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Individual knowledge management engagement, knowledge-worker productivity, and innovation performance in knowledge-based organizations: the implications for knowledge processes and knowledge-based systems

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Abstract The literature on the knowledge management relatively ignores an important concept, the individual knowledge management engagement-the degree to which a knowledge worker is involved with the knowledge management-related activities. This concept is imperative for nurturing the productivity of knowledge workers, knowledge management architecture effectiveness, and innovation. Therefore, this study proposes the mediating role of knowledge-worker productivity between individual knowledge management engagement and innovation. The data

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were collected from the 330 knowledge workers of IT sector of Pakistan and analyzed using the SmartPLS 3 Version 2.6. The results indicate the partial mediation of knowledge-worker productivity between the individual knowledge management engagement and innovation. The results suggest the pivotal role of individual knowledge management engagement in increasing the innovation and knowledge-worker productivity in the knowledge-based organizations.

Keywords Individual knowledge management engagement · Knowledge management · Innovation performance · Innovation · Productivity of knowledge workers

1 Introduction

Knowledge management has gained the popularity among the different disciplines, and practitioners as the wide range of empirical studies found its positive impact on the organizational performance, innovation, and thus the competitive advantage (e.g., Shujahat et al. 2017b; Kianto et al. 2016; Palacios et al. 2009). These relationships among the knowledge management, innovation, and organizational performance have become the universal positive as the wide range of empirical and quantitative studies have validated these interrelationships (e.g., Shujahat et al. 2017a, b; Darroch and McNaughton 2002). The architecture of knowledge management can be categorized into three elements: knowledge management infrastructure, knowledge management processes, and interaction between these two elements (Shujahat et al. 2017b; Curado and Bontis 2006; Syazwan Abdullah et al. 2006; Lin et al. 2002; Gold et al. 2001). Knowledge management infrastructure includes the elements like top leadership support for knowledge management implementation, the reward for knowledge-based activities, and the IT infrastructure; while the knowledge management process elements include the flow of knowledge (knowledge creation, knowledge sharing, and knowledge application) among the different functions and units in a given knowledge-based firm. The knowledge management infrastructure including IT infrastructure is enabled by the factors like ontologies, intranet, and knowledge-based systems/knowledge systems. Consequently, the knowledge management infrastructure enables the knowledge management processes which then ensure the high organizational performance, innovation, and thus competitive advantage for a knowledge-based organization (Shujahat et al. 2017b; Lee and Choi 2003).

However, the literature review indicates an important but ignored construct for the effective performance of knowledge management architecture including

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the knowledge-based systems, and that is the individual knowledge management engagement construct. The operational definition of individual knowledge management engagement is that it is an individual knowledge-worker's perception of the degree to which he/she is involved in an organization's knowledge management-related activities (Tseng and Fan 2011; Cabrera et al. 2006). To the best of authors' review, there are two studies that tested this construct namely: Tseng and Fan (2011) and Cabrera et al. (2006). Hence, addressing this particular relatively ignored construct empirically could be a relatively unique contribution. The knowledge management architecture, consisted of knowledge management processes and knowledge management infrastructure, is of no importance for the greater organizational performance and innovation until unless an individual knowledge worker interacts and utilizes these elements particularly the knowledge management infrastructure in order to acquire, share, and utilize the knowledge for timely and efficiently doing of his/her job tasks, innovation, and thus the higher organizational performance (Tseng and Fan 2011; Cabrera et al. 2006).

Based on this discussion, it can be deduced that the individual knowledge management engagement ensures that the knowledge worker acquires, creates, shares, and applies the knowledge from the knowledge management architecture that improves his/her decision-making, task efficiency, and thus the productivity (Shujahat et al. 2017b; Tseng and Fan 2011; Cabrera et al. 2006). The literature claims the universal positive relationship between knowledge management and innovation; or innovation is the direct outcome of knowledge management (e.g., Shujahat et al. 2017a, b; Kianto et al. 2016; Curado and Bontis 2006; Syazwan Abdullah et al. 2006; Gold et al. 2001). Hence, the individual knowledge management engagement, a facet or a micro-component of knowledge management, should also impact innovation positively.

However, the study does not test the impact of individual knowledge management engagement on innovation because the range of literature sources claims that the knowledge worker involvement in the creation, sharing, and utilization of knowledge-individual knowledge management engagement-can nurture the productivity of knowledge workers, that is the most striking challenge for the management practitioners and scholars in the twenty-first century (e.g., Shujahat et al. 2017b; Iranzadeh and Pakdelbonab 2014; Gomez 2007; Haas and Hansen 2007). If individual knowledge management engagement can nurture the productivity of knowledge workers, and its direct outcome as the facet of the knowledge management architecture is the innovation (e.g., Shujahat et al. 2017a, b; Kianto et al. 2016; Curado and Bontis 2006; Syazwan Abdullah et al. 2006; Gold et al. 2001), then by deductive logic and Drucker's knowledge-worker's productivity theory the outcome of productivity of knowledge-worker productivity should also be the innovation (e.g., Shujahat et al. 2017b; Iranzadeh and Pakdelbonab 2014; Gomez, 2007; Haas and Hansen 2007). Therefore, the purpose of this study is to test the mediating role of knowledge-worker productivity between individual knowledge management engagement and innovation. The data is collected from the knowledge-intensive or knowledge-based service sector organizations: IT (Information Technology) of Pakistan. The knowledge-workers (engineers, managers, and analysts, etc.) are targeted for the collection of data. The numbers of responses that have been used in the analysis

are 330. Results support that there is the case of partial mediation of knowledge-worker productivity between individual knowledge management engagement and innovation.

The remaining of this paper is presented as follows. First, the literature review is presented. In this section, the literature on the three constructs is presented for the operationalization and understanding of the constructs. This section is then followed by the two theories used and the arguments for the proposition of interrelationships among the constructs. The literature review is then followed by the research methodology section under which information on the data collection, instruments, and technique of data analysis is presented. Subsequently, the research methodology section is then followed by the two other sections: results and their discussion to explain the causality between the variables. Lastly, the study is concluded with the practical and theoretical implications and research recommendations.

2 Literature review

2.1 Knowledge-based innovation

The ultimate purpose of an existing firm including the knowledge-based firm is to grow that requires the sustainable competitive advantage (Shujahat et al. 2017a; David 2007; Barney 1991). For gaining the sustainable competitive advantage, the firms do employ the strategic management and strategists. One of the ways that strategic management and strategists adopt/adapt to gain the competitive advantage is the innovation (Honarpour et al. 2017; Klingebiel and Rammer 2014).

The innovation can be conceptualized from the traditional literature and knowledge-based literature (Shujahat et al. 2017b; Darroch and McNaughton 2002; Grant 1996). Traditional literature review on innovation posits different definitions of innovation. For example, innovation is the execution or the implementation of new products, processes, or the new marketing and organizational methods (Meroño-Cerdán and López-Nicolás 2017). Moreover, it is the development and subsequent execution of new and novel behaviors as well as ideas (Costa and Monteiro 2016).

Likewise, innovation can also be conceptualized regarding the knowledge-based process and outcome from the knowledge-based literature (Jiang and Li 2009; Du Plessis 2007). For example, it is a knowledge process that is meant to create new knowledge for the development of novel solutions (Cardinal et al. 2001). Another study defines the innovation as the creation of new knowledge and ideas that are meant to improve the internal processes, structures, and external customer-based products and services (Du Plessis 2007). In the same lines, the operational definition of innovation, adhering to the knowledge-based innovation conceptualization, is that it is the introduction of novel product with respect to characteristics or intended use, and the dynamic customer problem-solving processes by the virtues of the knowledge creation, sharing, and utilization to meet the changing and evolving needs of the customers (Shang et al. 2015). Synchronized with the aforementioned operational definition, the construct of innovation for the study is composed of two dimensions: product innovation (knowledge-based) and customer problem-solving

processes (knowledge-based) (Shang et al. 2015), and is consistent with that of Shujahat et al. (2017b).

This study by adhering to Shujahat et al. (2017b) makes it explicitly clear that this study measures the innovation by the scales/instruments that are based on the traditional literature conceptualization of innovation. The reason is that the scales/instruments for measurement are developed using the outcomes as the indicators/items, rather than the processes. It is not possible to operationalize and use the processes as the items/indicators. For example, the construct of product innovation could be developed using the outcomes like the number of new products introduced as the item while the process of creating the knowledge for offering the novel solutions cannot be offered. However, the knowledge-based innovation construct on the other hand as defined by the different definitions involves the knowledge processes as an antecedent. Hence, the knowledge-based innovation as the processes-related construct cannot be developed and used in the empirical and quantitative design. Therefore, the knowledge-based innovation in this study is measured using the items and scales of traditional innovation scales that are developed to measure the outcomes e.g., the product innovation and customer satisfaction.

There are a number of individual-level factors that impact the knowledge-based innovation, e.g., knowledge flows and knowledge capabilities, knowledge sharing, R&D fund, and knowledge-based trust etc. (Carayannis et al. 2000; Allen et al. 2007). However, by the Drucker's knowledge-worker's productivity theory, the most relevant individual determinant of innovation is the knowledge-worker productivity.

2.2 Knowledge-worker productivity

Like innovation, the knowledge-worker productivity can also be conceptualized from the traditional literature as well as knowledge-based literature. Traditional literature, simply put, defines productivity of an individual worker as the ratio of the output units produced to the input units used (Fernandez 2013). The reason is that the traditional literature that belongs to the twentieth century was mainly focused on the productivity of the manual workers that made the major part of the workforce in the 20th century in the predominant production sector of economies under the big umbrella of the scientific management theory and school of thought. Hence, the most prominent challenge for the management discipline and practitioners in the twentieth century was to increase the productivity of manual workers (Turriago-Hoyos et al. 2016; Drucker 1998, 1999).

In contrast, the twenty-first century is of knowledge and information resources under the umbrella of the knowledge economy and knowledge management. In this context, the knowledge workers are imperative for the knowledge-based organizations in the twenty-first century like the manual workers were imperative in the twentieth century. Therefore, the knowledge-based literature asserts that productivity of the knowledge worker is the creation of knowledge work that can ultimately be used to perform the task innovatively and timely, and promotes the greater innovation performance (Wright et al. 2018; Shujahat et al. 2017b; Iranzadeh and Pakdelbonab 2014; Gomez 2007; Haas and Hansen 2007). Hence, the knowledge workers

make the major part of the workforce in the twenty-first knowledge century in the predominant service sector of the knowledge economies that require the continuous innovation; and increasing their productivity is the most striking challenge for the management practitioners and scholars of the twenty-first knowledge century (Turriago-Hoyos et al. 2016; Drucker 1998, 1999; Nonaka 1994).

The operational definition of knowledge-worker productivity from knowledge-based literature asks for defining the knowledge worker and knowledge work for the clarity. Consequently, knowledge work is the creation and utilization of knowledge by the highly creative and smart workers to innovate continuously (Bosch-Sijtsema et al. 2009). Therefore, knowledge work can be seen as worker's operation or activity or an individual's trait to work creatively (Dahooie et al. 2011). These definitions of knowledge work help to conclude that knowledge-worker is the employee who creates, shares, and utilizes the tasks related to the knowledge work (Shujahat et al. 2017b; Thomas and Baron 1994). By this definition, the practitioners of the IT sectors like the analyst, programmer, and designer might be termed as knowledge-workers (Tsekouras et al. 2011; Curado and Bontis 2006; Drucker 1999; Nonaka 1994). Therefore, this point compelled the study to collect the data from the IT sector.

The definitions of knowledge work and knowledge worker enable the study to develop and operationally define the knowledge-worker productivity. Consequently, the productivity of knowledge worker is the efficiency of a knowledge worker to use the knowledge for the effective decision-making and the knowledge-based task improvisations (Ebert and Freibichler 2017; Plum et al. 2017; Shujahat et al. 2017b; Iranzadeh and Pakdelbonab 2014; Bosch-Sijtsema et al. 2009; Gomez 2007; Haas and Hansen 2007).

The knowledge-worker productivity is a knowledge-based construct and concept. Therefore, it is logical to assume that the factors related to the knowledge dynamics are comparatively more imperative for the productivity of knowledge workers. This study proposes that management of knowledge dynamics-knowledge management-could impact or nurture the productivity of knowledge workers significantly (Shujahat et al. 2017b; Iranzadeh and Pakdelbonab 2014; Gomez 2007; Haas and Hansen 2007).

2.3 Individual knowledge management engagement

The knowledge management is the process, function, and discipline that cultivates a culture that creates, shares, and applies knowledge for greater innovation performance, organizational performance, and competitive advantage. It consists of the two main elements: the knowledge management infrastructure and knowledge management processes (Shujahat et al. 2017a, b; Costa and Monteiro 2016; Andreeva and Kianto 2011; Zheng et al. 2011; Gold et al. 2001). However, this study maintains that these components of knowledge management are of no importance unless an individual worker gets involved with these knowledge management processes and infrastructure (Tseng and Fan 2011). Individual perception of the degree of involvement with the knowledge management activities within an organization is called the individual knowledge management engagement (Tseng and Fan 2011; Cabrera

et al. 2006). It is one of the relatively ignored concepts and constructs of knowledge management as to the best of authors' knowledge; there are only two studies on this concept in the literature (Tseng and Fan 2011; Cabrera et al. 2006). Tseng and Fan (2011) test the impact of the individual knowledge management engagement on job satisfaction and performance as part of the bigger model. The impacts are found significant and positive. Similarly, Carbera et al. (2006) test the determinants of individual knowledge sharing process engagement of knowledge workers which are found significant as well.

2.4 Knowledge-based view of the firm theory

At the risk of oversimplification, the knowledge-based view of the firm theory posits that an organization is the sum of knowledge resources which are pertinent for the competitive advantage (Shujahat et al. 2017a, b; Monteiro et al. 2017; Inkinen 2016; Garrido-Moreno et al. 2015; Grant 1996). The reason is that this resource is rare, valuable, and cannot be copied easily. Therefore, the comparative organizational performance of the firm that strives to create, share, and apply these knowledge resources would increase with sustainability as compared to its competitors who do not do so (Shujahat et al. 2017a, b; Costa and Monteiro 2016).

2.5 Drucker's knowledge-worker's productivity theory

Drucker's knowledge-worker's productivity theory postulates the six points for increasing the knowledge-worker productivity in the context of the knowledge economy in the twenty-first century. These six points are as follows (Shujahat et al. 2017b; Drucker 1998, 1999). First, increasing the knowledge-worker productivity requires that knowledge worker should only be focused on the knowledge-related tasks. Second, the knowledge workers must have job autonomy. Third, the ultimate aim of the knowledge-worker productivity is to innovate continuously. Fourth, to meet the changing needs of innovation, a knowledge-worker must learn and teach on the continuous basis. Fifth, knowledge-worker should focus to deliver on the quality and quantity of output both. However, the most important is the quantity of the output for the productivity of knowledge worker in the service sector that is more knowledge-intensive than the production sector. Lastly, knowledge worker should be treated as an asset rather than the cost.

2.6 Relationship between individual knowledge management engagement and innovation

The use of the knowledge-based view of the firm theory, past studies on the constructs related to the individual knowledge management engagement and innovation, and synthesized arguments from the literature posits the positive impact of the individual knowledge management engagement on innovation. From the knowledge-based view of the firm theory, innovation is the most strategic issue that can only be met by the virtues of the knowledge management. Under the concept of

the individual knowledge management engagement, an individual worker interacts/engages with the knowledge management architecture to create, share, and apply the knowledge. Thus, the knowledge worker gets involved with the knowledge management-related activities. This involvement in the knowledge management-related activities can equip the worker with the necessary knowledge that could be used to innovate on the continuous basis (Shujahat et al. 2017a; Ologbo et al. 2015; Andreeva and Kianto 2011; Lane et al. 2006; Drucker 1999; Grant 1996; Nonaka 1994). Moreover, a greater number of saturated literature sources consisted of empirical and systematic literature review researches maintain that there is almost a universal relationship between knowledge management organizational level and innovation (e.g., Shujahat et al. 2017a, b; Costa and Monteiro 2016; Ologbo et al. 2015; Andreeva and Kianto 2011; Zheng et al. 2011). As individual knowledge management engagement is one of the micro-components or the facets of knowledge management, therefore, it can be deduced that it impacts innovation performance significantly and positively.

Finally, synthesized literature in the form of arguments also supports the proposition that individual knowledge management engagement impacts the innovation positively. When a knowledge worker creates and utilizes the knowledge through the utilization of knowledge management architecture implemented in the organization, he/she can use it for the sake of performing the tasks innovatively, efficiently, and timely (Tseng and Fan 2011; Lee et al. 2013; Fernandez 2013; Nonaka and Takeuchi 1995; Nonaka 1994). These processes of knowledge creation and knowledge utilization by the engagement with knowledge management architecture can lead towards the improvement of the business processes and product innovation (Shujahat et al. 2017b).

2.7 Relationship between individual knowledge management engagement and knowledge- worker productivity

The use of Drucker's knowledge-worker's productivity theory, past studies, and the synthesized arguments from literature helps to deduce that individual knowledge management engagement impacts knowledge-worker productivity positively. By the Drucker's knowledge-worker's productivity theory, increasing the knowledge-worker productivity requires following things: the continuous learning and teaching on the part of the knowledge worker, job autonomy, and working on the performance of the knowledge work qualitatively and quantitatively, treatment as an asset, and knowledge-based tasks/job (Drucker 1998, 1999). The extant literature review maintains that knowledge management systems, knowledge management processes, and knowledge management infrastructure and correlates with these things (Kianto et al. 2016; Kivipõld 2015; Tseng and Fan 2011). Consequently, it can be maintained that individual knowledge management engagement impacts innovation positively.

Moreover, a knowledge worker can create and utilize the knowledge through the engagement and involvement with the knowledge management architecture implemented in the organization. Subsequently, he/she can use the created knowledge for the sake of performing the tasks innovatively, efficiently, and timely (Tseng and Fan 2011;

Nonaka 1994). Finally, the improvement in these efficiency aspects (task innovation and meeting time demands, etc.) can promote an increase in the knowledge-worker productivity (Shujahat et al. 2017b).

Finally, (Tseng and Fan 2011) empirically tested the impact of individual knowledge management engagement on the job performance of knowledge workers. The impact was found significant. However, the review of this study indicates that impact of individual knowledge management engagement on the productivity of knowledge workers has not been tested. As the job performance could be considered a closely-related construct and issue to the knowledge-worker productivity, therefore it can be deduced that individual knowledge management engagement impacts innovation positively (Shujahat et al. 2017b).

2.8 Relationship between knowledge-worker productivity and innovation

The use of the Drucker's knowledge-worker's productivity theory, synthesized arguments, and deductive logic implies that knowledge-worker productivity impacts innovation positively. The third postulate of the Drucker's knowledge-worker's productivity theory states that knowledge-worker productivity translates into innovation ultimately (Drucker 1998, 1999). This third postulate helps to deduce that when an organization has the objective and policy of continuous innovation performance, it pushes the knowledge workers to work with autonomy to innovate on the continuous basis (Shujahat et al. 2017b; Drucker 1999).

Also, Shujahat et al. (2017b) as part of the broader model proposes that productivity of knowledge workers mediates between the knowledge management processes at the organizational level and innovation performance. The data is collected from the knowledge workers of IT sector of Pakistan. The results indicate that knowledge worker productivity mediates significantly. However, the review of this study indicates that the study model does not consider the individual knowledge management engagement.

Furthermore, literature review claims that knowledge productivity-related dynamics can impact the innovation positively and significantly. In this regard, (Ramezan 2012) with empirical design concludes on the survey-based quantitative data that individual productivity regarding creation, sharing, and utilization of knowledge is linked to innovation.

Finally, when a knowledge worker performs the tasks innovatively, timely, and efficiently, he/she gets the feedback for the innovation/improvement from customers and other stakeholders as well as his/her self-reflection during the performance of the knowledge-based tasks (Shujahat et al. 2017b; Lee et al. 2013; Nonaka and Takeuchi 1995; Nonaka 1994). The feedback and self-reflection give the knowledge worker the opportunity to improve the business processes and product innovation (Shujahat et al. 2017b).

2.9 Research hypotheses and model

Based on the above literature, following hypotheses and research model are proposed (Fig. 1).

H1 Individual knowledge management engagement impacts innovation positively and significantly.

H2 Individual knowledge management engagement impacts knowledge-worker productivity positively and significantly.

H3 Knowledge-worker productivity impacts innovation positively and significantly.

H4 Knowledge-worker productivity mediates between Individual knowledge management engagement and innovation positively and significantly.

3 Methodology

3.1 Sample

This study targets the knowledge workers of the IT sector of Pakistan. Data is collected using the personal references with the managers through physical survey questionnaires, i.e., convenience sampling. Because in Pakistan, the business organizations have very less liaison with the academia and researchers, and the managers are vested with the high powers to impede a researcher from the data collection through the formal channels of invitation (Shujahat et al. 2017b). The total numbers of responses are 330. The reasons behind this sample are as follows (Shujahat et al. 2017b; Tsekouras et al. 2011; Nair and Vohra 2010). First, IT sector is the knowledge-intensive sector because of being a service sector. Second, it requires the knowledge workers with high levels of tacit and explicit knowledge so that they create and apply knowledge about the different tasks. Third, this sector of the country has implemented the information and knowledge management architecture in all its companies as the anecdotal evidence shows. Fourth, the engineers and the managers whose are knowledge workers by definitions and thus are targeted for data collection. Finally, these organizations are knowledge-based

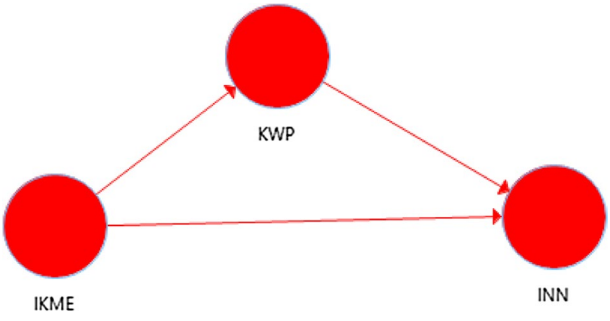

Fig. 1 Proposed research model

organizations and have the knowledge-based systems and knowledge management architecture, thereby involving the individual knowledge management engagement, knowledge-worker productivity, and knowledge-based innovation.

The study targets the software, computer, and electrical engineers and the managers (knowledge workers) who mainly use the knowledge-based systems and knowledge management architecture from the marketing, research and development, management of information system units, Finance, HRM departments. The 69.09 percent of the sample knowledge workers are the engineers and from engineering departments, while remaining are the managers (MIS, marketing, finance, and HRM). In the same line, the 71.21 percent of the sample is male while the remaining is female.

3.2 Measurement scales

First construct of the study is individual knowledge management engagement involving items about the individual knowledge worker engagement in the knowledge management related activities (knowledge acquisition, knowledge storage, knowledge sharing, and knowledge application). It is being measured using the 12 adapted items from the (Tseng and Fan 2011).

The second construct is the knowledge-worker productivity. It is being measured using the three dimensions, which is consistent with that of (Shujahat et al. 2017b). The three dimensions are as follows: job autonomy at work, timeliness, and the task efficiency. The scales are as follows: job autonomy is measured using the 2 adapted items from (Morgeson and Humphrey 2006); timeliness of knowledge worker is measured using the 2 adapted items from (Lerner et al. 2001); and lastly, task efficiency is instrumented using the 3 adapted items from the (Tangen 2005).

The last construct is the innovation that is measured using the two dimensions: product innovation and customer problem-solving processes innovation. It is being measured using the five adapted items from the (Wang and Ahmed 2004) for the first dimension, product innovation. Moreover, its second dimension, dynamic customers' problem-solving process, is being measured using the five adapted items from the scale of (Jayachandran et al. 2004). This construct composition and measurement is consistent with the Shujahat et al. (2017b).

3.3 Measurement technique

This study uses the SmartPLS 3 Version 2.6 for the data analysis. The SmartsPLS 3 Version 2.6 uses the PLS-SEM (Partial Least Square-Structural Equation Modelling) technique (Wong 2013). The method of the obtaining the results and reporting for the study is consistent with the recent literature (Shujahat et al. 2017b; Hussain et al. 2017; Kianto et al. 2016).

4 Results

A SmartPLS report of the survey-based research study should be divided into two models: measurement model and research model (Hussain et al. 2017; Wong 2013). Consequently, the results section is divided into these two subsections.

4.1 Measurement model

Measurement model subject to the reflective model includes the following components (Tables 1, 2): composite reliability, convergent validity, and discriminant validity (Hussain et al. 2017; Wong 2013). The threshold value for the compose reliability is 0.7 (Wong 2013; Bagozzi and Yi 1988). Consequently, all the latent constructs of the model possess the composite reliability (Table 1). The third component of the measurement model is the convergent validity. Its measure is Average Value Extracted (AVE) for which the threshold value is 0.5 (Wong 2013; Fornell and Larcker 1981). Likewise, all the latent constructs possess the convergent validity (Table 1).

Table 1 Outer loadings, composite reliability, and convergent validity

	Outer loadings	Composite reliability	Average variance extracted
IKME5 ← IKME	0.734	0.903	0.609
IKME8 ← IKME	0.700		
IKME10 ← IKME	0.807		
IKME11 ← IKME	0.817		
IKME2 ← IKME	0.825		
IKME4 ← IKME	0.792		
INN1 ← INN	0.622	0.920	0.565
INN10 ← INN	0.811		
INN2 ← INN	0.783		
INN3 ← INN	0.733		
INN4 ← INN	0.572		
INN6 ← INN	0.742		
INN7 ← INN	0.800		
INN8 ← INN	0.804		
INN9 ← INN	0.855		
KWP1 ← KWP	0.759	0.876	0.541
KWP3 ← KWP	0.699		
KWP4 ← KWP	0.657		
KWP5 ← KWP	0.737		
KWP6 ← KWP	0.799		
KWP7 ← KWP	0.754		

Table 2 Discriminant validity of the model

	HTMT ratio	Confidence interval low	Confidence interval up
INN → IKME	0.596	0.523	0.669
KWP → IKME	0.819	0.739	0.890
KWP → INN	0.630	0.554	0.700

The last component of the measurement model is the discriminant validly. The SmartPLS 3 offers a unique measure of establishing the convergent validity-HTMT (hetrotrait-monotrait) ratio for which the most liberal cut-off value criterion is 0.9 with the corresponding confidence interval up less than 1 (Henseler et al. 2015). It is maintained that each pair of the constructs of this study possesses the discriminant validity (Table 2). The study makes it explicitly clear that the HTMT ratio is not relatively a new measure anymore in the management literature as the recently published studies have already used it (e.g., Shujahat et al. 2017b; Hussain et al. 2017).

4.2 Research structural hypotheses model

The research structural research model mostly reports the values related to the tests of the hypotheses and the regression (Wong 2013). The value of regression or coefficient of determination for knowledge-worker productivity is 0.5. This value means that individual knowledge management engagement explains the 50% changes in the knowledge-worker productivity. Moreover, the value of the regression for the innovation is 0.351. This value of regression means that individual knowledge management engagement and knowledge-worker productivity together explain the 35.1% changes in the innovation.

The hypotheses of the study are tested in the following paragraphs respectively (Wong 2013).

It was proposed in H1 that individual knowledge management engagement impacts the innovation positively and significantly. The path coefficient for this hypothesis is positive and significant ($\beta = 0.296$, $p < 0.05$; Fig. 2; Table 3). Consequently, H1 is accepted.

Moreover, it was also proposed in H2 that individual knowledge management engagement impacts knowledge-worker productivity positively and significantly. The path coefficient for this hypothesis is positive and significant ($\beta = 0.707$, $p < 0.05$; Fig. 2; Table 3). Consequently, H2 is accepted.

Also, it was proposed in H3 that knowledge-worker productivity impacts innovation positively and significantly. The path coefficient for this hypothesis positive is and significant ($\beta = 0.344$, $p < 0.05$; Fig. 2; Table 3). Consequently, H3 is accepted.

Lastly, it was proposed in H4 that knowledge-worker productivity mediates between individual knowledge management engagement and innovation positively and significantly.

To assess the positive mediation of a latent construct, following three steps should be carried out (Preacher and Hayes 2008; Hussain et al. 2017).

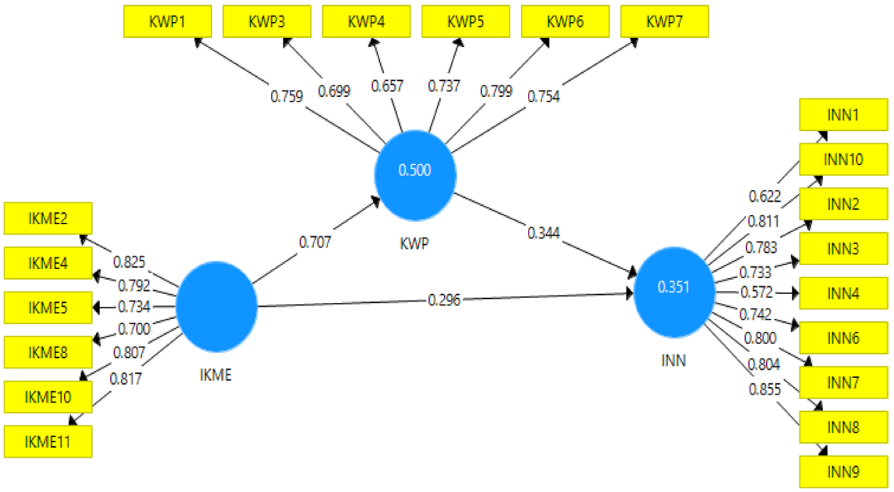

Fig. 2 Research structural model

Table 3 Total effects

	Path coefficients	Standard deviation (S)	T statistics (|O/S|)	p values
IKME → INN	0.540	0.032	16.769	0.000
IKME → KWP	0.707	0.032	22.138	0.000
KWP → INN	0.344	0.055	6.224	0.000

Table 4 Indirect effect

	Path coefficients	Standard deviation (S)	T statistics (|O/S|)	p values
IKME → INN	0.244	0.042	5.851	0.000

1. First, the total effect of the independent construct on the dependent one should be tested (Table 3). If it is positive and significant, then there are chances of mediation.
2. Second, the indirect effect (effect of independent construct on the dependent one via mediating construct) should be tested with the corresponding p value (Table 4). If it is positive and significant, then the mediation exists.
3. However, to confirm whether the mediation is partial or full, the direct effect or path coefficient should be checked (Table 5; Fig. 2). If the direct effect (remaining impact of the independent construct on the dependent one after the inclusion of the mediating construct) is significant, then there is the case of partial mediation. Otherwise, evidence supports the case for the full mediation. Lastly, the value

of VAF (variance accounts for) for mediation can be calculated by the formula (indirect effect/total effect).

Following this detailed method, the total effect is found positive and significant ($\beta = 0.54$, $p < 0.05$; Table 3). Subsequently, indirect effect is found positive and significant ($\beta = 0.254$, $p < 0.05$; Table 4). Next, the direct effect is found positive and significant ($\beta = 0.296$, $p < 0.05$; Table 5). Consequently, H4 is accepted with the conclusion of partial mediation of knowledge-worker productivity. Lastly, the calculated VAF value for the mediating construct is 0.4518 (Tables 3, 5). This indicates that 45.18% changes are accounted for the mediating construct.

5 Discussion

Following subsections discuss the results of the hypotheses respectively.

H1 Individual knowledge management engagement impacts innovation positively and significantly.

It was hypothesized that individual knowledge management engagement impacts innovation positively and significantly. The results certify this proposition and are consistent with the findings of the previous studies where the positive relationship between organizational level knowledge management processes and innovation was noted down (Costa and Monteiro 2016; Andreeva and Kianto 2011). The IT sector of Pakistan is a knowledge-intensive sector particularly because of being a service sector and involving high customer contact and collaboration. Hence, to perform the given tasks, the knowledge workers need the knowledge management architecture. Therefore, the IT sector organizations have employed these architectures. However, these architectures are of no importance until unless the knowledge workers interact with them to create, utilize, and share knowledge for the innovative solutions.

H2 Individual knowledge management engagement impacts knowledge-worker productivity positively and significantly.

It was hypothesized that individual knowledge management engagement impacts knowledge-worker productivity positively and significantly in the IT sector. Results validate this hypothesis. The knowledge workers of this era perform the

Table 5 Direct effects or path coefficients

	Path coefficients	Standard deviation (S)	T statistics (|O/S|)	p values
IKME → INN	0.296	0.055	5.393	000
IKME → KWP	0.707	0.032	22.138	0.000
KWP → INN	0.344	0.055	6.224	0.000

sophisticated tasks because of the dynamic nature of the business sectors and knowledge orientation. Hence, to perform the task and solve novel and dynamic problems, they are required to interact with the employed information and knowledge management architecture. In doing so, their productivity gets increased by large.

H3 Knowledge-worker productivity impacts innovation positively and significantly.

It was proposed that knowledge-worker productivity impacts innovation positively and significantly. Results validate this proposition and are consistent with the findings of the previous study where the positive relationships between the individual knowledge management engagement and the job performance (Tseng and Fan 2011) and knowledge-worker productivity and innovation were noted down (Shujahat et al. 2017b; Ramezan 2012). The anecdotal evidence shows that the Pakistani IT sector employed the knowledge management architecture and knowledge worker that have the breadth and width of explicit and tacit knowledge. During the conduct of job, these workers use this knowledge to serve the purpose of continuous innovation, e.g., novel customer problem-solving process and the new types of products.

H4 Knowledge-worker productivity mediates between individual knowledge management engagement and innovation positively and significantly.

It was proposed that knowledge-worker productivity mediates between individual knowledge management engagement and innovation positively and significantly. The knowledge management architecture (IT infrastructure, knowledge-based systems, and knowledge management processes) is helpful to a knowledge-based organization only when knowledge workers use and interact with it to create, share, and utilize the knowledge. This knowledge then can contribute towards improvement in the task efficiency and timeliness to complete.

6 Conclusion

The literature indicated a relatively ignored, but important construct and concept-individual/knowledge-worker knowledge management engagement-that ensure the effective performance of knowledge-based systems/knowledge systems and knowledge management architecture. The study maintained that individual knowledge management engagement improves the task efficiency, improvisations, and decision-making of knowledge workers- productivity of knowledge worker. Moreover, the study proposed the innovation as the main outcome of individual knowledge management engagement. Therefore, the purpose of the study was to test the mediating role of productivity of knowledge workers between the individual knowledge management engagement and innovation. The data were collected from the 330 knowledge workers (the engineers and managers) from the IT sector of Pakistan and was analyzed using the SmartPLS 3 Version 2.6. The results indicated the partial

mediation of productivity of knowledge workers between individual knowledge management engagement and innovation.

The theoretical contributions of the study are as follows. First, to the best of authors' knowledge, it is the third study to address the individual knowledge management engagement construct, which is all important for the effectiveness of overall knowledge management architecture and in particular for the knowledge-based systems and knowledge processes. Second, this study to the best of authors' knowledge tests the impact of individual knowledge management engagement on knowledge-worker productivity for the very first time. Third, the impact of individual knowledge management engagement on innovation is again another novelty. Fourth, the results verify the two theories used: Ducker's knowledge-worker productivity and knowledge-based view of the firm theory in the context of the developing country. In doing so, it adds the relatively new construct, individual knowledge management engagement, in these theories. Finally and more importantly, the study proves that the knowledge-based systems and knowledge management architecture are of no importance without the individual knowledge management engagement which can improve the decision-making and task efficiency of knowledge workers.

6.1 Practical implications

The learning outcomes for the practitioners are as follows. First, the knowledge management architecture and knowledge-based systems employed do not guarantee the success of the knowledge-based business firms regarding the innovation and productivity of knowledge workers unless workers get engaged with these things. Therefore, the knowledge-based organizations should not only take initiatives of knowledge management architecture and knowledge-based systems, but they need to ensure that their respective knowledge workers have the motivation, support, and knowledge to use the initiatives taken. Consequently, knowledge workers then can further the knowledge engineering process for their productivity and organizational innovation. Second, to meet the most striking challenge for management practitioners in the twenty-first century, increasing the productivity of knowledge workers, managers do need to employ the knowledge management architecture. Subsequently, they should motivate their workers to engage themselves and utilize this architecture to create, share, and utilize the knowledge to improve the task efficiency, timely completion of tasks, and the solutions of the emerging and dynamic problems. Finally, the results also indicate the pivotal role of the individual knowledge management engagement as the measure and toolkit of increasing the effectiveness of knowledge management architecture and knowledge-based systems.

6.2 Research limitations and recommendations

The research limitations and recommendations of the study are as follows. First, this study did not consider the second-order constructs of individual knowledge management engagement and knowledge-worker productivity. Future studies should explore and consider those in the models. Second, the results of the study can only

be generalized when these are replicated by the other studies in different contexts. Third, there might be some positive moderating variables or the contingency variables on the relationships/hypotheses of this study like organizational commitment and relationship with the supervisor. Future studies should investigate the impact of these variables. Fourth, there is relatively scant literature on the individual knowledge management engagement which is an important construct about knowledge management architecture for theoretical development and practical implications. The future researches should consider expanding it. Fifth, the individual and organizational enablers of individual knowledge management engagement should be explored and tested. Finally, the review of the past studies on the relationships between the knowledge management processes and productivity of knowledge workers indicate that there is no comprehensive and conclusive evidence that test the impact of knowledge management on productivity of knowledge workers and unearths the mechanism of this relationship from the literature.

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