
The effect of high performance work systems on radical innovation in knowledge-based companies through moderating role of innovation capabilities

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Abstract: The present study aims to examine the effect of high-performance systems through moderating role of marketing capabilities on radical innovation of knowledge-based companies. The statistical population of study includes all managers and employees of Iranian knowledge-based companies that are located in Isfahan province. The statistical sample of study includes 165 individuals. The results of present study suggest that the variables of employee autonomy, training and development of employees, participation in decision-making, job security and performance management affect radical innovation of knowledge-based companies significantly. In addition, the results suggest that the variables of job security and job clarity do not affect radical innovation of knowledge-based companies significantly. In addition, results of testing moderating hypothesis suggest that innovation capabilities with adjustment coefficient of 0.527 moderate the effect of high-performance systems on radical innovation significantly.

Keywords: high-performance systems; radical innovation; innovation capabilities; knowledge-based companies.

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1 Introduction

Despite the scholarly attention to the role of knowledge in creating a competitive advantage, only scant attention has been paid to the internal organisational structure of firms and innovation outcomes (Boxall and Macky, 2009). In this paper, the relationship between the internal organisation structure, more specifically a firm's strategic human resource (HR) practices which is represented as high performance work system (HPWS), and its innovative output is explored. Because demand for innovative competencies and change in the organisation is increasing, the managers do not merely focus on different aspects of human resources management (HRM) practices such as recruitment, training, employing and compensation system distinctively (Beugelsdijk, 2008). The managers integrate all of these organisational aspects and activities into an integrated system so as to enhance the performance and cooperation of employees (Harley et al., 2007). This has led to development of HPWSs which maximise the equilibrium between social system of the organisation and its technical system (Lee and Hsieh, 2010).

A major strength of this study is the theoretically informed context-embedded selection of HPWS practices in explaining innovative behaviour of the firms. The goal of the present study is to complement the existing body of knowledge on HPWS practices, and contribute to the discussion on firms' innovative behaviour. To do this, eight hypotheses on the relationship between a firm's HPWS practices and its ability to produce innovation are developed. We are not so much trying to push the frontier on creativity research, but use it as a framework to theorise on the relationship between innovation and strategic HRM (HPWS) and empirically relate HPWS practices to innovation. Drawing on insights from the resource-based view (RBV) of the firm (Barney, 2001), it is argued that HRM that is strategically oriented towards the fostering of creativity promotes the ability of firms to generate innovations, thereby contributing to a sustained competitive advantage.

It should be noted that these companies are among most significant firms the survival of which requires innovation and development of modern marketing strategies. Such industries could play an effective role in economy of Iran because of their relative

advantages in terms of creating value-added and high rate of employment. Therefore, the primary objective of present study is measuring interactive model of HPWSs in terms of their effect on developing radical innovation of knowledge-based companies through moderating role of innovation competencies. The present study reviews relevant theoretical principles regarding HPWS, radical innovation and finally innovation competency. Then, test of relevant hypothesis is conducted.

2 Literature review

2.1 High-performance systems

Significant changes of social, economic and competitive contexts outside of organisations have challenged effectiveness of organisations. That is why organisations tend to turn into high-performance ones. In this regard, understanding environmental changes is an inevitable phenomenon. In terms of environmental changes, these environmental changes are divided into six categories detailed in the following (Leggat et al., 2008).

- **Rate of changes:** At the moment, one is witnessing increasing changes of workplace. The rising competition, focus on core competencies, development of new technologies such as internet, and new business opportunities have significantly changed the nature of business.
- **Quality products and abundance of services:** In future, it is expected to see higher-quality products in large numbers. The reason might be the knowledge used in development of such products and high level of customisation available for offering customer's favourite products. That is why the speed of offering new services and delivering those to services is more than before. In other words, companies identify customers' demands and expectations quickly and seek to satisfy them efficiently. One might state that offering quicker services to customers and quality of products and services are major activities of current companies (Boxall and Macky, 2009).
- **Globalisation:** Now, organisations cannot limit themselves to local markets because they face increasing dynamism of customers. In the era of business competitions at regional, national and global scales, organisations should go beyond their geographical boundaries and extend the limit of their activities to national scale (Harley et al., 2007). As a result, organisations require to identify different cultures so as to realise globalisation.
- **Short lifecycle of products:** The easier and quicker competitors imitate products and services of other organisations, the shorter their lifecycle could be. It is currently believed that markets mature quicker. This means that customers learn to distinguish between good and bad products and they opt for luxury and high-quality products. Therefore, measures of quality in the market have enhanced. For survival in such a market, organisations should use latest technology and knowledge (Zhang and Morris, 2014). The objective of HPWS is influencing the performance of a company by promoting efficiency of employees and teams, encouraging employees' skill,

competency, commitment and motivation, increasing quality of work and offered services, adding to quality of services offered to clients, increasing profitability and growth, and creating more value for shareholders with help of company employees (Boxall and Macky, 2009).

- **Development of global networks:** Today, organisations and customers could use telecommunication technology to connect with different corners of the world. Development of the internet facilitates communication between customers and organisations. Therefore, such technologies contribute to efficiency of companies and increase customer satisfaction (Guthrie, 2001).
- **Awareness of environment:** In the current era, increasing awareness of the environment and need for maintaining such awareness in future make the organisations and individuals plan their activities in a manner that minimises damage to the environment. They also should be prepared for unexpected events and environmental changes. The findings of experimental studies on effectiveness of HPWS on performance of the company point to positive results. However, there is no evidence supporting the effectiveness and factors behind it. It is probable that the association between HPWS and performance might be due to effectiveness of a set of external variables. In other words, effect of these systems on performance of a company is due to existence of such variables (Guthrie, 2001; Shin and Konrad, 2017).

In a study on modelling of quality based on approach of HPWS, Mihail and Kloutsiniotis (2016) suggested that HPWS exerts a strong effect on professional social identity in intensive care unit. As a mediator, the variable, (i.e., social identity) incrementally mediates in the association between HPWS and psychological empowerment. In this study, he pointed to seven variables of job security, performance management, employee autonomy, employment and selection, training and development of employees, participation in decision making and job clarity as major parts of high-performance system. Similar results were reported by Boxall and Macky (2009) and by Leggat et al. (2008) regarding the association of HPWS with efficiency and quality. Based on results of present study, innovative methods and complicated HPWS system exert a significant and positive influence on efficiency of people and performance of an organisation. Another group of studies support these results.

Zhang and Morris (2014) suggested that companies with better performance opt for investment in complicated methods of HRM so as to attain high performance because they know that human resources is the most significant asset of a company and potentials and inherent talents of people could be developed through training. In this regard, a model was developed which represents the effect of HPWS on organisational output. The model includes a set of underlying factors of organisational context which is associated with decision of a company to utilise HPWS and performance of the company. A number of variables of organisational context such as size and performance of the company are associated with decision of a company to adopt HPWS and performance output (Boxall and Macky, 2009; García-Chas et al., 2016). It is expected that companies with performance show higher tendency to adopt complicated methods of HRM. However, these systems should significantly add to performance of the company so as to encourage the companies to adopt them (Leggat et al., 2008).

Garg and Punia (2017) conducted a study on possibility of developing a conceptual model of HPWS in 17 Indian insurance companies and suggested that managers do not emphasise different aspects of HRM such as training, selection of HR, participation, performance evaluation, and clear job description individually; the managers integrate all of these activities into a single system so as to increase performance and participation of employees. This led to development of HPWS. In addition, García-Chas et al. (2016) explained HPWS model and pointed to necessity of adopting this method for increasing job satisfaction, especially in small organisations. They also alluded to necessity of using HPWS system for developing practical solutions, dealing with existing threats, obtaining a roadmap for reducing weaknesses of small organisations and changing such weaknesses into strengths by proper exploitation of HR.

2.2 Radical innovation

The innovation is result of successful management of a company in cases in which model of business and technology changes. A proper radical innovation could cause basic changes in competitive setting of the industry (Dobni, 2008). It should be noted that equilibrium and integration of investment portfolio and developing proper mix of incremental, breakthrough and radical innovations to match the realities of the company are highly significant. Leminen et al. (2016) conducted a study on role of network structure in radical innovation and suggested that entrepreneurial managers involved in electronic and telecommunication industries use incremental innovations more frequently than radical innovations in first three years of their management. In addition, they suggested that different mixes of environmental, organisational, structural, procedural and managerial factors contribute to incremental and structural innovations. This means that under definite conditions, either radical innovation or incremental innovation might develop. These findings match the conclusions of Domínguez Escrig et al. (2016) as well as Inauen and Schenker-Wicki (2012) who suggested that structural and strategic factors contribute to radical innovations. Such factors are different from structural and strategic factors since latter factors contribute to incremental innovation (Leminen et al., 2016).

2.3 Innovation capabilities

Innovation capabilities reflect competency of a company in terms of development, enforcement and improvement of new ideas, products or processes which contribute to strategic advantage and performance of a company (Menguc and Auh, 2006). Innovation capability is a means of organisational change which helps a company develop innovations. Such capability also reflects tendency of the company to exclude routine and daily tasks which do not match the new setting. In addition, tendency of the company to admit new ideas contributes to its competitiveness. In this regard, Ilori et al. (2017) studied innovation capabilities and innovation in core processing industry in south-western Nigeria. They concluded that organisations with high innovation potential will be able to respond to environmental challenges quicker. Such organisations use new productions and market opportunities better than non-innovative organisations. In this regard, the main mental responsibilities of organisation are learning, development and innovation. As a result, innovation capability process enables companies to obtain a better process of development, manufacturing or service provision than common

operations so as to attain better performance. Managerial innovation is a capability which improves the performance of a company by developing new regulations, policies and methods of management. Managerial innovation approaches innovation from viewpoint of management. Innovation capability of the company in terms of effective collection, exploitation and management of knowledge is one of the major sources of survival of the company. Based on a set of knowledge-based capability, ability to recruit could act as a source of competitive advantage for a company. Breznik and Hisrich (2014) mutually studied innovation capabilities and capturing knowledge in knowledge-based industries of Taiwan. They collected their required data from 171 companies in three knowledge-based insurance, electronic and medical sciences. They concluded that in these industries, innovation capabilities affect knowledge absorption ability positively, encourage employees so as to absorb new knowledge and information and make them use the new knowledge to develop innovation in the organisation. In the paper, authors compared innovation capabilities with a relatively new approach to strategic management so as to understand the potential of such innovations in terms of contributing to sustainable competition. In order to obtain financial achievements, value should be created for customers and this will not be practical unless operational processes are dominated and match them with demands of customers. Attainment of operational superiority and developing value-creating processes is possible if a proper work place is offered to employees and reinforces innovation, learning and growth in the organisation.

2.4 HPWS and radical innovation

Research in innovation has been extensive in the past two decades due to the important role innovation plays in today's competitive market. Ries and Trout (1981) perceive innovation as a form of learning. Other scholars suggest innovation is a mean through which organisations respond to a variety of environmental changes (Peters et al., 1982).

Previous HRM research found support for the closed link between HRM and innovation, (e.g., Ma Prieto and Pilar Perez-Santana, 2014). In particular, some research focused on the role HRs play to support innovation. Hayton (2005) for example, observed that companies should attract, retain, and develop talented employees in order to develop an environment that facilitates innovation. In particular, HRs are perceived as important capital with a set of traits, expertise, skills, and motivation to innovate (Zhou et al., 2013). Consequently, effective HRM practices can promote the desired individual attributes needed to promote innovation.

A number of scholars have studied the relationship between HRM practices and organisational innovation (Fu et al., 2015). Laursen and Foss (2003) for example, found that most HRM practices adopted by manufacturing companies led to innovative performance. A recent study by Zhou et al. (2013) which investigated the impact of different HRM systems on firm innovation performance found a positive link.

Taking each practice separately, previous research showed some support for the link of HR practices to organisational innovation. For example, the use of comprehensive recruitment and selection process can play a major role in creating a talented pool of people who are needed for organisational innovation (Jiang et al., 2012). Raghuram and Arvey (1994) found support for a consistency between external sources of recruitment and innovation. With regard to the degree of employees' training, there is an agreement that appropriate training aimed at enhancing their skills and knowledge is critical for facilitating innovation (Lau and Ngo, 2004). Some studies proposed a broad application

of training in order to develop the skills and knowledge of employees (Schuler and Jackson, 1987). Others suggested that limited training programs are required (Miles and Snow, 1984) as talented people can be brought from the external market when needed. In general, there has been empirical support for the link between providing extensive training programs and organisational innovation (Lu et al., 2015; Mark and Akhtar, 2003). With respect to performance appraisal, results of previous research showed a connection between performance evaluation and an increased level of creativity (Lu et al., 2015). Schuler and Jackson (1987) argued that performance appraisal that is more oriented toward long term and group-based achievements will encourage innovation. Moreover, some empirical studies regard results-oriented (Miles and Snow, 1984) and performance-oriented (Mumford, 2000) appraisal as important for becoming an innovative organisation. Adding to this, the feedback provided for employees can enhance the intrinsic motivation for innovative ideas (Zhou et al., 2013).

The reward system can motivate employees to become innovative as well. Several studies have emphasised the use of pay for performance and profit sharing in order to improve organisational performance. While an effective incentive system can be used in order to motivate employees at work, it can also be an effective tool for attracting and retaining innovative people to work at the company. Cano and Cano (2006) found that the most effective HRM practices that can stimulate innovation is providing employees with financial rewards as well as recognising their achieved performance. In general, providing appropriate rewards which are linked to new ideas provided and applied by employees may encourage employee innovativeness. Finally, inconsistencies were found in the literature with regard to the importance of employment security for promoting organisational performance. While some scholars argue for temporary employment in order to ensure innovativeness (Miles and Snow, 1984; Sheppeck and Militello, 2000), others emphasise the need for employment security in order to get highly committed employees which will result in positive outcomes, particularly innovation (Díaz-Fernández et al., 2015; Schuler and Jackson, 1987). In a similar vein, Jiménez-Jiménez and Sanz-Valle (2008) conclude that companies which provide its employees with employment security can generate talented employees who are self-confident, risk adoption-ready and who are involved in innovative practices. Overall, while there is no guarantee that all employees will become innovative, the provision of employment security can create a sense of commitment by employees. Consequently, employees will be more willing to engage in innovative activities. Therefore, we propose the following hypothesis:

Based on theoretical principles of the present study, the following hypotheses were developed:

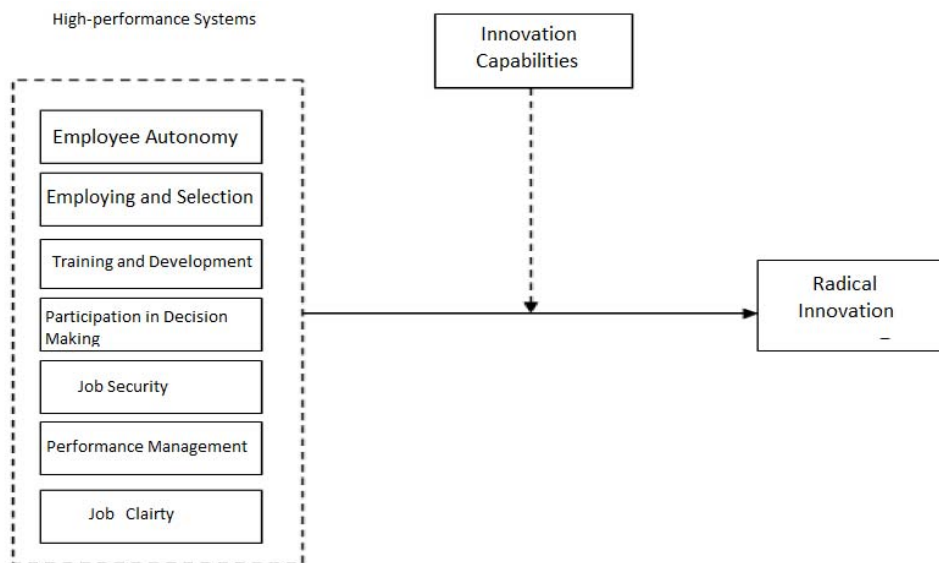
- H1 Independence of employees affects radical innovation of knowledge-based companies positively.
- H2 Employment and selection affect radical innovation of knowledge-based companies positively.
- H3 Training and development of employees affect radical innovation of knowledge-based companies positively.
- H4 Participation in decision making affects radical innovation of knowledge-based companies positively.

- H5 Job security affects radical innovation of knowledge-based companies positively.
- H6 Performance management affects radical innovation of knowledge-based companies positively.
- H7 Job clarity affects radical innovation of knowledge-based companies positively.
- H8 High-performance systems positively affect affects radical innovation of knowledge-based companies through moderating role of innovation capabilities.

2.5 Conceptual model

The conceptual model of present study was selected based on direct addressing of the notion of high-performance systems. Numerous studies have been conducted concerning different aspects of high-performance systems. However, the model of present study is developed based on notions of high-performance systems as well as Mihail and Kloutsiniotis (2016). In addition, the model emphasises radical innovation and this is one of the significant reasons behind selecting it.

Figure 1 Conceptual model of present study



Source: Mihail and Kloutsiniotis (2016)

3 Methodology

The structure of present study is based on structural equation modelling. Therefore, partial least squares (PLS) method was adopted for analysis of collected data. The statistical population of present study includes 520 employees of knowledge-based

companies located in Isfahan City. In this case, simple random sampling is done. Through the equation for sampling of limited population, the sample included 290 individuals. After distribution of questionnaire among the samples, 180 questionnaires were collected and 165 were identified as proper for analysis. In order to measure effect of variables on each other, standard questionnaire was used. This standard questionnaire is modelled on Mihail and Kloutsiniotis (2016).

3.1 Descriptive study of research variables

In this survey, nine primary variables were selected and then, they were analysed based on a conceptual model. Description of variables is significant since results of testing research hypotheses could be obtained based on collected data and indicators of those variables. The research data has interval scale. In order to describe research variables, central and distribution measures were used as detailed in the following.

Table 1 Descriptive measures for research variables

<i>Research variable</i>	<i>Sample size</i>	<i>Mean</i>	<i>SD</i>	<i>Skewness</i>	<i>Kurtosis</i>
Employee autonomy	165	3.26	3.092	-0.291	0.577
Employing and selection	165	3.17	3.381	0.210	-0.284
Training and development of employees	165	3.47	4.628	-0.318	-0.737
Job security	165	3.86	2.329	-0.609	-0.322
Performance management	165	3.19	2.014	-0.598	-0.344
Job clarity	165	3.69	4.444	-0.247	-0.704
Radical innovation	165	3.05	2.180	-0.589	-0.318
Innovation capabilities	165	3.78	2.274	-0.412	-0.329

As shown in Table 1, all of the variables are at desirable levels.

4 Findings

The findings of present study could be divided into two general parts. The first part is concerned with validity and reliability of constructs and indicators. In PLS method, two tools of AVE and CR are used for evaluation of reliability of constructs. Because Cronbach's alpha offers a stricter estimation of internal reliability of variables, Composite reliability measures are used in pathway models of PLS. The selection between reliability coefficients is not significant. In any case, the value of Cronbach's alpha is more than 0.7. Based on Table 2, CR and Cronbach's alpha of all constructs should exceed 0.7.

Based on calculated values of the measures, it is evident that all CR values are larger than 0.7 and the value of AVE is larger than 0.6. Therefore, composite or construct reliability is supported. In addition, construct validity and reliability are supported based on numbers of the following table.

Table 2 Results of analysing validity of variables

Research variable	AVE	Cronbach's alpha	CR
Employee autonomy	0.770	0.851	0.859
Employing and selection	0.672	0.849	0.860
Training and development of employees	0.699	0.902	0.947
Job security	0.602	0.974	0.919
Performance management	0.741	0.888	0.941
Job clarity	0.710	0.836	0.932
Radical innovation	0.628	0.869	0.899
Innovation capabilities	0.678	0.912	0.940

4.1 Data analysis

The second group of findings are concerned with test of structural model and research hypotheses. In this regard, path coefficient and coefficient of determination are used. The path coefficient shows the share of predictor variables in explaining variance of criterion variable. The coefficient of determination signifies the variance of criterion variable as explained by predictor variables. In the present study, SmartPLS software was used. The software is applicable for structural equation modelling based on PLS method. After test of conceptual model for the present study, the software output is represented in Figures 2 and 3.

Figure 2 General research model in standard m (see online version for colours)

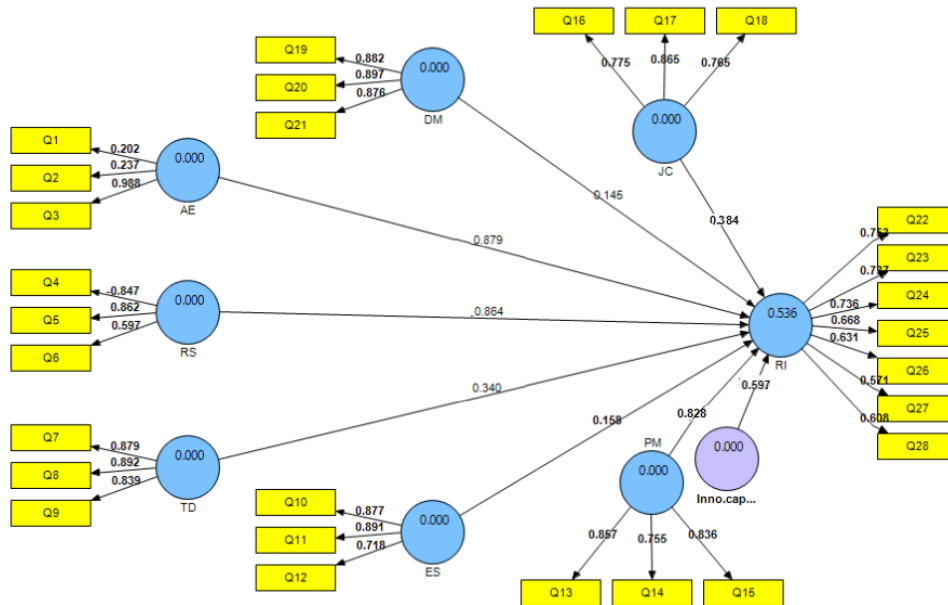
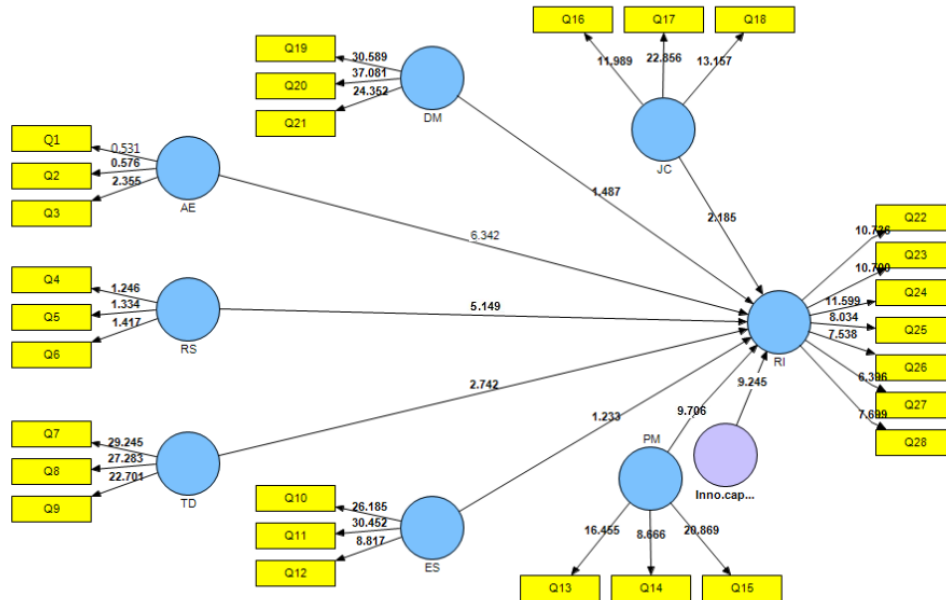


Figure 3 General research model in significance mode (see online version for colours)



The latent and explicit variables, path coefficient and load factors are represented in Figure 3. The numbers between latent variables of the model (variables shown in the circles) and explicit variables (variables in rectangular shape) signify load factors. The associations between latent variables are research hypotheses. The numbers on the associations signify path coefficients.

Based on Figure 3, the first hypothesis regarding influence of employee autonomy on development of new products by knowledge-based companies is supported with 99% probability since value of critical coefficient or t-value, (i.e., 6.342) is out of the range of [-1.96, 1.96].

The second hypothesis regarding influence of employing and selection on development of radical innovation of knowledge-based companies is supported with 99% probability since value of critical coefficient or t-value, (i.e., 5.149) is out of the range of [-1.96, 1.96].

The third hypothesis regarding influence of training and development of employees on development of radical innovation of knowledge-based companies is supported with 99% probability since value of critical coefficient or t-value, (i.e., 2.742) is out of the range of [-1.96, 1.96].

The fourth hypothesis regarding influence of participation in decision making on development of radical innovation in knowledge-based companies is supported with 99% probability since value of critical coefficient or t-value, (i.e., 1.233) is out of the range of [-1.96, 1.96].

The fifth hypothesis regarding influence of job security on development of radical innovation in knowledge-based companies is denied since value of critical coefficient or t-value, (i.e., 9.706) is in of the range of [-1.96, 1.96].

The sixth hypothesis regarding influence of performance management on development of radical innovation in knowledge-based companies is supported with 99%

probability since value of critical coefficient or t-value, (i.e., 2.185) is out of the range of $[-1.96, 1.96]$.

The seventh hypothesis regarding influence of job clarity on development of radical innovation of knowledge-based companies is denied since value of critical coefficient or t-value, (i.e., 1.487) is in the range of $[-1.96, 1.96]$.

The eight hypothesis suggests that high-performance systems positively affect radical innovation through moderating role of innovation capabilities.

Based on Figure 2, the variable of innovation capabilities with adjustment coefficient of 0.527 modifies the influence of high-performance systems on radical innovations significantly. As a result, the eighth hypothesis is supported.

Table 3 shows the result of causal analysis of structural equation model used for testing research hypotheses.

Table 3 Results of research hypotheses

<i>Hypothesis</i>	<i>Beta coefficient</i>	<i>T-statistic</i>	<i>Result</i>
Employee autonomy → Radical innovation	0.879	6.362	H0 Denied
Employing and selection → Radical innovation	0.864	5.149	H0 Denied
Training and development of employees → Radical innovation	0.340	2.742	H0 Denied
Job security → Radical innovation	0.157	1.233	H1 Denied
Performance management → Radical innovation	0.828	9.706	H0 Denied
Participation in decision making → Radical innovation	0.384	2.185	H0 Denied
Job clarity → Radical innovation	0.145	1.487	H1 Denied

Table 4 Explained variance of dependent variables

<i>Dependent variable</i>	<i>R²</i>
Radical innovation	0.535

Table 5 Mean of commonality values

<i>Research variables</i>	<i>Commonality</i>
Employee autonomy	0.357
Employing and selection	0.783
Training and development of employees	0.605
Job security	0.625
Performance management	0.644
Participation in decision making	0.629
Job clarity	0.677
Radical innovation	0.755

4.2 Test of PLS model

Goodness of fit (GOF) was suggested for simultaneous evaluation of fitness of internal equation models as well as external measures of data. This index is squared product of multiplying mean of commonality values and mean of coefficients of determination.

As Chin (1998) suggested, the explained variance/mean of coefficients of determination (R^2) for the endogenous variable, (i.e., radical innovation) should be 0.2 at least. Ideally, the value of R^2 should exceed 0.3. Therefore, as shown in Table 5, the endogenous (dependent) variable obtained the ideal value.

$$GOF = \sqrt{(\text{communality}) \times (R \text{ square})} \quad (1)$$

Therefore, the calculated value of *GOF* is 1.54 which signifies fitness of the model.

5 Summary and conclusions

The objective of present study is to highlight the significance of effect of high-performance systems on development of radical innovation in knowledge-based companies through moderating role of innovation capabilities. The results suggested that innovation capability acts as a moderating variable between radical innovation and high-performance systems. Based on structural equation modelling, one could state that employee autonomy and performance management are more influential than other factors of high-performance systems on development of radical innovation. The employees believe that learning and development of their capabilities depends on their tendency to learn as well as their motivation. One of the significant promoting factors is participation in organisational decision-making. In similar studies, (e.g., Inauen and Schenker-Wicki, 2012), a positive and significant association between participation in decision-making and radical innovation was pointed out.

Based on findings of present study, knowledge-based companies should promote motivation and untapped potential of employees for development of knowledge and learning and develop precise plan of innovation capabilities if they intend to improve innovation capability in their organisational structure. Considering the fact that learning capability of employees is not generally fixed and it could be developed, the managers of knowledge-based companies may offer proper training courses so as to enhance employees' absorptive knowledge capacity. Promotion of such capacity will be followed by development of innovation potential in knowledge-based companies. Considering the fact that among different aspect of HPWS, performance management was highlighted as most significant factor the proper principles of performance management should be considered so as to provide the condition for development of innovation capabilities and attaining radical innovations. In this regard, it is essential to define clear objectives for such companies so that all of their employees and teams have a clear vision of them. In that case, different teams and employees of the company will regard realisation of such objectives as part of their role.

The increasing rate of development of new technologies makes knowledge-based companies act differently so as to guarantee their success and progress. More specifically, knowledge-based companies should seek new sources of competitive advantage and implement new forms of competition. Such measures require clear understanding of nature and dynamism of competition. Considering the increasing development of knowledge-based companies and rising competition between them, if these companies cannot develop their basic or distinct capabilities for attaining a working approach to radical innovations, the leading competitors may offer better services and lead the market. Such competitors will guarantee their profitability in short term and their survival in long-term. Therefore, knowledge-based companies will benefit from competitive advantage when they can offer better value based on development of radical innovation and improvement of innovation capabilities. In such a case, they can fix their position in the market. The innovation capability is a tangle asset of companies. The asset facilitates quick provision of new products and use of new technologies for realisation of competitive edge; this makes such asset highly significant for knowledge-based companies. The result of present study also suggests that knowledge and capacity that knowledge-based companies acquire by application of HPWSs contribute to their innovation capability and provision of innovative products and services. The capital accumulated in knowledge-based companies after they adopt HPWS affects their learning from each other and improves innovation capabilities of such companies.

As results of present study suggest, if knowledge-based companies intend to attain new values in comparison with competitors the top managers of such companies should take some measures which enable radical innovation in products and services. Among such measures, one could point to focus on development of high-performance systems as well as innovation capabilities. In this regard, such companies should actively seek weaknesses of HPWS which is a potential source of profitability. They also should develop certain programs for reinforcing training and occupational development of employees before implementation of an innovative concept. During and after implementation of an innovative notion, such companies should be able to adapt with new conditions ahead. Knowledge-based companies should be risk taking when it comes to investment in new ideas. They should be able to estimate the risk of innovative capabilities, welcome innovative strategies and believe in radical innovation. In addition, they should adopt new methods for development of HPWS and arrange for exploitation of employee's participation in all parts of the company.

In regard to future studies, it is recommended to analyse the effect of HPWSs on development of radical innovation while effect of other factors, (e.g., learning culture and dynamic capabilities) on innovation capability is examined. The present study was solely concerned with knowledge-based companies located in Isfahan Province. Therefore, future studies may highlight the factors affecting radical innovation in companies located in other provinces of Iran. This issue points to possibility of comparison between different providences. The future researchers may use the model for other knowledge-based companies involved in certain industries such as pharmaceutical or telecommunication companies as well as companies with edge technologies. The study of knowledge-based companies engaged in other industries may contribute to highlighting hidden angles of this subject.

This study presents several practical implications. First, our empirical results provide beneficial information to R&D practitioners. Our results indicate that HR capability is positively related to ambidextrous technological innovation at R&D centres. Specifically,

our results suggest that R&D managers should exert effort to develop employee skills, (i.e., T-shaped skills and technology brokering) and behaviours, (i.e., personal initiative and cooperation). Second, our research findings can be integrated into the HRM strategy of R&D employees. Specific HR practices related to staffing, performance appraisal, compensation, training and career development need to be designed and implemented to improve the aforementioned elements of T-shaped skills, personal initiative, technology brokering, and employee cooperation. For example, we suggest that individual competencies need to be assessed in accordance with HR capability to increase ambidextrous technological innovation in R&D centres. Specifically, the competencies of R&D employees might be evaluated by developing in-depth knowledge of their specialties and an extensive understanding of other areas of expertise. Third, managers at R&D centres should focus on encouraging both individuality and sociality among R&D researchers to facilitate ambidextrous technological innovation. Individuality highlights that each individual researcher should be qualified with multiple skills and proactive behaviour. To completely realise ambidextrous technological innovation, researchers should also be equipped with social skills to demonstrate their willingness to share and combine knowledge with others.

5.1 Limitations

The present study was conducted on a sample of managers and employees of Iranian knowledge-based companies located in Isfahan City. One may cautiously extend the results to other organisations. In addition, it is probable that moderating variables affect responses. The latter limitation was not addressed in present study due to deficiency of resources and extent of studies.

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