processes were acknowledged in the early stages of the human capital theory. On the other hand, scholars who study human capital have not paid much attention to the different functions and mechanisms that contribute to the effects of human capital on venture outcomes [79]. The accumulation of human capital and its subsequent transmission are crucial aspects of this innovative process [25].

Human capital and radical innovation

Radical innovation is a term for a company's ability to develop new products and services and improve the ones it already has [87]. On the other hand, the resource-based view (RBV) says that a company's human capital is valuable, limited, hard to copy, and impossible to replace [16]. Therefore, it shows that human capital is essential to the organization from a strategic point of view of radical Innovation [8]. People care a lot about the ability of a company to develop radical innovation and how it manages its human capital. It is because so much attention has been paid to how the two are related. In addition, workers are believed to play a crucial part in radical innovation. Workers acquire the information, expertise, and experience (Human Capital) required for innovation through learning [32]. Barba-Aragón and Jiménez-Jiménez [10] regard the strategic management of human capital as crucial for cultivating radical innovation in a firm, implying a significant role of human capital for boosting radical innovation. Similarly, Rampa and Agogué [72] claimed that the human capital had to be trained to enhance their creative and innovative capabilities, which would help promote radical innovation in the organization. Thus, the studies linking human capital to radical innovation imply that human capital can be used as a tool to encourage continuous learning.

In light of the human capital theory, the present study predicts that human capital with proper knowledge and expertise can help bring about innovation within an organization. Thus, based on the aforementioned literature, the following hypothesis can be formulated.

H1 Human capital has a significant impact on radical innovation.

Human capital and incremental innovation

Incremental innovation refers to making existing products and services more valuable. The production of new knowledge and using human resources to acquire new skills contribute to creation at the company level [12]. This information can be obtained either through research and development (R&D) or through the talents and capabilities of staff members [64]. Most studies examining the relationship between human capital and incremental innovation have been conducted at the national level [11] or in enterprises as a control variable which shows that human capital significantly influences the existing model and makes it more useful for the firm (refers to incremental innovation process) [18]. Similarly, according to Schneider [76] a view at the firm's level is required to comprehend how human capital and incremental innovation interact. Employees who have received sufficient training can draw more incredible inspiration from their experiences in the real world. In less-developed nations, it was discovered that training (human capital) and creativity to change for the better (incremental innovation) are intertwined, however, Robinson and Mulvaney [73] did not discover any such connection between the two variables. Some researchers are looking for a means to measure human capital that is more advanced and related to incremental innovation [4]. Thus, based on the aforementioned studies and the theoretical conception of human capital theory, the present study predicts that human capital can play a crucial role for adding value to existing products and services of a firm, leading to incremental innovation. Thus, the following hypothesis can be formulated:

H2 Human capital has a significant impact on incremental innovation.

The mediating role of entrepreneurial passion

Entrepreneurial passion refers to an entrepreneur's strong feelings for a particular entrepreneurial action

or field, such as invention, beginning a new business, or continued development, that they conduct as part of their business [19]. Many studies have examined how an entrepreneur's passion and human capital affect the success of their companies by promoting new working ideas (innovation) [26]. Several researchers have investigated how much passion, effort, and innovative ideas (radical or incremental) entrepreneurs put into running their interactions with the help of human capital and how they are interconnected [52]. The study of Chebo and Kute [21] states that an entrepreneur's passion and human capital are the essential components that business owners work hard on to get a good return on their time and effort. Over time, entrepreneurs with a lot of passion and human capital are more likely to set and reach high-performance goals for their new businesses. Meanwhile, researchers are beginning to comprehend the numerous elements of entrepreneurial passion [63]. They have discovered that passion is essential for launching and growing new enterprises, but innovation (radical and incremental) is crucial for the business's growth [43]. As a result, researchers have advocated for a more in-depth examination of how passion influences entrepreneurship with the help of human capital and radical or incremental innovation [19]. For instance, Zou [92] regarded entrepreneurial passion as a crucial element for cultivating innovation in a business. Similarly, Luu and Nguyen [57] reported entrepreneurial passion as a significant determinant of innovation capabilities and strategies of a firm. Thus, the present study predicts a significant mediating effect of entrepreneurial passion, indicating that it would enhance the impact of human capital on both radical and incremental innovation. Thus, the study posits that human capital of an organization should possess sufficient entrepreneurial passion so that they can contribute towards establishing an innovation-based environment within the organization. Thus, the following hypotheses can be formulated:

H3 Entrepreneurial passion plays a significant mediation role in the relationship between human capital and radical innovation.

H4 Entrepreneurial passion plays a significant role in the relationship between human capital and incremental innovation.

The mediating role of entrepreneurial alertness

Entrepreneurial alertness has recently received much interest in research on the options for new business owners since it could help explain how to identify opportunities [77]. Kirzner [47] is regarded as the originator of the concept of entrepreneurial alertness due to his early work on the subject. People who think like entrepreneurs may learn more about how opportunities arise and how to capitalize on them [58]. It has also been linked to other variables recognizing organizational impacts, such as human capital and innovation (incremental and radical). These factors influence business in a variety of ways, including creation (innovation) [30], strategic decisions (human capital) [74], and improved business performance [2]. Similarly, entrepreneurial awareness is now associated with additional characteristics such as human capital, demonstrating an understanding of how organizations work with innovation, whether radical or incremental [91]. According to Tang [82], an entrepreneur who is constantly alert to exploring fresh ideas for existing models (radical or incremental innovation) has a better chance of coming up with more inventions. According to Clausen [22], radical or incremental innovation modes are among the many methods active entrepreneurs use to bring innovative ideas to life with the help of human capital. In addition, Amit and Zott [5] claim that alert and updated entrepreneurs who help in the improvement of competitive employees' characteristics (human capital) and get a modification in working ideas (innovation) improve and help the business to merge. Tang et al. [85] reported a positive and significant impact of entrepreneurial alertness on innovation capabilities of a firm, indicating that entrepreneurial alertness helped introduce unique and innovative opportunities for enhancing financial performance of the firm. Similarly, Levasseur et al. [54] also regarded entrepreneurial alertness as a crucial determinant of firm innovation. Thus, based on these studies, the present study posits that human capital must possess entrepreneurial alertness to support an innovative environment in the firm. Thus, the following hypotheses can be formulated:

H5 Entrepreneurial alertness plays a significant mediation role in the relationship between human capital and radical innovation.

H6 Entrepreneurial alertness plays a significant mediation role in the relationship between human capital and incremental innovation.

Methodology

Research methods and procedures

In the present investigation, the researcher employed a purposive sampling strategy, which entailed purposefully choosing a specific sample. The application of purposive sampling is consistent with the research questions and characteristics of the study. By using this approach, the

researcher has the opportunity to deliberately choose people who had entrepreneurial qualities. Moreover, the researcher also ensured that these entrepreneurs provide professional services in various sectors such as manufacturing, telecommunication, education, banking, and finance, service, and agriculture in Pakistan. Notably, the data collection period was from April to August 2022. This is because certain industries such as agriculture might reveal varying patterns of activity throughout the year. Therefore, selecting a period involving spring and summer months (April to August) ensures the provision of more consistent representation of entrepreneurial activities. Most importantly, the focus of research was on data collection and analysis within a specific time constraint. Based on the cross-sectional nature of study, the time period between April to August was selected.

Furthermore, the researcher shared the measurement instrument with professionals in the industry and academic experts specialized in entrepreneurship to ensure the content validity, reliability, and accuracy of the items in the construct. Based on the ideas pitched by the professionals and entrepreneurs, a slight context-specific modification was incorporated to the final draft of the questionnaires. Moreover, in order to guarantee precision and effectiveness, a pilot study was undertaken, including 35 participants who were requested to answer the surveys items. Those who participated were comprised of an accurate representation of entrepreneurs being considered. Mentionable, upon assessing responses from the participants, it emerged that no adjustments are necessary in the survey questions. The researcher has tried to fulfill all the standards of ethical consideration by remaining unbiased and keeping the data obtained from respondents confidential. Moreover, their relative permissions through e-mails have been taken for using the scales of the concerned authors.

Finally, the survey was conducted to, and 500 questionnaires were sent to the entrepreneurs from various sectors. As far as the nature of the study is concerned, it meets the standards of explanatory research, as research has already been adopted and tested based on existing theories. This study is based on essential analytical procedures, and results cannot be concluded based on the experiences of others as in exploratory studies. Hence, objectivity is preserved, and the explanatory nature of the research was conducted. However, 400 questionnaires were returned, of which 382 were considered usable in this study for running different tests and checking the final status of the hypothesis. Notably, the sample size of 382 is adequate for path analysis as the minimum sample required for SEM is 200 [48].

Among 382 respondents, 212 were males and 170 were females, with a percentage of 55.5 and 44.5, respectively. The respondents' experience varies in less than 2 years, 2–5 years, 5–8 years, and more than 8 years, with respective percentages of 13.6, 42.9, 33.8, and 9.7, correspondingly. The age of different respondents also varied, being less than 25 years, 25–35 years, 35–45, and 45 years or more, with the percentage of 32.2, 39.8, 24.1, and 3.9, correspondingly. Please see "Appendix 1".

Measures

Human Capital was measured using a nine-item scale adopted by Bontis [15]. Several items included are *"Focused on succession training program," "There is a cooperation of employees within teams," "Employees come up with new ideas," "The business focuses on upgrading employees' skills," "There is strong interpersonal communication in teams," "Employees give their all," "Individuals learn from others."*

Entrepreneurial alertness has been measured using a nine-item scale [83] on a Likert scale of 1–5. The items measured the respondents' scanning and search capacity, association and connection capability, and evaluation and judgment ability. Sample of the items in entrepreneurial alertness included *"I have frequent interactions with others to acquire new information," "I see links between apparently unrelated pieces of information," and "I can distinguish between profitable opportunities and not-so-profitable opportunities".*

For entrepreneurial passion, the scale comprising five items has been used. Three items measured the passion for inventing, founding, and developing, and two measured positive feelings, including confidence and optimism. Sample items for entrepreneurial passion were *"I am optimistic about developing new approaches to make existing things better" and "Being the inventor of a new product/service/process is an important part of who I am."* The items were measured on a five-point Likert Scale from 1 ("Strongly Disagree") to 5 ("Strongly Agree").

Radical innovation, five items scale has been used based on five points Likert scale by Sood and Tellis [80]. Items measured the changes and technological advancement employed by the firm that was new in the industry that covered *"new products," "new services," "methods of production," "new sources of supply," and "new methods of organization."*

The scale for incremental innovation was comprised of five items [45]. The scale for incremental innovation covered items that discussed changes adopted by the firm within the last 3 years that other firms previously used in terms of *"new products," "new services," "new methods of production," "new sources of supply" and "new ways of organizing."*

Results and data analysis strategy

Statistical Package for Social Sciences (SPSS) 21.0 and Analysis of Moment's Structure (AMOS) 24.0 were employed for data analysis. AMOS is a statistical package for the application of SEM and aids researchers in the application of advanced multivariate analysis. It allows researchers to build behavioral and attitudinal models reflective of complex associations and allows for the testing of complex causations through an intuitive interface [44]. The direct and indirect impact of the construct's relationships is widely studied by adopting this technique [50] as it explains the interaction between variables [38]. The study performed component analysis to gauge the structure and factor loadings, followed by testing the model's fitness in AMOS, and conducted the path analysis to evaluate the linkage among constructs using SEM.

Before factor analysis and path analysis, the instrument's reliability is tested with Cronbach Alpha, and a cut-off value is set to 0.7, as recommended by researchers [38]. To test the model's measurements, reliability, and validity of all constructs under the study, the Confirmatory Factor Analysis (CFA) was operationalized [7]. A high convergent validity ensures that the item only has information on the corresponding factor [23]. Hence, the composite reliability should be equal to or higher than 0.7 [37]. The average variance extracted should be higher than 0.5 to establish no convergent validity issue [38]. The indicators for model-fit measures taken into consideration to endorse the suitability of structural models were Minimum Discrepancy Function by Degrees of Freedom divided (CMIN/DF), Standardized Root Mean Squared Residual (SRMR), Comparative Fit Index (CFI), PCLOSE, and Root Mean Square Error of Approximation (RMSEA). According to Hu and Bentler [42], the acceptable threshold level for CMIN/DF is acceptable fit > 3, excellent fit > 1, the acceptable threshold range for CFI is 0.9, and values greater than 0.95 are considered excellent. Similarly, for SRMR acceptable region lies between 0 and 0.08, whereas for RMSEA excellent acceptance region is between 0 and 0.05, values greater than 0.05 and lesser than 0.08 are considered acceptable and values above 1 are considered poor. Finally, for PCLOSE acceptable fit < 0.05, excellent fit > 0.05 respectively. In the second step, verification of serial mediation hypothesized relationships was tested.

Description of study variables

The Table 1 explains and presents the range for the variables (maximum and minimum), standard deviation, mean, and skewness for all variables included in the conceptual framework. The mean value for HC, RIN, EA, EP, and IIN are 3.38, 3.51, 3.57, 3.36, and 3.63 respectively.

Table 1 Descriptive of study variables (N = 382)

Constructs	Min	Max	Mean	SD	Skewness
RIN	1.00	5.00	3.3845	0.92796	−0.507
HC	1.00	5.00	3.5797	1.13293	−0.646
EA	1.00	5.00	3.3607	0.97271	−0.282
EP	1.00	5.00	3.5178	1.06179	−0.546
IIN	1.00	5.00	3.6340	1.04943	−0.519

HC human capital, *EP* entrepreneurial passion, *EA* entrepreneurial alertness, *RIN* radical innovation, *IIN* incremental innovation *α* Cronbach's alpha; *CR* composite reliability

Table 2 Discriminant validity (N = 382)

	RIN	HC	EA	EP	IIN
RIN	0.829†				
HC	0.535**	0.850†			
EA	0.609**	0.508**	0.915†		
EP	0.501**	0.530**	0.491**	0.800†	
IIN	0.503**	0.554**	0.499**	0.445**	0.814†

HC human capital, *EP* entrepreneurial passion, *EA* entrepreneurial alertness, *RIN* radical innovation, *IIN* incremental innovation

**Correlation is significant at the 0.01 level (2-tailed)

† represents significance of R2 over correlation values through which discriminant validity established

The cut-off value for the skewness ranges from −1 to +1 [46]. The skewness values for HC, RIN, EA, EP, and IIN in the table above are −0.507, −0.546, −0.646, −0.282 and −0.519 respectively, which shows that there is some degree of familiarity among the data points and that they are all relatively close to each other in terms of value. This also indicates that there are no outliers present in the data set that could potentially skew the results.

Discriminant validity

Table 2 demonstrates the validity of all the variables, i.e., HC, RIN, EA, EP, and IIN, are dissimilar or discriminant from the other variable. The above-stated table elaborates that all these constructs are different from each other. RIN is 0.829, different from HC, EA, EP, and IIN. In this way, the discriminant validities are 0.850, 0.915, 0.800, and 0.814 for HC, EA, EP, and IIN, respectively, which shows that the values are distinct from all other variables.

Convergent validity

Cronbach's alpha is a test that measures the reliability or internal consistency of your study variables. The threshold value for Cronbach's alpha is 0.70, but values greater than that are also acceptable. The Table 3 shows

Table 3 Reliability and convergent validity (N = 382)

Constructs	Reliability		Convergent validity
	Cronbach alpha (α) coefficients	Composite reliabilities (CR)	Average variance extracted (AVE)
RIN	0.868	0.916	0.687
HC	0.815	0.959	0.722
EA	0.895	0.979	0.838
EP	0.902	0.899	0.641
IIN	0.852	0.907	0.662

HC human capital, *EP* entrepreneurial passion, *EA* entrepreneurial alertness, *RIN* radical innovation, *IIN* incremental innovation, *α* Cronbach's alpha, *CR* composite reliability, *AVE* average variance extracted

that the values for all the variables (HC, RIN, EA, EP, and IIN) are greater than 0.80, illustrating that all variables included in the study are reliable. Therefore, this consistency test allows the researcher to study the traits of the evaluation scale and the items that form the scale. The CR values for HC, RIN, EA, EP, and IIN are 0.959, 0.916, 0.979, 0.899, and 0.907 respectively—all of which are greater than 0.7 and therefore suggest that these values are acceptable. Similarly, the AVE values for HC, RIN, EA, EP, and IIN are 0.722, 0.687, 0.838,

0.641, and 0.662 respectively—all of which are greater than 0.50 and also suggest that these values are acceptable. In conclusion, the instrument used for the study has internal consistency and is valid.

Confirmatory factor analysis

CFA is a method that is used to test and verify the theory of dimension and measurements. CFA is performed in a series of steps, where the individual loadings for the construct items are calculated in the first step. Table 4 presents the individual loadings for the construct items and it is evident that all contribute effectively to the construct variance as item loadings are greater than 0.5 and none of the constructs are cross-loaded [90].

Several indices were used to ascertain the reliability and validity of the conceptual framework. The values of the indices depicted in Table 5 indicate that all indices reflect values from the acceptable regions i.e., χ^2/df are less than 3; for GFI, IFI, and CFI is ≤ 0.90; and for RMSEA is ≥ 0.08 [17]. The model below displayed the GFI = 0.894, IFI = 0.983, CFI = 0.983, and RMSEA = 0.036. The confirmatory factor analysis (CFA) illustrated in the diagram below shows that the studied model is good and that the variables have a meaningful, significant relationship.

The first step in CFA is to create a hypothesis about the fundamental variables underlying the measures

Table 4 Factor loadings

	1	2	3	4	5
EA1	0.869				
EA2	0.758				
EA3	0.564				
EA4	0.711				
EA5	0.831				
EA6	0.729				
EA7	0.771				
EA8	0.710				
EA9	0.753				
EP1				0.695	
EP2				0.742	
EP3				0.706	
EP4				0.739	
EP5				0.710	
RI1		0.727			
RI2		0.748			
RI3		0.761			
RI4		0.876			
RI5		0.678			
II1					0.892
II2					0.904
II3					0.726
II4					0.831
II5					0.701

Table 5 Nested confirmatory factor analysis (N = 382)

	Model Fit indices	Threshold range	Observed values
Nested model	χ^2		13,638.634
	Df		528
	χ^2/df	Lesser than 3	1.489
	GFI	≤ 0.80	0.894
	IFI	≤ 0.90	0.983
	CFI	≤ 0.90	0.983
	RMSEA	≥ 0.08	0.036

χ^2 Chi square, *Df* degree of freedom, *CFI* comparative fit index, *RMSEA* root mean square error of approximation

used. This may involve putting limits and restraints on the model based on the developed hypothesis. By doing this, the researcher is trying to force the model to be consistent with their theory. CFA is a reliable process for examining a theory where a perfect factor model is stated. It is important to only load constructs onto real and definite factors in order to accurately measure the goodness of fit for that specific model. This allows researchers to investigate the hypothesis that there

is a linkage between observed constructs and their applicable latent variable(s).

Structural equation modeling

SEM is a statistical software used to analyze complex multivariate models and evaluate the structural relationship between variables [14]. This tool comprises of two primary elements: factor analysis and multiple regression analysis. The structural association between latent variables and measured constructs can be investigated using this software.

Table 6 indicates that all six hypotheses were accepted. The above structural equation modelling table shows that the two linear hypotheses, i.e., HC → RI and HC → IIN have a *p* value shown in steric ***, which means that human capital significantly impacts radical and incremental innovation. A unitary increase in human capital would cause 14.5% increase in radical innovation and 14.3% increase in incremental innovation as shown in Table 6. Moreover, Mediation relationships HC → EP → RI, HC → EA → RI, HC → EP → IIN, HC → EA → IIN are also accepted due to their significant p-value illustrated as 0.010, which shows the hypothesis is accepted. It is commonly known that a p-value greater than 0.05 will illustrate that the concerned hypothesis has a significant impact and is relatively acceptable. Entrepreneurial passion and alertness strongly mediate between human

Table 6 Structural model results

Effects	Hypothesized path	B	S.E	*P* value	Conclusion
Linear effects					
Hypothesis 1 (+)	HC → RI	0.145	0.057	***	Accepted
Hypothesis 2 (+)	HC → IIN	0.143	0.060	***	Accepted
Mediation effects					
Hypothesis 3 (+)	HC → EP → RI	0.272	0.045	0.010	Accepted
Hypothesis 4 (+)	HC → EA → RI	0.276	0.044	0.010	Accepted
Hypothesis 5 (+)	HC → EP → II	0.182	0.045	0.010	Accepted
Hypothesis 6 (+)	HC → EA → IIN	0.182	0.043	0.010	Accepted

HC human capital, *EP* entrepreneurial passion, *EA* entrepreneurial alertness, *RIN* radical innovation, *IIN* incremental innovation *α* Cronbach's alpha; *CR* composite reliability

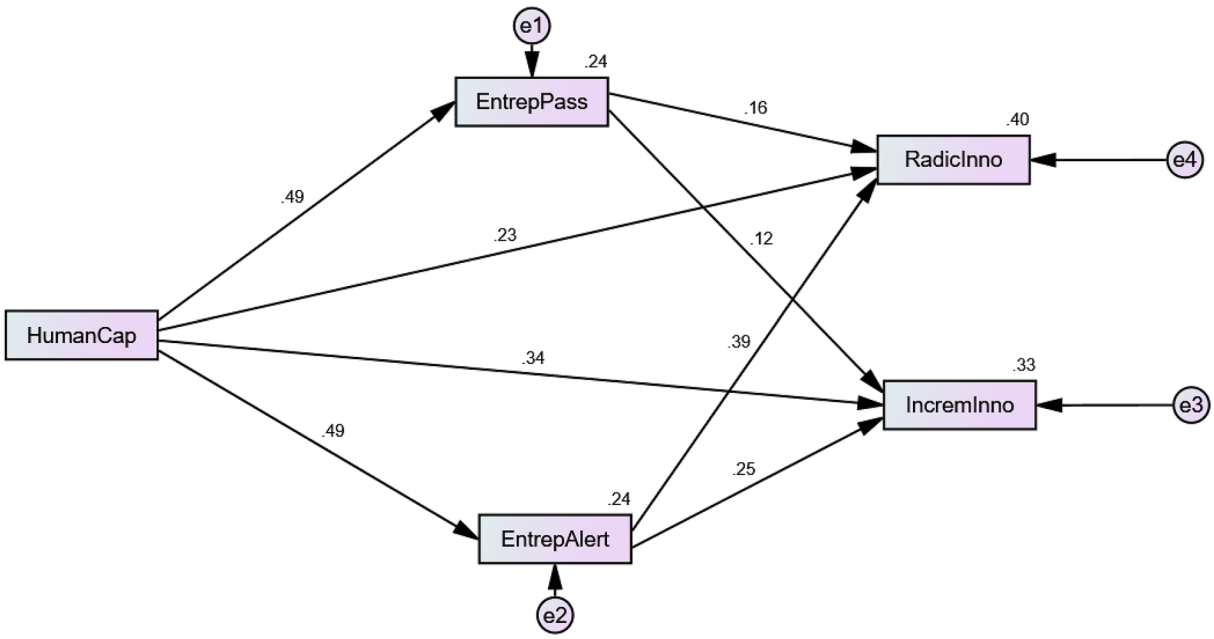

Fig. 1 Structural equation modelling

capital and radical innovation and human capital and incremental innovation. Also see Fig. 1.

Discussion

For a nation's economic growth, innovation is considered an important driver. This has encouraged many developing and developed countries to take the necessary steps to initiate innovative processes, especially in SMEs. Pakistan is also one such country i.e., it focuses on promoting entrepreneurs for encouraging innovative ideas in different firms leading to economic growth. In this process, human capital is considered to play an important role. Thus, the present research study was also conducted to determine the impact of human capital on different types of innovation under study, considering the mediating role of entrepreneurial alertness and passion in Pakistan. For this study, the quantitative analysis of the conducted survey was done, and CFA and SEM were used to obtain the required results.

The six main findings were obtained from the present study. First, human capital has a significant impact on radical innovation. This finding was aligned and complements the research undertaken by Pradana et al. [70]. The role of human capital in enhancing innovation is critical as it contributes to the continuity of a company through the generation of new ideas to transform products, services, or production processes [3, 28]. Investing in human capital boosts employees' knowledge, skills, and creativity, which directly impacts the likelihood of positive change in the firm [28].

Furthermore, research states that organizational knowledge and learning significantly affect the radical innovation process. Firms investing to increase market knowledge and learning to increase human resources capabilities will increase the chances of radical innovation. The findings against this hypothesized path, aligns with the research undertaken by Tiberius et al. [86]. Another study also complements and aligns with the findings. In this regard, a research by Barba-Aragón and Jiménez-Jiménez [10] stated that radical innovation plays an essential role in the success of an organization. Radical innovation gives companies a competitive edge and enables them to adopt advanced technologies for long-term profit and success.

Second, human capital has a significant influence on incremental innovation. Studies also stated that skilled and efficient employees are involved in firms that are effectively organized to perform best by utilizing incremental innovation. These results align with the research by Haneda and Ito [40] and McDowell et al. [59]. The third and fourth findings showed that entrepreneurial passion significantly mediated the relationship between human capital and radical and incremental innovations. Many research studies also align with the finding of current study. Therefore, these studies also reveals the significant mediating impact of entrepreneurial passion in the context [57]. One such study also stated that entrepreneurial passion has a significant mediating role in the relationship between creativity and entrepreneurial orientation [33]. This is considered to be essential for both radical as well as incremental innovation. Finally, the fifth and sixth results presented the significant mediating role of entrepreneurial alertness in the relationship between human capital and radical and incremental innovations. Researchers believe that entrepreneurial alertness helps entrepreneurs determine the required solutions from the given information for both radical and incremental innovations, and skilled employees are found to play an essential role in this process [53, 84]. Studies have shown that firms that hire energetic and passionate young managers experience greater levels of radical innovation. Therefore, these findings also corresponds to the work undertaken by Acemoglu et al. [1]. Employees with higher entrepreneurial alertness can identify opportunities and assess the profitability of opportunities, which positively affects the incremental innovation of firms [54]. Entrepreneurial passion is a driving force that impacts individuals' cognitive and behavioral abilities. It motivates individuals to take bold steps, avail opportunities and start new businesses, thereby boosting innovation [20].

Conclusion

In conclusion, this research substantially accomplished the objectives of thoroughly investigating the impact of human capital on both radical and incremental innovation, while also considering the mediating influences of entrepreneurial passion and entrepreneurial alertness. All stated hypotheses have been verified, demonstrating the substantial influence of human capital and the mediating variables generating multiple kinds of innovation within the scope of this study. These results highlight intricate interactions and underline the diverse range of variables that contribute to innovations inside organizations.

Theoretical implications

The present research study is found to have theoretical, practical, as well as social and policy-related implications. The present research study improves the knowledge related to the impact of human capital on different types of innovations, improving the content related to entrepreneurial passion and entrepreneurial alertness. The present research extends the human capital theory by developing a potential association between human capital and both radical and incremental innovations. However, the incorporation of entrepreneurial mindset

and alertness as mediators provides a more comprehensive understanding of the way through which human capital influences innovation. However, the incorporation of mediators in the present study also extends human capital theory by depicting that the influence of HC on the outcomes of innovation is not direct only but can also be influenced through entrepreneurial attitudes and perceptions. It also improves the theoretical framework of the variables under study by establishing the link between human capital and radical and incremental innovation in Pakistan. Previous studies have established the link between entrepreneurial passion and innovation [55, 78]. Still, the current study has added to the research model by incorporating entrepreneurial passion and alertness as the mediator between human capital and innovation. The study has laid the grounds for entrepreneurial research regarding radical and incremental innovation in Pakistan, which serves as a guide for future researchers.

Practical implications

Practically, the present study encourages the managers of different firms to take essential measures such as holding training sessions and awareness programs for the employees to improve the company's human capital for the firm's overall benefit. This research provides beneficial insights for the managers. The managers should invest in enhancing the human capital of their workforce through different training sessions and awareness programs [34]. Professional investors can also be encouraged through this study by not only considering a firm but also the entrepreneurial passion exhibited by its workforce. Policy makers can also gain insights from this study by focusing on an environment that promotes better human capital development. Policy makers can also gain insight from this study and design initiatives that fosters entrepreneurial activities among the youth. Educational institutions can also pay heed towards incorporating programs that improves entrepreneurial skills, alertness, and passion. The study emphasizes entrepreneurial passion and alertness to enhance the relationship between human capital and innovation [31, 55]. Therefore, managers and investors should pay attention to these factors that are extremely significant in developing the firm's innovation strategies. Professional investors should focus more on entrepreneurial passion instead of jumping onto preparedness. The present research study not only promotes innovation types and human capital but also introduces the concept of entrepreneurship in a very different way that will encourage the youth to become future entrepreneurs. This will encourage them to promote innovative ideas that would lead to radical innovations, thus resulting in the country's economic growth [24]. This research study will also encourage policymakers to develop policies that encourage human capital by promoting human rights and equal opportunities [67]. Providing an environment for developing entrepreneurial activities lies with the government, policymakers, the education sector, and firms. Entrepreneurial programs that help individuals enhance skills and use their entrepreneurial alertness and passion should be developed. Hence, this will also help to improve various firms' overall code of conduct, encouraging innovative processes.

Limitations and future research directions

This research advances to the prevailing understanding on the development and effects of entrepreneurial passion and alertness, specifically in relation to human capital and innovations. This study employed standard statistical techniques for assessing the research model. Nevertheless, it is imperative to take into account certain limitations while interpreting the results. Therefore, the present investigations, hereby acknowledge certain limitations. First, study involves the self-reported data; therefore, it has introduced the possibility of bias [68]. In this way, respondents may provide answers that corresponds with perceived societal norms or expectations as compared to their true expressions or attitudes [69]. To mitigate this, future research could explore complementary methods, such as observational data or external validation.

Second, considering cross-sectional research design inhibits the researcher's ability to generalize the findings of mediation mechanism. Notably, this underlines the relevance to execute longitudinal research in order to comprehend the mediating impact of entrepreneurial passion and alertness. Moreover, it is essential to take into account the extent to which the results may be applied to other contexts outside of Pakistan. The research specifically examined a distinct geographic and cultural environment; therefore, it is important to employ care when applying the findings to other instances. Future research endeavors might be improved by using various samples to strengthen the external validity of the results.

For future studies, a larger sample size can be selected for a better and more practical analysis. Furthermore, the current study has evaluated the research problem in Pakistan's cultural context. Future research should examine whether cultural factors influence entrepreneurial alertness and passion on firm activities. One potential research gap also lies in exploring the role of organizational culture as a potential moderator between the current IVs and DVs. This is because unless the culture is not supportive or flexible, employees may feel reluctant to implement an entrepreneurial mindset and practice innovation. Therefore, top management support and

organizational culture are the significant predictors of gaining effective organizational outcomes with human capital and innovation.

Appendix 1: Demographic profile of the respondents

Demographic profile	Frequency	Percentage (%)
Gender		
Male	212	55.50
Female	170	44.50
Experience of entrepreneurs		
Less than 2 years	52	13.60
2–5 years	164	42.90
5–8 years	129	33.80
More than 8 years	37	9.70
Age		
Less than 25 years	123	32.20
25-35 years	152	39.80
35-45 years	92	24.10
45 years or more	15	3.90
Organization type		
Sole proprietorship	50	13.10
Partnership	120	31.60
Company	210	55.30

Abbreviations

HC Human capital
II Incremental innovation
RI Radical innovation
EP Entrepreneurial passion
EA Entrepreneurial alertness
SME Small and medium enterprises
HCT Human capital theory

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None.

Author contributions

TR and MM conducted literature review, wrote research abstract, introduction, motivation, methodology, discussion and implications in addition to interpreting and analysing results. MAA, ANA and SA conducted literature review, collected data and rote research limitations. EH analysed data, formulated the applied model, interpreted and analysed results. All authors read and approved the final manuscript.

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Declarations

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Competing interests

The authors declare that the research was conducted without any commercial or financial relationships that could be construed as a potential competing interests. The author declares that they have no competing interests.

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