Journal of Business Research 94 (2019) 442–450

Contents lists available at ScienceDirect

Journal of Business Research

journal homepage: www.elsevier.com/locate/jbusres

Translating the impact of knowledge management processes into knowledge-based innovation: The neglected and mediating role of knowledge-worker productivity

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ARTICLE INFO

Keywords:
Knowledge management processes
Innovation
Innovation performance
Knowledge-worker productivity
Knowledge worker

ABSTRACT

This study proposes a novel research model to investigate the neglected and pivotal mediating role of knowledge-worker productivity between knowledge management processes (knowledge generation, knowledge sharing, and knowledge application) and innovation. The data were collected from the 369 knowledge workers in the IT sector of Pakistan and analyzed using the SmartPLS 3 Version 26. The results indicate that knowledge-worker productivity mediates between two knowledge management processes (knowledge creation and knowledge utilization) and innovation. However, surprisingly, it does not mediate between knowledge sharing and innovation. The results support the pivotal role of knowledge-worker productivity-the most striking challenge for the management discipline in the 21st century-in knowledge-based innovation. Moreover, the results signify the overarching role of the human and cultural approach to knowledge management over the Big Data and IT and system-based approaches.

1. Introduction

According to Peter Drucker, the father of modern management theory, the most striking challenge for management scholars and strategists in the 20th century was to increase the productivity of manual workers. The reason was that the business firms were predominantly production-oriented and there was more focus on the quantity of production. Therefore, management scholars employed scientific management techniques to increase the productivity of manual workers in terms of task efficiency (Drucker, 1999; Fernandez, 2013; Iazzolino & Laise, 2016; Joo, Park, & Lim, 2016; Moussa, Bright, & Varua, 2017; Palvalin, van der Voordt, & Jylhä, 2017). However, the 21st century firms are predominantly serving in the service sector and driven by the knowledge and digital economy. They have currently a greater focus on the quality of service and production. Therefore, the most striking challenge for management scholars and strategists in 21st century is to increase the "productivity of knowledge-workers" mainly in terms of unstructured intellectual tasks (Drucker, 1999; Iazzolino & Laise, 2016; Iazzolino, Laise, & Gabriele, 2017; Moussa et al., 2017; Palvalin, 2017; Palvalin et al., 2017; Ramírez & Nembhard, 2004; Shujahat, Hussain, Javed, Thurasamy, & Ali, 2017; Turriago-Hoyos, Thoene, & Arjoon, 2016).

The Kianto, Vanhala, and Heilmann (2016) recommend testing the impact of knowledge management on individual soft aspects as the organizational level hard aspects like innovation have already been tested widely. As referred above, the most striking challenge for the strategists and management scholars is to increase the knowledge-worker productivity. Hence, testing the impact of knowledge management on knowledge-worker productivity-an intellectual and soft issue of individual worker-could be an interesting contribution (Iazzolino & Laise, 2016; Joo et al., 2016; Moussa et al., 2017; Palvalin et al., 2017). However, there are two problems in this regard as elaborated in the following.

First, the ultimate outcome of knowledge management aspects is innovation, which, in turn improve the organizational performance and thus enhances the competitive advantage (Andreeva & Kianto, 2011; Zack, McKeen, & Singh, 2009). However, there are many aspects of knowledge management. The most important and relevant one is knowledge management processes because it lies irrespective of an organization conscious implementation of knowledge management

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https://doi.org/10.1016/j.jbusres.2017.11.001
Received 9 September 2017; Received in revised form 31 October 2017; Accepted 1 November 2017
Available online 08 November 2017
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architecture (Costa & Monteiro, 2016). Therefore, a great deal of research studies have found the positive impact of knowledge management processes, practices, and infrastructure on innovation (e.g., Acosta, Palacios, & Popa, 2014; Al-Husseini & Elbeltagi, 2015; Chen, Tao, & He, 2012; Lai, Hsu, Lin, Chen, & Lin, 2014; Shu, Page, Gao, & Jiang, 2012; Zheng, Zhang, & Du, 2011). Hence, it can be deduced that outcome of each aspect of knowledge management is innovation (Zack et al., 2009).

The second problem is that there have been some studies that test the impact of knowledge management on aspects of employee productivity implicitly regarding task efficiency (Gomez, 2007; Haas & Hansen, 2007; Iranzadeh & Pakdelbonab, 2014). The task efficiency is one of the aspects of knowledge-worker productivity which focuses on the material and quantitative production-related contributions but does not address the intellectual aspects (Joo et al., 2016; Moussa et al., 2017; Palvalin, 2017; Palvalin et al., 2017).

Keeping into consideration these two problems, this study proposes that if the outcome of knowledge management is innovation and knowledge management can nurture knowledge-worker productivity then by deductive logic and Drucker's knowledge-worker's productivity theory the ultimate outcome of knowledge-worker productivity should be innovation (Drucker, 1999; Iazzolino & Laise, 2016; Joo et al., 2016; Moussa et al., 2017; Palvalin, 2017; Palvalin et al., 2017). Therefore, the purpose of the study is to test the mediating role of knowledge-worker productivity on the relationships between knowledge management processes and innovation. The data were collected from 369 knowledge workers in the IT sector of Pakistan. The SmartPLS 3 Version 26 was used for analysis. The results indicate that knowledge-worker productivity mediates significantly between two knowledge management processes (knowledge creation and knowledge utilization) and innovation.

The remaining part of the paper is organized as follows. First, the literature was reviewed, upon the basis of which the hypotheses of the present study were formulated and presented in Section 2. Section 3 outlines the methodology. Then the results were presented and discussed in Section 4. Lastly, the study is concluded.

2. Literature review

2.1. Innovation

Innovation can be defined from the two perspectives: traditional and knowledge-based. There are many definitions of innovation that are available in the traditional literature. E.g., innovation is the creation and application of new and novel products, services, and internal organizational processes for customer satisfaction (Meroño-Cerdán & López-Nicolás, 2017). However, the operational definition is the introduction of novel products in regards to the characteristics and use, and the implementation of new customer problem-solving processes to meet the regular dynamic needs of stakeholders (Shang, Yao, & Liou, 2017). This definition suggests two dimensions for the construct in this study: product and the customer problem-solving innovation. On the other hand, the conceptualization of innovation from the knowledge-based perspective does not add anything to the construct of innovation for measurement in empirical studies as the knowledge-based innovation is operationalized by the outcomes like the number of new products introduced over last few years (Du Plessis, 2007). Therefore, this conceptualization only adds the knowledge creation and application as its precursor which leads towards the new products and processes. Therefore at the risk of oversimplification of literature, knowledge-based innovation is creation and application of knowledge to create new knowledge regarding novel products and processes for customers (Costa & Monteiro, 2016; Du Plessis, 2007; Leiponen, 2006; Harkema, 2003; Cardinal, Alessandri, & Turner, 2001).

2.2. Knowledge-worker productivity

Like innovation, knowledge-worker productivity can also be defined from traditional and knowledge-based literature. Traditional literature posits that the firms in the 20th century were production-oriented and hence the major percentage of the workforce was manual workers with mechanical work. Hence, there was more focus on the quantity of production (Drucker, 1999; Joo et al., 2016; Moussa et al., 2017; Palvalin, 2017; Turriago-Hoyos et al., 2016). Therefore, the management scholars focused on the techniques of scientific management to increase the productivity of manual workers by decreasing the unproductive physical motions. Hence, traditional literature under the paradigm of scientific management terms the productivity of worker as the “employee productivity” and defines and measures it as the ratio of output units produced to the input units used (Drucker, 1999; Fernandez, 2013; Iazzolino & Laise, 2016; Moussa et al., 2017; Palvalin et al., 2017). In this context, Peter Drucker maintained that the most important challenge for management strategists and scholars in the twentieth century was to increase the productivity of manual workers (Drucker, 1999; Palvalin, 2017; Palvalin, Vuolle, Jääskeläinen, Laihonen, & Lönnqvist, 2015; Turriago-Hoyos et al., 2016).

The literature related to the conceptualization of knowledge-worker productivity from the knowledge-based view posits that in contrast to the 20th century, the 21st century firms are mainly service-oriented and hence the major part of the workforce is not the mechanical and manual. The reasons are the quality focus, high expectations of innovation from customers, and customized goods and services (Moussa et al., 2017; Ramírez & Nembhard, 2004). The major part of the workforce in the twenty-first century is the knowledge workers whose tasks are widely unstructured and intellectual (Drucker, 1999; Iazzolino et al., 2017; Palvalin et al., 2017; Turriago-Hoyos et al., 2016). Therefore in this context, Peter Drucker put forward that the most striking challenge for management scholars and practitioners is to increase the productivity of knowledge-workers (Iazzolino et al., 2017). To operationalize knowledge-worker productivity, it seems imperative to define knowledge work and knowledge workers (Huang & Jim Wu, 2010).

Knowledge work is the sort of intellectual and cognitive work in which new knowledge is created and applied (Iazzolino et al., 2017; Mládková, Zouharová, & Nový, 2015; Palvalin, 2017). Hence, a knowledge worker job is to create and utilize the knowledge to get the knowledge as an output regarding new products and services (Kelloway & Barling, 2000; Mládková et al., 2015; Palvalin, 2017; Palvalin et al., 2015; Turriago-Hoyos et al., 2016). By this definition, analyst, programmers, software engineers, designers, concept designers, and managers, can be considered as knowledge workers (Curado & Bontis, 2006; Iazzolino et al., 2017; Joo et al., 2016). This compelling point reinforced the data collection from the IT sector for this study.

Operationalizing knowledge-worker productivity particularly in a survey-based questionnaire research is a difficult task because of two aforementioned unstructured and dynamic concepts: knowledge work and knowledge worker (Iazzolino et al., 2017; Thomas & Baron, 1994). There are no accepted categories and methods to measure the knowledge-worker productivity (Iazzolino et al., 2017; Ramírez & Nembhard, 2004). However, the extant literature review reports that aggregated dimensions of knowledge-worker productivity include the timeliness of worker, quality delivery, task efficiency, job autonomy, satisfaction of stakeholders, creativity, and innovative behaviour (Fernandez, 2013; Iazzolino et al., 2017; Moussa et al., 2017; Palvalin et al., 2015). These dimensions have carefully been taken into account for the measurement.

2.3. Knowledge management

Knowledge management is a discipline and function in which knowledge is created, acquired, shared, codified, and utilized through

an enabling environment to increase innovation and organizational performance (Andreeva & Kianto, 2011; Hajir, Obeidat, Al-dalahmeh, & Masa'deh, 2015; Zack et al., 2009). There are two main components of knowledge management: knowledge management environment and knowledge management processes. The most important component is knowledge management process which creates the knowledge and survives irrespective of formal organizational support for knowledge management (Andreeva & Kianto, 2011). Therefore, this study focuses it.

Different studies define knowledge management processes in different ways. At the risk of oversimplification, knowledge management process aggregately is composed of knowledge acquisition, knowledge creation, knowledge transfer, knowledge storage, and knowledge application (Costa & Monteiro, 2016; Inkinen, 2016). However, the operational definition of knowledge management processes is: the process of knowledge creation, knowledge sharing, and knowledge utilization (Ahmad, Lodhi, Zaman, & Naseem, 2017; Shujahat et al., 2017). The reason for the difference is that the definitions differ in their level of aggregation of the processes but are cynically related. In short, knowledge management involves three or four main processes as outlined by Andreeva and Kianto (2011).

Knowledge management ensures the right flow of knowledge through two primary strategies: codification and personalization (Shujahat et al., 2017). Codification strategy is related to the extraction and storing of the knowledge in explicit form through the ICT structure while personalization strategy focuses on the direct human-interactions for knowledge sharing purpose (Curado & Bontis, 2006; Merat & Bo, 2013; Shujahat et al., 2017).

The knowledge management processes are explained as follows:

2.3.1. Knowledge creation

Knowledge creation is a process in which new knowledge is created through the four sub-processes of organizational knowledge creation theory on a continuous basis (Andreeva & Kianto, 2011; Collins & Smith, 2006; Nonaka & Takeuchi, 1995). The four processes are socialization, combination, externalization, and internationalization (Collins & Smith, 2006; Lai et al., 2014; Nonaka & Takeuchi, 1995). The antecedents of these processes are the opportunity, motivation, capability, and greater perceived importance. The organizations must work on these antecedents to ensure the creation of knowledge (Andreeva & Kianto, 2011; Shu et al., 2012).

2.3.2. Knowledge sharing

Knowledge sharing is donation and collection of knowledge among the different knowledge units in a firm (Becerra-Fernandez, Gonzalez, & Sabherwal, 2004; Nonaka, 1994). It is the behaviour of workers to transfer their insights (Hooff & De Ridder, 2004). It can be categorized into formal vs. informal and donation vs. collection elements of knowledge (Hooff & De Ridder, 2004; Taminiau, Smit, & Lange, 2009). Knowledge sharing is more significant than knowledge generation as the knowledge bulks reside in an employee and are of no importance until those are shared and applied (Al-Husseini & Elbeltagi, 2015). Its antecedents include the intrinsic and extrinsic incentives, social and organizational norms, organizational values, and top leadership support (Hsu, Ju, Yen, & Chang, 2007).

2.3.3. Knowledge utilization

Lee, Leong, Hew, and Ooi (2013) state that knowledge utilization is also called knowledge implementation or knowledge application. It relates to responding to different types of knowledge an individual entity has within an organization (Gold, Malhotra, & Segras, 2001). Knowledge utilization is the application of knowledge that has been shared (Song, Bij, & Weggeman, 2005). It is new created knowledge created, which becomes part of an organizational behaviour and processes for the problem-solving through assimilation (Chen et al., 2012). It is more important than other two processes because knowledge that is created and shared is of no importance until it is applied (Chen & Huang, 2009).

2.4. Knowledge-based view of the firm theory

Knowledge-based view of the firm theory is a firm level theory which categorizes a firm as the mix of heterogeneous knowledge assets to give it competitive advantage (Denford, 2013; Grant, 1996). However, it demands two things. First, knowledge of the firm must be valuable, non-imitable, and rare (Curado & Bontis, 2006; Merat & Bo, 2013). Second, there should be the processes of knowledge creation, knowledge transfer, and knowledge application (Alguezaui & Filieri, 2014; Erden, Klang, Sydler, & von Krogh, 2014; Grant, 1996; Shujahat et al., 2017).

2.5. Drucker's knowledge-worker productivity theory

Drucker's knowledge-worker's productivity theory maintains that there are six determinants of knowledge-worker productivity (Drucker, 1999; Huang & Jim Wu, 2010; Iazzolino et al., 2017; Palvalin et al., 2017; Turriago-Hoyos et al., 2016). These are as follows:

1. The productivity of knowledge-workers requires that what the task is. The knowledge-worker's work should be knowledge-oriented.
2. Knowledge workers should have autonomy.
3. The responsibility of knowledge workers is to innovate continuously.
4. There should be continuous learning and teaching on part of knowledge-workers.
5. The quality and the quantity are at least equally important for knowledge-workers.
6. Knowledge-workers should be treated as intellectual assets.

2.6. Knowledge management process and innovation

Extant theoretical and empirical literature maintains by using the knowledge-based view of the form theory that those organizations that manage their knowledge assets effectively perform comparatively better than those who do not do so (Díaz-Díaz & Pérez, 2014; Grant, 1996; Lane, Koka, & Pathak, 2006; Ologbo, Nor, & Okyere-Kwakye, 2015). Moreover, it also maintains that the relationship between knowledge management and innovation is universal. So it would be redundant to explain the different studies that found the positive relationship between the knowledge management processes and innovation (Andreeva & Kianto, 2011). Hence, this study just names few of those studies that maintained the positive relationship:

1. between knowledge creation and innovation (Lai et al., 2014; Shu et al., 2012; Chen et al., 2012; Andreeva & Kianto, 2011; Zheng et al., 2011; Numprasertchai, Kanchanasanpetch, & Numprasertchai, 2009; Leiponen, 2006; Smith, Collins, & Clark, 2005);
2. between knowledge sharing and innovation (Taminiau et al., 2009; Song, Fan, & Chen, 2008; Lin, 2007; Lee et al., 2013; Andreeva & Kianto, 2011; Lee et al., 2013; Al-Husseini & Elbeltagi, 2015; Andreeva & Kianto, 2011; Acosta et al., 2014; S.K.S. Wong, 2013; Iqbal et al., 2011; Yeşil, Koska, & Büyükbeşe, 2013; Ologbo et al., 2015; Chen et al., 2012);
3. between knowledge utilization and innovation (Chen et al., 2012; Lee et al., 2013; Song et al., 2005; Soto-Acosta, Popa, & Palacios-Marqués, 2016; Zhang, Benedetto, & Hoenig, 2009).

2.7. Knowledge management and knowledge-worker productivity

By knowledge-based view of the firm theory, effective management of knowledge resources increases the innovation (Andreeva & Kianto,

2011; Grant, 1996). As the innovation is the ultimate outcome of knowledge-worker productivity, therefore it can be deduced that knowledge management impacts on knowledge-worker productivity positively (Iranzadeh & Pakdelbonab, 2014). Similarly, by Drucker's knowledge-worker's productivity theory, self-management, job autonomy, quality delivery, treatment of knowledge-worker as an asset, and continuous learning and teaching regarding the knowledge sharing on the part of knowledge workers determine their productivity (Drucker, 1999). Knowledge management correlates high with these determinants (Hasani & Sheikhesmaeili, 2016; Honarpour, Jusoh, & Md Nor, 2016).

To the best of authors' knowledge, there are four studies that discuss knowledge management-knowledge-worker productivity relationship. These are namely (Gomez, 2007; Haas & Hansen, 2007; Iranzadeh & Pakdelbonab, 2014). Iranzadeh and Pakdelbonab (2014) tested the role of knowledge management implementation in University of Tabriz. The results find that all knowledge management processes impact on task efficiency positively. Haas and Hansen (2007) tested the impact of knowledge sharing on timeliness, work quality, and competencies. The study concluded that codified knowledge sharing correlate high with the timeliness of workers. Moreover, personal advice knowledge sharing increases the work quality and competencies. Ali (2013) founded the positive impact of knowledge sharing practices on work efficiency, competencies, performance, and customer satisfaction in the investment sector. The last study, Gomez (2007) founded the significant impact of knowledge management implementation on the initial response time, time to solve a problem, and the volume of cases in a longitudinal study in one of the 500 fortune companies.

Argumentatively, it can be maintained that the three knowledge management processes impact knowledge-worker productivity positively. When a worker faces difficulties or problems in the task improvisations, knowledge management processes motivate him/her to become engaged with knowledge creation to create and assimilate the knowledge. This created knowledge then can be used to increase the task efficiency, thereby improving the productivity (Andreeva & Kianto, 2011; Shu et al., 2012).

Likewise knowledge creation, knowledge sharing also impacts knowledge-worker productivity positively. By the virtues of knowledge sharing, workers get an opportunity to share the lesson learned and increase their knowledge bases through the collection of knowledge. This donation and collection of knowledge helps them to further assimilate knowledge for the effective tasks efficiency and making less mistakes (Al-Husseini & Elbeltagi, 2015; Hooff & De Ridder, 2004).

Likewise knowledge creation and knowledge sharing, knowledge utilization impacts knowledge-worker productivity positively. When knowledge is utilized effectively by the workers in individual and group tasks, it results in tasks efficiency. However, the effect of knowledge utilization does not remain limited to the task efficiency. When knowledge is implemented, learning takes place because of one's own and the customers' reflection. Learning in such contexts then leads towards the creation of reflection-based knowledge to solve dynamic problems (Lee et al., 2013).

2.8. Knowledge-worker productivity and innovation

The knowledge-based view of the firm theory puts the greater emphasis on the development of human knowledge that can be used to increase innovation performance (Grant, 1996; Kianto et al., 2016). Moreover, by Drucker's knowledge-worker's productivity theory, the effective knowledge-worker continuously works towards the innovation (Drucker, 1999; Drucker, 1998). In addition to these two theories, Ramezan (2012) in empirical research design concludes that the individual level knowledge creation, knowledge transfer, and the knowledge utilization-knowledge worker productivity-are linked to the innovative behaviour.

Argumentatively, it can be maintained that customers' feedback and self-reflection of workers tend to improve the innovation processes and outcomes. Through the self-reflection and the customers' feedback, the workers tend to get the knowledge about the novel and the difficult tasks. This, in turn, improves the innovation processes and the outcomes regarding novel solution and the products for customers (Lee et al., 2013; Drucker, 1999; Drucker, 1998).

2.9. Research hypotheses

Based on the above literature review, the following research hypotheses are proposed.

H1. Knowledge-worker productivity mediates between the knowledge creation process and innovation.

H2. Knowledge-worker productivity mediates between the knowledge sharing process and innovation.

H3. Knowledge-worker productivity mediates between the knowledge utilization process and innovation.

2.10. Research model

Based on the above literature, the following research model is formulated (see Fig. 1).

3. Methodology

3.1. Sample and data collection

The study samples the knowledge workers (software engineers, analysts, designers, electrical engineers, marketing, finance, HR, and IT managers) in the IT industry of Pakistan because service sector is innovation and knowledge-intensive and workers have greater autonomy to focus on both quality and quantity there.

The data were collected through the personal physical survey questionnaires. The sample amounts to 369 responses. Of all the 369 responses, 72% (262) are technical managers (e.g., engineers, analyst, and designers) while the remaining participants are administrative managers; 55.28% (204) are frontline managers, 6.23% strategists, while the remaining portion is of middle managers.

3.2. Instruments

All the instruments are adapted. There are total five constructs: three knowledge management processes, knowledge-worker productivity, and innovation. Table 1 presents the instruments for measuring the three knowledge management processes.

The second construct, knowledge-worker productivity, is measured using the three dimensions: timeliness of workers, their tasks efficiency, and the autonomy (Table 2). Meeting the time demands and task efficiency both measure the quantitative aspect of productivity while job autonomy is used as a proxy to measure the important qualitative aspects, e.g., customer satisfaction and innovative behaviour. The construct composition is consistent with the guidelines of (Fernandez, 2013; Moussa et al., 2017; Palvalin, 2017; Palvalin et al., 2015; Palvalin et al., 2017).

Last construct, innovation, is measured using the two dimensions: product innovation and customer problem solving (Table 3).

3.3. Technique

The study employs the SmartPLS 3 Version 26 software for analysis. The software uses the PLS-SEM technique (K.K.K. Wong, 2013). The method of analysis and presenting the results are consistent with the (Hussain, Shujahat, Malik, Iqbal, & Mir, 2018; Kianto et al., 2016; K.K.K. Wong, 2013) while given that the nature of the models of

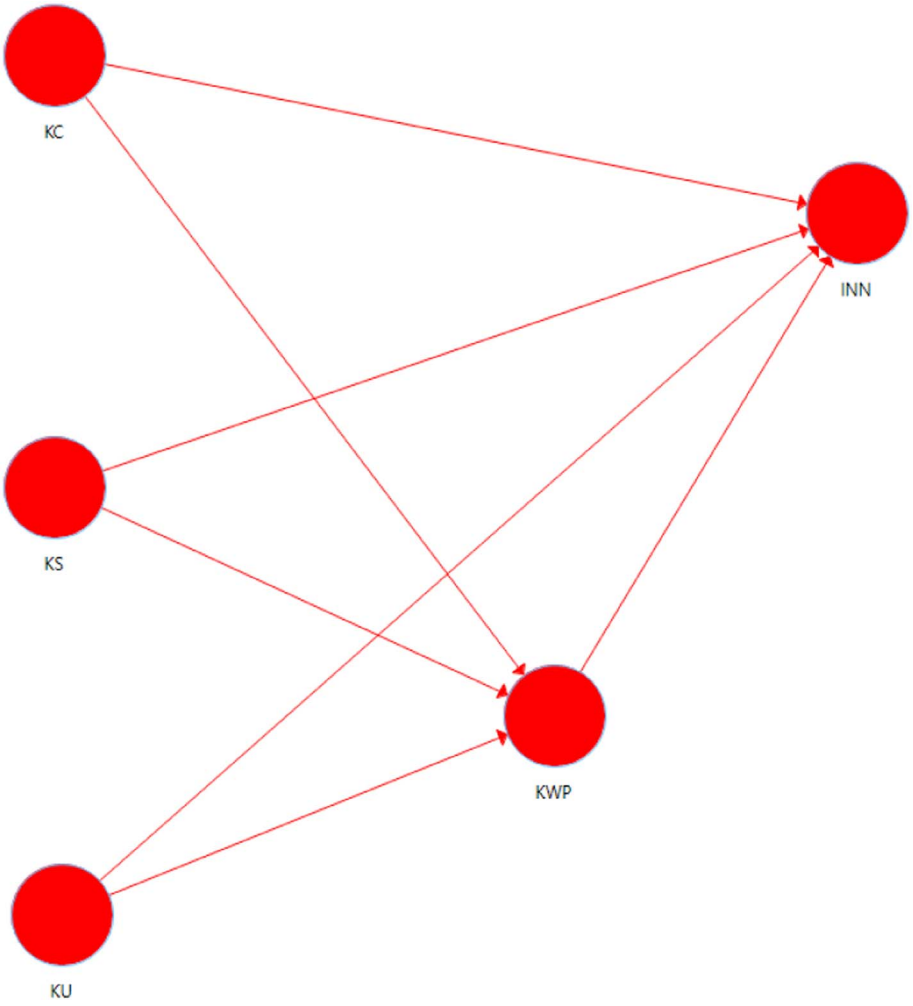

Fig. 1. Research model.

Table 1
Constructs of knowledge management processes.

Construct	Number of items	Instrument
Knowledge creation	9	CEN (2004)
Knowledge sharing	9	CEN (2004)
Knowledge utilization	9	CEN (2004)

Table 2
Construct of the knowledge-worker productivity.

Dimension	Number of adapted items	Scale/instrument
Job autonomy at work	3	Morgeson and Humphrey (2006)
Meeting time demands	2	Lerner et al. (2001)
Work efficiency	2	Tangen (2005)

Table 3
Construct of the innovation.

Dimension	Number of adapted items	Scale/instrument
Product innovation	3	Wang and Ahmed (2004)
Customer problem-solving capability	4	Jayachandran, Hewett, and Kaufman (2004)

referred studies is same like this.

4. Results and discussion

4.1. Measurement model

The measurement model evaluation requires the four things: outer loadings, composite reliability, convergent validity, and discriminant validity (Tables 4; 5). The threshold value of composite reliability for a given construct is 0.7 (Bagozzi & Yi, 1988). The Table 4 posits that all the constructs have composite reliability value > 0.70. The measure of convergent validity is the Average Variance Extracted for which the threshold value is 0.5 (Fornell & Larcker, 1981). Consequently, all the constructs possess the convergent validity (Table 4).

The SmartPLS 3 software offers a unique measure to establish the discriminant validity for a pair of two constructs: HTMT-ratio and confidence interval up. The liberal threshold values for the HTMT-ratio and corresponding confidence interval up are < 0.9 and 1 respectively (Henseler, Ringle, & Sarstedt, 2015). Consequently, HTMT ratios and the corresponding confidence intervals up for each pair are < 0.9 and 1 respectively (Table 5). Hence, model possesses the discriminant validity.

4.2. Structural model and discussion

To assess the positive and significant mediating role of a construct, following steps should be followed (Hussain et al., 2018; K.K.K. Wong, 2013; Preacher & Hayes, 2008). First, the total effect and the

Table 4
Outer loadings, reliability, and convergent validity.

	Outer loadings	Composite reliability	Average variance extracted
INN1 ← INN	0.673	0.835	0.504
INN2 ← INN	0.712		
INN3 ← INN	0.778		
INN6 ← INN	0.719		
INN7 ← INN	0.664		
KC4 ← KC	0.773	0.834	0.503
KC5 ← KC	0.640		
KC7 ← KC	0.785		
KC8 ← KC	0.695		
KC9 ← KC	0.637		
KS4 ← KS	0.670	0.835	0.504
KS5 ← KS	0.782		
KS6 ← KS	0.777		
KS7 ← KS	0.660		
KS8 ← KS	0.649		
KU3 ← KU	0.679	0.848	0.528
KU5 ← KU	0.794		
KU6 ← KU	0.706		
KU7 ← KU	0.759		
KU8 ← KU	0.687		
KWP1 ← KWP	0.674	0.811	0.519
KWP3 ← KWP	0.713		
KWP4 ← KWP	0.764		
KWP5 ← KWP	0.727		

Table 5
Discriminant validity.

	HTMT ratio	Confidence interval low	Confidence interval up
KC → INN	0.518	0.369	0.674
KS → INN	0.508	0.354	0.674
KS → KC	0.746	0.612	0.868
KU → INN	0.491	0.371	0.643
KU → KC	0.630	0.490	0.756
KU → KS	0.738	0.603	0.858
KWP → INN	0.636	0.473	0.802
KWP → KC	0.566	0.411	0.735
KWP → KS	0.468	0.324	0.650
KWP → KU	0.563	0.391	0.743

Table 6
Total effects.

	Path coefficient (O)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	p values
KC → INN	0.216	0.083	2.605	0.009
KC → KWP	0.281	0.082	3.429	0.001
KS → INN	0.186	0.090	2.067	0.039
KS → KWP	0.059	0.106	0.556	0.579
KU → INN	0.180	0.076	2.366	0.018
KU → KWP	0.246	0.098	2.501	0.012
KWP → INN	0.312	0.076	4.086	0.000

Table 7
Indirect effects.

	Path coefficients (O)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	p values
KC → INN	0.088	0.038	2.336	0.020
KS → INN	0.018	0.036	0.516	0.606
KU → INN	0.077	0.034	2.279	0.023

corresponding significant value of impact of independent variable on dependent one should be assessed (Table 6). If it is positive and significant, then indirect effect (the impact of independent variable on dependent variable through the mediating variable) should be assessed (Table 7). If it is found significant and positive, then there are chances of either full or partial mediation. Otherwise, there is no mediation. Finally, to assess whether there is case of full or partial mediation, the direct effect of independent construct on dependent one should be assessed (Table 8; Fig. 2). If it is found significant and the value of path coefficient is decreased as compared to the total effects, then there is a case of partial mediation. Otherwise, there is full mediation. Based on these steps, the three hypotheses are tested respectively.

Table 8
Direct effects.

	Path coefficients (O)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	p values
KC → INN	0.128	0.091	1.414	0.158
KC → KWP	0.281	0.082	3.429	0.001
KS → INN	0.168	0.081	2.073	0.038
KS → KWP	0.059	0.106	0.556	0.579
KU → INN	0.103	0.073	1.426	0.154
KU → KWP	0.246	0.098	2.501	0.012
KWP → INN	0.312	0.076	4.086	0.000

In H1 it was proposed that knowledge-worker productivity mediates significantly between knowledge creation and innovation. The total effect of knowledge creation on innovation is positive and significant ($\beta = 0.216$, $p < 0.05$; Table 6). Subsequently, the indirect effect of knowledge creation on innovation through the knowledge-worker productivity is also positive and significant ($\beta = 0.088$, $p < 0.05$; Table 7). Thus, there are chances of either full or partial mediation. Subsequently, the direct effect is assessed. To test whether there is a case of full or partial mediation, direct effect is assessed. The path coefficient for the direct effect of knowledge creation on innovation after the inclusion of mediating variable is found positive but insignificant ($\beta = 0.12$, $p > 0.05$; Table 8; Fig. 2). Thus, full mediation is concluded, and H1 is accepted. These results are consistent with the findings of past studies on knowledge creation and task efficiency (Gomez, 2007; Iranzadeh & Pakdelbonab, 2014) and, productivity and innovation (Ramezan, 2012). The customers in the IT sector of Pakistan require the customized products at a higher quality delivery. This requirement compels the workers to engage themselves with the knowledge creation processes continuously. The knowledge creation through the synthesis of self-reflection, customers' reflection, and engagement with knowledge management processes paves the way from knowledge-worker productivity towards the greater innovation performance.

In H2 it was proposed that knowledge-worker productivity mediates between knowledge sharing and innovation. The total effect of knowledge sharing on innovation is found positive and significant ($\beta = 0.186$, $p < 0.05$; Table 6). Subsequently, the indirect effect of knowledge sharing on innovation through knowledge-worker productivity is found positive but insignificant ($\beta = 0.018$, $p > 0.05$; Table 7). Thus, no mediation is concluded, and H2 is not accepted. These results are not consistent with the findings of past studies on knowledge sharing and productivity (e.g., Haas & Hansen, 2007). The insignificance might be attributed to the codification strategy that ensures the provision of explicit documented knowledge through online sources and thus less direct human-interaction for knowledge sharing. Moreover, by Myer Briggs Type Indicator theory, the introvert nature of the engineers might also be a reason for less knowledge sharing among them during the interaction.

In H3 it was proposed that knowledge-worker productivity mediates between knowledge utilization and innovation. The total effect of knowledge utilization on innovation is found positive and significant ($\beta = 0.18$, $p < 0.05$; Table 6). Subsequently, indirect effect is also found positive and significant ($\beta = 0.077$, $p < 0.05$; Table 7). Finally, the direct effect of knowledge utilization on innovation after the

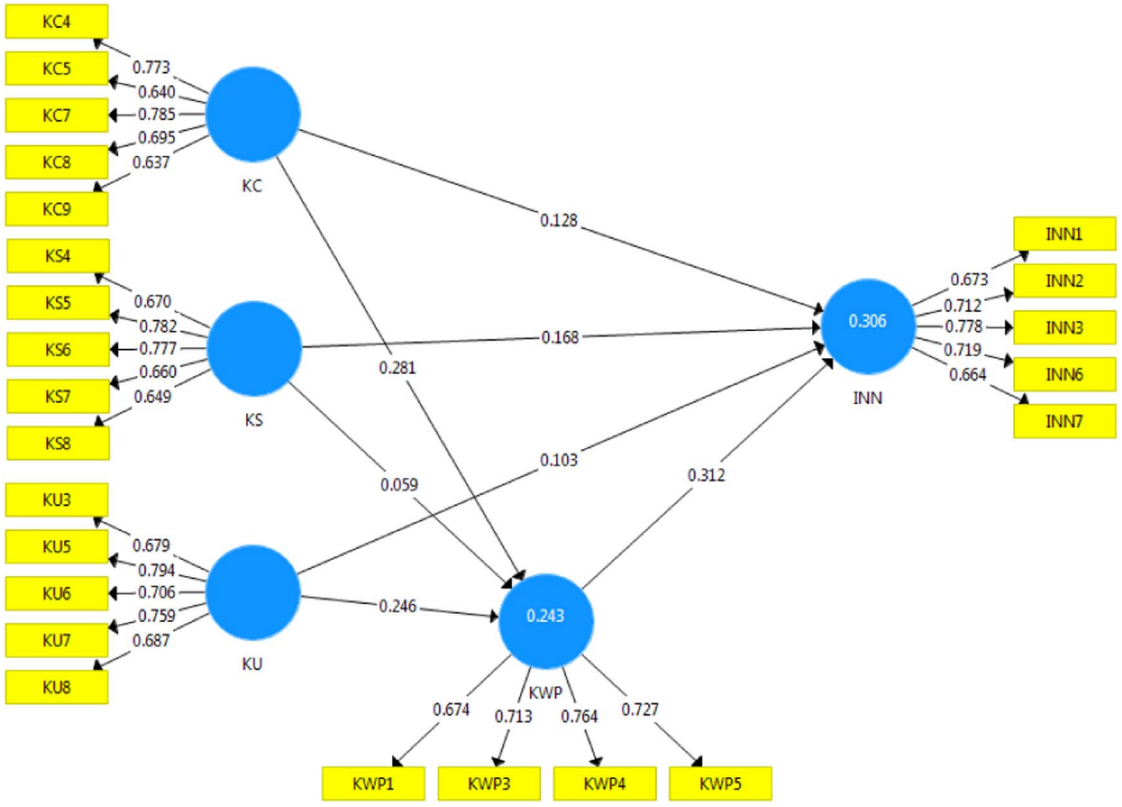

Fig. 2. Research structural paths model.

inclusion of mediating variable is positive but insignificant (β = 0.103, p > 0.05) (Table 8; Fig. 2). Thus, full mediation is concluded, and H3 is accepted. These results are consistent with the findings of past studies on knowledge utilization and task efficiency (Gomez, 2007; Iranzadeh & Pakdelbonab, 2014) and productivity and innovation (Ramezan, 2012). The increase in knowledge utilization processes tends to make the workers inclined towards the use of the knowledge to deliver the service quality and quantity. This inclination results in an increase in the productivity. Through the interaction of knowledge utilization processes, self-reflection, and customers' feedbacks, workers tend to increase the knowledge creation that ultimately increases the innovation outcomes.

5. Conclusion

The purpose of this study was to test the model on the neglected and pivotal mediating role of knowledge-worker productivity on the relationships between three knowledge management processes and innovation for the very first time. Data were collected from the IT sector of Pakistan on a sample of 369 knowledge workers on the managerial positions. The results indicate that knowledge-worker productivity mediates significantly between two knowledge management processes (knowledge creation and knowledge utilization) and innovation. However conflictingly, it does not do so between knowledge sharing and innovation because knowledge sharing does not impact knowledge-worker productivity significantly.

The results on the mediating role of knowledge-worker productivity on the relationships between two knowledge management processes (knowledge creation and knowledge utilization) and innovation verify the Drucker's knowledge-worker's productivity theory, organizational knowledge creation theory, and knowledge-based view of the firm theory. However, non-acceptance of H3 on the mediating role of knowledge-worker productivity defies the knowledge-based view of the firm theory and the Drucker's knowledge-worker's productivity theory. In doing so, the study claims that non-acceptance might be attributed to the implementation of codification strategy of knowledge management and the introvert nature of the engineers.

The practical implication of the study is that the human and cultural approach to knowledge management still has an overarching role over two other emerging approaches (the Big Data approach and the IT and system-based approach). Because this study proposes that it is the chain effect of knowledge management processes on innovation through the knowledge-worker productivity which fulfils the purpose of knowledge management, which is the innovation, in the age of digital knowledge-based economy. Hence, organizations should value knowledge workers as they ultimately use ICT systems, Big Data, and other knowledge management elements to improve their productivity, and thus innovation.

Research limitations are as follows. First, this study ignores the interrelationships among knowledge management processes. The future studies can consider it. Second, this study only draws on three knowledge management processes. The future studies might consider other knowledge management processes subjected to the contexts. Lastly, there is a scant amount of empirical studies on the underlying mechanism of knowledge management impact on the productivity of knowledge workers.

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