BUSINESS AND MANAGEMENT FACTORS RELATING TO FIRM INNOVATION PERFORMANCE

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ABSTRACT

The resource based theory emphasise the important of knowledge based resources for firm innovation performance. This study identified the firm knowledge based assets such as R&D, absorptive capacity, knowledge management and so forth. This research paper analyse the Pakistani software industry (i.e., at micro level) and provided contribution to the knowledge in terms of analysis of knowledge intensive sector by using cross sectional data techniques. This empirical study is based on 2-month survey of 69 software firms in Islamabad region. Factor and stepwise probit regression analysis are used to examine the relationship between business and management factors and firm innovation performance. Firm size, strategic focus, culture and knowledge management have a positive impact on the firm's innovation performance. In comparison, lifecycle, leadership abilities and absorptive capacity have negative association to firm performance. Overall, our empirical findings suggests that firms with low level of R&D, resource constraint, poor networks and less motivated employees affect the innovation performance of these software firms.

Keywords*: Absorptive Capacity, Innovation, R&D, SMEs*

Introduction:

Innovation is an important resource for firm's competitive advantage (Katila and Shane, 2005). Innovativeness reflects a firm's tendency to engage in and support new ideas, novelty, experimentation and creative process that may result in new products / service or technological processes (Lumpkin and Dess, 1996). Similarly, innovation increases the employee's skills, knowledge; likewise at macro level promote economic growth through international trade (Wong *et al.* 2007). This clearly indicates that innovation is key driver of firm (*i.e.*, micro level) and economic growth (*i.e.*, macro level). Nevertheless, this paper focuses upon micro level analysis of firm and motivates our study to identify the key factors of firm's innovation performance. For instance, the empirical study of Radas and Bozic (2009) based on Croatian SMEs identified internal and external drivers of innovation. Internal factors such as i) firm size; ii) leadership abilities; iii) R&D and external factors such as i) networks; ii) financial resources and so forth could have a positive impact on the firm's innovation performance. However, some studies suggest that small and medium size firms are less innovative than large firms due to resource constraints (*e.g.*, Freel, 2000). For instance, low level of skilled labour, poor management and marketing capabilities, weak networks could affect the innovative performance of SMEs more than large firms (Freel, 2000).

In addition, previous studies (*e.g.*, Harris and Trainor, 1995; Harhoff, 1998) analysed the manufacturing industry and showed little evidence related to knowledge-intensive sector *(i.e.*, software firms). For instance, Correa (1996) study investigated the export performance of software firms instead innovation performance. Further, these software firms are mainly comprises SMEs and have higher innovation abilities because of highly qualified IT professionals and better organisation capabilities (Matusik and Heeley, 2005). These knowledge intensive firms have strong linkages with other sectors of the economy such as banking sector, airline industry and the manufacturing sector which improve the innovative performance of all firms, whether small or large firms (Westhead, 1997). However, the growth of this knowledge intensive sector requires investment in organisational capabilities such as to improve the business and management factors (*e.g.*, strategic focus, leadership,

knowledge management) relating to firm innovation performance (*e.g.,* De and Dutta, 2007).

This paper has been divided into 4 sections; section 1 discusses the literature review and identified the key factors of firm innovation performance. Section 2 present research methodology and empirical analysis (*i.e.,* factor and regression analysis). Lastly, section 3 discusses the conclusion and policy implication of this research study.

Section – I

Absorptive Capacity:

The resource based view of firm suggests that a firm should invest in intangible assets (i.e., knowledge-based assets) to improve the firm innovation performance[1]. These intangible assets refer to various antecedents of firm innovation performance such as R&D, HRM practices, human capital and linkages with other firms and research organisations (*e.g.,* Harris and Reid, 2010). Further, firm's investment in knowledge based assets would not only enhance its firm existing stock of knowledge but it would also benefit from the external stock of knowledge (Harris and Reid, 2010). Interestingly, Cohen and Levinthal (1989) stated that a related concept closely linked to intangible assets is known as absorptive capacity: this absorptive capacity referring to "firm ability to recognise, assimilate and apply scientific information for the purpose of new product development and innovation".

In addition, Zahra and George (2002) developed a conceptual model of firm's absorptive capacity. This model shows that potential (knowledge acquisition and assimilation) and realised (knowledge transformation and exploitation) absorptive capacity improves the firm's innovation performance. On the other hand, a number of researchers empirically tested whether investment in R&D increases a firm's absorptive capacity and profitability and found that R&D is important antecedent of absorptive capacity (Koch and Strotman, 2008; Leahy and Neary, 2004).

However, SMEs cannot afford to invest in R&D due to resource constraints and forming strong collaboration such intra-and inter-firm relations and university-industry linkages may improve the firms' absorptive capacity (Zahra and George, 2002).

Similarly, Schiller (2006) emphasised the role of university-industry linkages (UIL) for innovation performance of SMEs. Nonetheless, he argued that there is wide gap between the absorptive capacity of private firms and knowledge production universities. In developing countries, universities conduct less research than teaching and a low quality of human capital may affect network relationship.

The literature survey investigated proxies such as R&D, networks, HRM, human capital, knowledge management and others. However, these examples of literature were not specifically focused on the services sector (IT industry). This motivated the research question as to whether software firms have high absorptive capacity and what expected link with firm innovation performance. Supported by the literature findings, hypothesis is developed to examine the relationship between absorptive capacity and firm's innovation performance. The hypothesis is as follows:

H1*: A firm with higher absorptive capacity has a positive association to firm performance.*

Knowledge Management:

Previous studies on R&D discussed whether R&D generates new knowledge and a firm with new knowledge could enhance its innovation performance (Harris and Trainor, 1995). However, managing knowledge is always challenging for firms whether small or large and an effective way of managing knowledge increase firm performance (Sparrow, 2001). Sparrow (2001) conducted a qualitative research on knowledge management in SMEs and suggested that 'appreciation of individuals and shared understanding', 'effective knowledge base and system', 'integrated and contextualised action need for knowledge projects', and 'effective learning process' are the major components of knowledge management and these could improve the success of firms. Furthermore, a number of researchers investigated the positive relationship between knowledge management and firm's innovation performance (*e.g.,* Vanharanta and Koskinen, 2002; Gloet and Samson, 2012).

For instance, Gloet and Samson (2012) argued that knowledge management is a multidimensional construct and organisation explicit (IT related) and implicit (people driven or non-linguistic/non-numerical form) knowledge have a positive impact on the firm's innovation performance. Knowledge management includes organisation strategies, use of information technology; effective HRM practices[2],

[1] From the perspective of input resources, one of the most common indicators used to measure the firm innovation performance is firm undertaking R&D (Domingo and Borras, 2007). Similarly, Hagedoorn and Cloodt (2003) identified the indicators of firm innovation performance such as R&D undertaking, use of patent count, using of patent citation or count of new product development. In addition, Acs *et al.* (2002) also considered firm undertaking R&D as proxy of firm innovation performance. In our case, we have used firm undertaking R&D as dependent variable to measure firm innovation performance instead other indicators. In developing countries it's very hard to have data on IPRs for measuring firm innovation performance (Ghoneim, 2003).

[2] A human resource management practice enriches knowledge management through effective recruitment and selection, appraisal and reward system. Further, training and development support knowledge management. Managers should connect HR-activities to overall organisation strategies for improving organisational performance and managing knowledge effectively and efficiently (Gloet and Samson, 2012).

Employees knowledge sharing/teamwork, organisation structure (e.g., democratic), senior management support and so forth are important determinants of firm innovation performance (Gloet and Samson, 2012).
In summary, the empirical studies of Vanharanta (2002) and Gloet and Samson (2012) clearly showed that knowledge management have positive impact on the firm's innovation performance. The following hypothesis is to be tested:

H2: Knowledge management has positive impact on the firm innovation performance.

Organisational Culture, Leadership and Business Improvement Methods:

Organisational culture is an important resource for a firm's sustained competitive advantage (Zahra *et al.* 2004). Additionally, Zahra (*et al.* 2004) investigated the four dimension of organisational culture in family firms, which are i) individual (*i.e.*, individual excellence) versus ii) group orientation (*i.e.*, stress collaboration, sharing knowledge); iii) internal (*i.e.*, within firm boundaries) versus iv) external culture orientation (i.e. customers, competitors, suppliers and markets). Moreover, Zahra *et al.* (2004) stated that group and external cultural orientation encourages firm's innovative performance and entrepreneurial activities in such family firms appear to rely only on individual and internal cultural orientation. Furthermore, Nold (2012) conducted a study on 28 large US manufacturing firms. Nold (2012) investigated that organisational culture provides the link between knowledge process (*e.g.*, knowledge creation, knowledge management and organisation learning) and organisational performance (*i.e.*, price/earnings ratio). His study identified the elements of organisational culture such as i) altruism; ii) reciprocity; iii) trust; iv) openness; v) sociability; vi) motivation; and vii) commitment. In particular, the trust between management and among employees bridges the gap between knowledge processes and organisational performance (Nord, 2012). Overall, this study suggested that trust is an important factor of organisation culture, which assists the firm knowledge processes and its performance.
Nevertheless, Morris and Pavett (1992) examined a study of cross-cultural management styles (i.e. leadership, motivation, communication, decision making and controlling) between USA and Mexican firms and their impact on firm performance. They found that Mexican firms' leadership abilities are more of an 'authoritative type[3]' compared to US firms which are of a 'participative type[4]'. Their findings investigated the relationship of these two different cultures countries and found that the firm performance (labour productivity) was statistically significant to the style of management for both Mexico and USA. However, the labour productivity for USA firms was higher than for Mexican firms. This suggests that more a democratic style of leadership is an important resource for firm performance. Similarly, participative leadership encourage employees to focus on individual and organisational goals, and this make them more to work harder (Sadikoglu and Zehir, 2010). Employees feel sense of ownership when there is open communication between employees and management and this reduce their fear of job insecurity and make them more productive (Goetsch and Davis, 2006). Furthermore, Rejas *et al.* (2006) conducted a study on 126 Chilean small firms. Their study suggested that participative (*e.g.*, leader involve subordinates in decision making) and supportive leadership (*e.g.*, establishing good relations with subordinates and satisfying their needs) abilities have a positive impact on the organisational effectiveness.[5]
Furthermore, Sadikoglu and Zehir (2010) examined[6] the positive relationship between total quality management practices and firm multiple performance measures (customer & employee's satisfaction and innovative performance). Their study identified 8 factors of total quality management through extensive literature survey such as i) leadership; ii) training; iii) employee management; iv) information and analysis; v) supplier management vi) process management; vii) customer focus and; viii) continuous improvement have a positive impact on overall firm performance (Sadikoglu and Zehir, 2010). Similarly, Hoang and Igel *et al.* (2010) emphasised the importance of total quality management practices (*e.g.*, customer focus, employees' involvement, education and training) for higher firm innovation performance. The study[7] of Hoang and Igel *et al.* (2010) suggests that TQM-practices large firms have higher quality implementation programs compared to small firms due to their resource constraint. Examples from the literature clearly indicates that firm with open culture,

[3] Management tends to be more paternalistic and there is less freedom for employees. Their decision making, communication with employees is limited.

[4] Employee participation is important in decision making, and they are involved in setting organisational goals, and communications among employees are vertical direction.

[5] They measured organisational effectiveness through set of factors such as satisfaction of personnel, growth, image, and relative position of the organisation, economic, financial and budgetary situation.

[6] They used factor analysis and structural equation modelling (SEM) for 373 Turkish manufacturing firms.

[7] This study showed the relationship between implementing total quality management (TQM) and organisation characteristics (size, industry type, type of ownership, and degree of innovation). The structural equation modelling (SEM) was used to investigate the 204 Vietnamese firms; results showed that manufacturing and large firms had higher TQM abilities compared to firm from services sector.

democratic style of leadership, quality improvement programs have a significant impact on the firm's innovation performance. We proposed to draw our next hypotheses as follows:

H3: Organisational Culture, Leadership, Business Improvement Methods have a positive relationship with firm's innovation performance.

Firm Lifecycle and Strategic Resources:

Churchill and Lewis (1983) developed lifecycle stage model for SME development, resource availability and growth. This model discusses the five stages of SMEs growth; Stage I - Existence: in this stage the main problems of the business are obtaining customers and delivering the product or services. Stage II - Survival: The Company has developed and has sufficient customers, product or services. Stage III - Success: The decision facing owners at this stage whether to expand or to keep the company stable. Stage IV – Take-off: In this stage the key problems are how to grow rapidly and how to finance the growth. Stage V – Resource Maturity: challenges at this stage are, first, to consolidate after growth and second, to retain the advantages of small size, including flexibility. In addition, Jones (2009) investigated the crisis stages which are classified as 'plateaus' for SMEs growth. In other words, this model shows that firms face crisis at every stage of life-cycle which must be resolved to avoid the collapse of the business. For example, a firm at start-up stage (*i.e.*, an early stage of the firm) requires funds and cost control and pricing for their products and services to boost firm sales volume. Similarly, a firm at survival stage (*i.e.*, when a firm begin to expand) may face challenges such as hiring new professional managers, technological innovations, work-force diversity, market regulations, logistic and utility expenses and so forth. In the third stage (i.e., maturity), a firm can make substantial growth due to highly innovative products and exports: even at maturity stage firms could have a issues such as 'over ambitious investments in new technologies', 'intense competition', 'market regulations', and 'currency fluctuations' (Jones, 2009). Overall, this life-cycle model[8] suggested that SMEs passes through series of life-cycles and at every stage, SMEs have to face new challenges and crises. This model indicates that firms' managing their challenges and crises over a time effectively would likely to have higher innovative performance.

In contrast, Miles and Snow *et al* (1978) referred to the organisational strategies for maintaining effective performance. They developed a general model called 'adaptive cycle' which was based on certain strategies to provide solution to the organisational problems[9]. Their research identified three strategic types of organisations: defenders, analysers, and prospectors. The defender strategy (i.e., top management) emphasis on efficiency and cost reduction to maintain existing markets (low level of uncertainty); Analysers – focus on maintaining and growing existing markets while seeking out new markets to sustain and increase growth; Prospectors – a focus on finding and exploiting new product and market opportunities to drive growth (Miles and Snow *et al.* 1978). In addition, the fourth strategy called 'Reactor' states that some organisations do not have clear strategy with a tendency to react to market changes in lag manner (Miles and Snow *et al.* 1978). Overall, their model (i.e., adaptive cycle) suggests that organisations adjust to their environments by pursuing these strategies for better innovation performance. In summary, SMEs life-cycle stage models (*e.g.*, Jones, 2009) apparently suggest that firms are more likely to have higher innovation performance, if firms manage their crises effectively. In other words, firms with lower abilities to manage such challenges and crises would likely to have lower firm performance or simply may go out of the business. On the other hand, firm with better strategies such as defenders, analysers and prospector could improve the firm's innovation performance. The hypotheses are as follow:

H7: Firm lifecycle resources and strategic resources have a positive relationship with firm's innovative performance.

Research Methodology:

A research survey was undertaken in two stages. In the first stage, a pilot study of firms was conducted in two regions of Pakistan i.e., Islamabad (the capital of Pakistan) and Rawalpindi district. A final survey was made again during April-May, 2010. A list of 300 IT companies was provided by Pakistan Software Export Board (PSEB). However, 100 firms were excluded from the list, because the firms were not involved purely in the software business or the list did not provide the information about the firms' whereabouts. Finally, 150 firms were randomly selected from the list of 200 firms for face-to-face interviews of owner-managers using structured questionnaire. Firms were contacted through emails ad phone calls for appointment and only 69 firms responded (46%) for interviews. Of the total, 65 firms were interviewed in Islamabad and the remaining 4 in Rawalpindi. Further,

[8]In the fourth stage, firm will expand its product range; it will use sophisticated technologies and opening the new branches into emerging markets. However, the challenges and crises would remain there to affect their firm performance.

[9] These problems were categorised into entrepreneurial, engineering and administrative. The entrepreneurial problems includes such as how create a stable set of products. The engineering problems such as how to produce and distribute good or services as efficiently as possible. Lastly, administrative problem related to how to maintain strict control of the organisation in order to ensure efficiency.

8 firms refused to provide only financial information. The average times per interview took approximately 35 minutes and were held at the key informant's workplace. Stata-10 has been used for empirical analysis.

Discussion of empirical results:

In order to measure the business and management variables, initial information was collected on Likert Scale (1 = strongly agree to 5=strongly disagree); such as 'lifecycle', 'strategic focus', 'leadership', 'culture', 'business improvement methods', 'knowledge incorporation and acquisition', and 'absorptive capacity'. Firms' replies were re-coded for each question as '2 = strongly agree', '1 = agree', '0 = neutral', '-1 = disagree', '-2 = strongly disagree'. For extracting core information principal component factor analysis has been used. Principal component factor analysis reduces the number of variables and examines the structure relationship between variables. These factors are extracted based on Kaiser Criterion (Kaiser, 1960); which suggest that retain those factors with Eigen values equal or greater than one.

Table 1 provides information on the factor analysis of 'lifecycle' of the business. A number of questions were asked to each firm (n=69) related to the firm survival and expanding their business. Two factors are extracted: factor 1 connected to the firm survival problem and factor 1 linked with expansion in the business. For improved correlation between the variable and each factor, variance maximising orthogonal[10] is used. In Table A1 factor 1 & 2 shows higher factor loadings (shown in bold italic values); these factor loadings represent correlation of a variable with a factor. The first question (*i.e.*, as variable) has higher factor loading which is 0.8987; this suggest that business with a problem of obtaining customers would be likely to have more survival problems. The second statement with factor loading -0.8830 implies that businesses with sufficient customers and their higher customer satisfaction would be less likely to have survival problems. Similarly, the last three questions are positively related to factor 2 (expanding the business). Additionally, the column labelled as 'uniqueness' measures the variance of variable that is not connected with other variables in the factor model. This is with first variable which has uniqueness value og 0.1716; and states that the variable is not shared by 17.61% with other variables in the factor model. In order to test the appropriateness of factor model the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is 0.4948. Similarly, we have obtained factors for variables such as 'strategic focus', 'leadership', 'organisational culture', 'business improvement methods' and so forth (See Tables from A1 to A7).

Furthermore, Table 8 shows the factor analysis of firm absorptive capacity. Six principal component factors (with Eigen value equal or greater than one) are retained and these are labelled as 'sharing knowledge', 'job knowledge', 'internal knowledge', 'external knowledge', 'linkages', and 'innovation'. For a better correlation between these variables and factors, variance maximising orthogonal rotation is used. Factor 1 (positive correlation with sharing knowledge) implies that managing employees, knowledge incorporation and management role could improve the firm's knowledge sharing across the organisation. In summary, each question of absorptive capacity shows positive correlation with factors (shown in bold italics). To test the factor model appropriateness, KMO measure of sampling adequacy is 0.5146. In summary, we observed lower KMO test values (less than 0.8) for most of the factor models, which suggests that few observations (n=69) might one of the reasons for weak factor models (see Table A8).

Regression Analysis:

This subsection introduces stepwise probit model[11] using maximum likelihood function. This maximum likelihood method presents the estimate values that maximise the likelihood, of observing the outcomes. In addition, the stepwise approach includes only significant results (probability values) in the mode choosing $P-values \leq 0.15$ and ignoring insignificant results when $P-values \geq 0.2$. Table A9 provides information on the list of variables used in the regression model, their definitions, means standard deviations (*i.e.*, measure of dispersion) (See Table A9).

Before estimation the correlation matrix is used to present the correlation between two variables and indicates that any variable that is perfectly correlated with itself (see Table 10). The correlation matrix is used to examine the problem of multicollineairty. Multicollineairty arises when some or all of the explanatory variables are highly correlated with each other and it is hard to tell which variable is influencing the explained variable. Overall, three variables showed multicollnearity and this will be considered for analysis. However, in the majority of cases correlation between variables are lower than 0.5 and this suggest that multicollinearity is not an issue (see Table A10).

Stepwise probit estimation is used to investigate the relationship between business and management

[10] Which minimised the variance around the new variables (new factor), and increases the variability of new factor. This means that factors are uncorrelated with each other.

[11] Firm undertaking R&D has been used as dependent variable to measure firm innovation performance. However, in this survey only few firms (n=14) undertook R&D, which suggest that firms are externally constrained to invest on research and development. Further, the survey data shows that approximately 12% of firms sought finance in the past three years.

factors and firm's innovation performance. The estimates values and marginal effects are presented in Table 1. The robust standard error method is used to eliminate the hetroskedasticity. In addition, three variables of absorptive capacity are dropped (*i.e.* internal knowledge, external knowledge and employee's knowledge) due to higher correlation with other explanatory variables. The model provides high *P-values* or insignificant coefficients if the regression model keeps these three variables causing multicollinearity. Of the 61 observations, the *Pseudo* R-squared showed that nearly 37% variation in firm innovation performance is explained by the model. Furthermore, the link-test is used to see whether the model is adequately satisfied without omitted variable bias. The variable prediction hat-square apparently indicates that the model is correctly specified (See Table 1).

The model shows the positive relationship between firm's size and firm innovation performance (*i.e.*, undertaking R&D) (See Table 1). This implies that large firms are more likely to undertake R&D and are more innovative than small firms. This finding supported the argument of Freel (2000), which says that small firms face resource constraint. Additionally, in the last column the marginal effect for firm size is 0.087; which means 100% increase in the firm size the firm innovation performance is increase by 8.7%. In addition, firm strategic focus has a significant impact on the firm's innovation performance. The marginal effect for firm strategic focus (new ideas) is 0.1664; which means 100% rise in the firm strategic focus the firm innovation performance increase by nearly 17%. This outcome implies that firms with new ideas (*e.g.*, by searching new markets) would likely to have higher innovation performance and supported the literature finding of Miles and Snow *et al.* (1978). Furthermore, firms with open culture (*e.g.*, clear organisational structure, roles and responsibilities), internal and external knowledge incorporation have a positive impact on the firm's innovation performance. These finding supported the literature findings of Zahra *et al.* (2004) and Gloet and Samson (2012) that culture and knowledge management have a significant impact on the firm innovation performance. Their marginal effects are presented in the Table 1. For instance, the marginal effect of knowledge incorporation is 0.1273; which means 100% increase in the firm internal knowledge sources (see Table A6) the innovation performance would likely to rise by approximately 13%.

In comparison, the negative relationship between lifecycle (*i.e.*, expand) and firm innovative performance rejected our prior hypothesis. This suggests that these small software firms are facing problems (e.g., how to finance growth, lower profits) in terms of expanding their businesses. In other words, this outcome supported the argument of Jones (2009) that when a firm start to expand may face challenges such as innovation output, hiring skilled employees and so forth. The marginal effect for firm lifecycle is -0.0730; which means a 100% rise in the business expansion problem and firm innovation performance would likely to reduce by nearly 7%. In addition, the negative relationship between firm leadership abilities (*i.e.*, motivation) and innovation performance has rejected the prior expectation. This outcome implies that the lack of motivation among employees towards creative ideas, innovative tasks reduce the innovation performance of these software firms. Lastly, the model shows the negative between absorptive capacity and firm's innovation performance; rejected our prior expectation. This suggests that few firms are engaged in R&D, poor university-industry linkages, shortage of skills may reduce the absorptive capacity of these software firms. Alternative, this outcome implies that low investment in knowledge-based assets reduce the innovation performance of these firms.

Table 1: Business and management factors relating to firm innovation performance using stepwise Probit model

Firm undertaking R&D (as dependent) Coefficients	*Z*-value	$\partial x / \partial y$ [1]	
Size	0.6332*** (0.2218)	2.85	0.0847
Lifecycle (expand)	-0.5458** (0.2783)	-1.96	-0.0730
Strategic Focus (new ideas)	1.2433*** (0.3090)	4.02	0.1664
Leadership (motivation)	-0.4089* (0.2358)	-1.73	-0.0570
Organisational Culture (openness)	0.5112* (0.2887)	1.77	0.0684
Knowledge Incorporation-1	0.6590* (0.3428)	1.92	0.0882
Knowledge Incorporation-2	0.9515*** (0.3532)	2.69	0.1273
Absorptive Capacity (sharing knowledge)	-0.6140* (0.3680)	-1.67	-0.0821
Absorptive Capacity (innovation)	0.4265 (0.2869)	1.49	0.0570
Constant	-3.5880*** (0.8955)	-4.1	-
Pseudo R^2 = 0.3718			
Model Specification *Predict-hat*	1.1293***	3.13	
Predict-hat square	0.1062	0.79	

Robust standard errors are in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.
[1]shows marginal effects after probit

Conclusion and policy implications:

This study was based on empirical analysis of small software firms by analysing the business and management factors of firm innovation performance. The probit model found that firm size, strategic focus, organisation culture, knowledge management has a positive impact on the firm's innovation performance. On the other hand, firm lifecycle, leadership abilities, absorptive capacity showed negative impact on the firm's innovation performance. This implied that these software firms had poor abilities to internalise external knowledge. Alternatively, this outcome suggest that these software require more investment in knowledge-based assets (R&D, networks, skills) for higher firm innovation performance. In summary, policy makers should give more attention to investment in knowledge-based assets both at micro and macro level.

Limitations and future research work:

Few observations (n=69) result in lower factor model appropriateness and low variation in dependent variable (firm undertaking R&D) showed moderate goodness-of-fit. This apparently suggests that larger data survey could be extended to other parts (*e.g.* Karachi, Lahore) of the country for better analysis. The non-availability of data on patent counts/IPRs could be used for measuring firm innovation performance instead firm undertaking R&D.

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Table A1: Factor analysis of firm's lifecycle

	Factor-1 Survival	Factor-2 Expand	Uniqueness	KMO[1]
The main problem of the business are obtaining customers and delivering the products and services	**0.8987**	0.1440	0.1716	0.5019
The company has developed sufficient customers and satisfy them sufficiently with its products and services	**-0.8830**	0.0582	0.2169	0.1538
The decision facing owners at this stage is whether to expand or keep the firm stable, profitable, providing a base for alternative owner activities	-0.1332	**0.8436**	0.2706	0.4640
The key problems facing business how to grow rapidly and how to finance growth	0.3478	**0.4677**	0.6603	0.4837
Challenges are to consolidate and control financial gains brought on by rapid growth, and retain the advantage of small size, including flexibility	0.0860	**0.6780**	0.5330	0.4604

[1]Overall Kaiser-Meyer-Olkin (KMO) measuring of sampling adequacy is **0.4948**

Table A2: Factor analysis of firm strategic focus

	Factor-1 New Ideas	Uniqueness	KM0[1]
The company has a narrow range of products and markets	**-0.5233**	0.7262	0.5993
The company continually searches for new markets opportunities	**0.5264**	0.7229	0.6348
Company watch their competitors closely for new ideas, and then rapidly adopt those which appear to be the most promising	**0.7579**	0.4256	0.5614
Organisation makes changes until forces to do so by environmental pressures	**-0.6006**	0.6393	0.5966

[1] Overall Kaiser-Meyer-Olkin (KMO) measuring of sampling adequacy is **0.5871**

Table A3: Factor analysis of firm leadership abilities

	Factor-1 Creativity	Factor-2 Motivation	Uniqueness	KMO[1]
The senior management team make a point 'being seen' around the organisation	-0.1263	**0.5830**	0.6442	0.5113
Management foster creative thinking and innovation in the company	**0.5643**	0.1189	0.6674	0.5213
Our top management like to try new ways of doing things	**0.7332**	0.0767	0.4566	0.5116
Management spend adequate time planning change	**0.6187**	0.0573	0.6139	0.6147
If the company is performing well, change is still priority	**0.7623**	-0.0212	0.4185	0.5592
The organisation is working to a clear business plans	0.3511	**0.4960**	0.6307	0.5141
Management encourages everyone in the organisation to come up with new ideas	0.0136	**0.8351**	0.3025	0.4388
The management team take time to think constructively/creatively about the future	0.3402	**0.5550**	0.5762	0.5350

[1] Overall Kaiser-Meyer-Olkin (KMO) measuring of sampling adequacy is **0.5146**

Table A4: Factor analysis of organisational culture

	Factor-1 Openness	Factor-2 Change	Uniqueness	KMO[1]
There is strong team spirit at all levels of the organisation	0.4902	**0.6240**	0.3704	0.8106
The culture in this organisation promote change	-0.0141	**0.7539**	0.4315	0.5165
Two way communication happens at levels of the organisation	**0.5079**	0.4974	0.4946	0.6801
There is clear organisational structure which everyone understands	**0.6396**	0.0745	0.5854	0.7088
There are clearly defined roles and responsibilities	**0.6352**	0.0781	0.5904	0.7392
The structure of the organisation facilitates change	0.1486	**0.7886**	0.3560	0.4916
The organisation is not bureaucratic	**0.5839**	0.2130	0.2130	0.7393
There is feeling of openness in the organisation	**0.6918**	0.2146	0.2146	0.6220
Overall, employees have access to all resources to get the job done	**0.6515**	0.0864	0.0864	0.7289
Employees are involved in setting and agreeing performance targets	**0.5848**	-0.1424	-0.1424	0.6752
Everyone in the company has a good grasp of how the organisation is performing	**0.5894**	-0.0161	-0.0161	0.6625
Employees get useful feedback about their work	**0.4881**	0.4615	0.4615	0.7251

[1] Overall Kaiser-Meyer-Olkin (KMO) measuring of sampling adequacy is **0.6846**

Table A5: Factor analysis of business improvement methods

	Factor-1 Total Quality	Uniqueness	KMO[1]
The organisation has formal/informal total quality continuous program	***0.7645***	0.4155	0.9149
Responsibilities for the TQ/CI programme are clearly defined	***0.8727***	0.2384	0.9014
Successful TQ/CI problem solving teams are spread throughout the organisation	***0.9108***	0.1704	0.8562
The program is adequately resourced	***0.8875***	0.2124	0.9116
There is clearly defined reward and recognition scheme for TQ/CI team	***0.8075***	0.3480	0.9305
Greater than 50% workforce are involved in TQ/CI processes	***0.6403***	0.5900	0.8576
TQ/CI program is used to improve processes	***0.7730***	0.4025	0.9108
The TQ/CI program has clear goals. Objectives and measure of success	***0.8904***	0.2072	0.8757
A number of quality improvement have been achieved through this program	***0.8758***	0.2330	0.9002

[1] Overall Kaiser-Meyer-Olkin (KMO) measuring of sampling adequacy is **0.8947**

Table A6: Factor analysis of knowledge incorporation

	Factor-1 Knowledge-Incorp-1	Factor-2 Knowledge-Incorp-2	uniqueness	KMO[1]
Everyone is in possession of the information/knowledge necessary to do their job	-0.1816	**0.8802**	0.1922	0.4609
Knowledge that employees hold in their heads (i.e., tacit knowledge) is managed and captured effectively	0.4141	**0.7434**	0.2759	0.6792
Efforts are made to share information/knowledge across the organisation	**0.6464**	0.3658	0.4483	0.7864
Lessons learn from daily experiences and projects are captured and disseminated	**0.7125**	-0.1088	0.4806	0.6935
New information/knowledge is effectively incorporated within the process and routines within the organisation	**0.8534**	-0.0306	0.2708	0.6763
Active management of information/knowledge produces a range of business benefits	**0.6367**	0.3356	0.4821	0.6940

[1] Overall Kaiser-Meyer-Olkin (KMO) measuring of sampling adequacy is **0.6780**

Table A7: Factor analysis of knowledge acquisition

	Factor-1 Knowledge-acq1	Factor-2 Knowledge-acq2	Uniqueness	KMO[1]
We conduct frequent market research so that we are aware of customer needs	**0.6378**	0.2213	0.5442	0.5890
Licensing is a method we often use to obtain information/knowledge or technology	**0.6428**	0.2134	0.5143	0.5809
We have developed new products/services in collaboration with other firms	0.3629	**0.8672**	0.8672	0.4584
We are well aware of the information/technology being developed by our competitors	**0.7138**	0.4218	0.4218	0.4886
We have become and information/technology supplier to other firms in this sector	0.3755	**0.7709**	0.7709	0.4905
We usually go to outside private sector bodies (*e.g.*, consultants) to find fresh opportunities for finding new products/services	0.1588	**0.7552**	0.4045	0.5631
We usually go to outside public sector bodies (*e.g.*, Universities) to find fresh opportunities for finding new products/services	-0.0959	**0.8300**	0.3019	0.5092

[1] Overall Kaiser-Meyer-Olkin (KMO) measuring of sampling adequacy is **0.5349**

Table A8: Factor analysis of firm's absorptive capacity

	Factor-1 Sharing Knowledge	Factor-2 Employees knowledge	Factor-3 Internal Knowledge	Factor-4 External knowledge	Factor-5 Linkages	Factor -6 Innova tion	Uniquen ess	KMO [1]
Everyone is in possession of the information/knowledge necessary to do their job	0.0817	**0.8508**	-0.1215	0.0602	0.0501	0.0069	0.2485	0.4986
Knowledge that employees hold in their heads (tacit knowledge) is managed and captured effectively	**0.6196**	0.5530	0.1604	0.1435	-0.0601	0.0251	0.2597	0.6356
Efforts are made to share information/knowledge across the organisation	0.2983	0.3139	**0.5968**	0.1617	-0.1195	0.3962	0.2589	0.6523
Lessons learn from daily experiences and projects are captured and disseminated	0.1108	-0.0824	**0.8810**	0.0056	0.0957	-0.1187	0.1815	0.6085
New information/knowledge is effectively incorporated within the process and routines within the organisation	**0.5967**	-0.2301	**0.5483**	0.0858	-0.0117	0.1001	0.2722	0.6008
Active management of information/knowledge produces a range of business benefits	**0.8666**	0.0902	0.1279	-0.1021	0.1412	0.0596	0.1906	0.5676
We conduct frequent market research so that we are aware of customer needs	-0.1275	0.3892	0.1571	**0.6530**	0.1534	0.0698	0.3527	0.6200
Licensing is a method we often use to obtain information/knowledge or technology	0.0857	0.0551	-0.0154	**0.7959**	0.1503	-0.1006	0.3232	0.6315
We have developed new products/services in collaboration with other firms	-0.3426	0.3990	0.2164	-0.0234	-0.0516	**0.6131**	0.2975	0.4999
We are well aware of the information/technology being developed by our competitors	-0.0231	-0.2704	0.0249	**0.6339**	-0.0324	0.3350	0.3063	0.4104
We have become and information/technology supplier to other firms in this sector	0.2594	-0.1257	-0.1267	0.0548	0.1904	**0.8320**	0.1693	0.4078
We usually go to outside private sector bodies (*e.g.*, consultants) to find fresh opportunities for finding new products/services	0.0621	-0.2534	-0.2313	0.2675	**0.7481**	0.1026	0.2366	0.3793
We usually go to outside public sector bodies (*e.g.*, Universities) to find fresh opportunities for finding new products/services	0.0196	0.2217	0.1924	-0.0483	**0.8219**	0.0432	0.2338	0.5127

[1] Overall Kaiser-Meyer-Olkin (KMO) measuring of sampling adequacy is **0.5146**

Table A9: List of variables and their definitions

Variables	Definitions	σ_1	$\overline{X}_1$
R&D	Dummy coded 1 if firm undertook R&D	0.202	0.405
Size	Logged of size	3.357	1.135
Labour Productivity	Log (sales/employees) in 2009	9.204	0.204
Survival	Factor 1 from Table A1 measuring lifecycle of the business	0.000	1.00
Expand	Factor 2 from Table A1 measuring lifecycle of the business	-0.000	1.00
New Ideas	Factor 1 from Table A2 measuring strategic focus of the business	-0.000	1.00
Creativity	Factor 1 from Table A3 measuring firm leadership abilities	0.000	1.00
Motivation	Factor 2 from Table A3 measuring firm leadership abilities	0.000	1.00
Openness	Factor 1 from Table A4 measuring firm culture	-0.000	1.00
Change	Factor 2 from Table A4 measuring firm culture	-0.000	1.00
Qualities	Factor 1 from Table A5 measuring business improvement methods	-0.000	1.00
Knowledge-Incorp1	Factor 1 from Table A6 measuring knowledge incorporation	0.000	1.00
Knowledge-Incorp2	Factor 2 from Table A6 measuring knowledge incorporation	-0.000	1.00
Knowledge-Acq1	Factor 1 from Table A7 measuring knowledge acquisition	-0.000	1.00
Knowledge-Acq2	Factor 2 from Table A7 measuring knowledge acquisition	0.000	1.00
Sharing knowledge	Factor 1 from Table A8 measuring firm absorptive capacity	0.000	1.00
Employees Knowledge	Factor 2 from Table A8 measuring firm absorptive capacity	0.000	1.00
Internal Knowledge	Factor 3 from Table A8 measuring firm absorptive capacity	0.000	1.00
External Knowledge	Factor 4 from Table A8 measuring firm absorptive capacity	-0.000	1.00
Linkages	Factor 5 from Table A8 measuring firm absorptive capacity	0.000	1.00
Innovation	Factor 6 from Table A8 measuring firm absorptive capacity	0.000	1.00

[1]Represent standard deviation and mean of each variable

Table A10: Correlation matrix of all variables used in the model

		1	2	3	4	5	6	7	8	9	10	11	12
1	RD	1.0											
2	Size	0.1	1.0										
3	Survival	-0.3	0.2	1.0									
4	Expand	-0.1	0.1	0.0	1.0								
5	New Ideas	0.3	0.2	-0.3	0.2	1.0							
6	Creativity	0.1	0.0	-0.1	0.2	0.3	1.0						
7	Motivation	-0.2	0.2	0.1	0.0	0.0	0.1	1.0					
8	Openness	0.0	-0.	-0.1	0.1	0.1	0.0	0.5	1.0				
9	Change	0.2	0.1	-0.2	0.2	0.1	0.6	0.2	0.0	1.0			
10	Qualities	0.1	0.2	0.0	0.1	0.2	0.2	0.0	0.1	0.3	1.0		
11	Knowledge-incorp.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.4	1.0	
12	Knowledge-incorp.2	0.2	0.2	0.0	0.2	0.2	0.2	0.1	0.1	0.2	0.3	0.0	1.0
13	Knowledge-acqui.1	0.4	0.1	-0.1	0.1	0.2	0.0	0.2	0.1	-0.1	0.3	0.1	0.2
14	Knowledge-acqui.2	0.1	0.2	-0.2	0.0	0.1	0.2	0.2	0.3	0.2	0.1	0.1	0.1
15	Sharing-knowledge	0.0	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.1	0.2	0.6	0.4
16	Employee-knowledge	0.3	0.1	-0.2	0.1	0.3	0.0	0.1	0.0	-0.1	0.2	0.0	0.1
17	Internal-knowledge	0.2	0.2	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.2	**0.9**
18	External-knowledge	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.3	**0.8**	-0.2
19	Linkages	0.1	0.2	-0.2	0.0	0.1	0.1	0.2	0.3	0.1	0.1	0.0	0.0
20	Innovation	0.2	0.2	0.1	0.0	0.1	0.0	0.1	0.2	0.1	0.2	0.2	0.1
21	Labour productivity	0.0	0.1	0.0	0.1	0.1	0.3	0.1	0.1	-0.2	0.1	0.0	-0.1

"Knowledge incorp = knowledge incorporation; knowledge-acqui = knowledge acquisition"													
		13	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**			
13	Knowledge-acqui.1	1											
14	Knowledge-acqui.2	0.0	1.0										
15	Sharing knowledge	0.0	0.1	1.0									
16	Employees knowledge	**0.9**	0.1	0.0	1.0								
17	Internal-knowledge	0.1	0.1	0.0	0.0	1.0							
18	External-knowledge	0.0	0.0	0.0	0.0	0.1	1.0						
19	Linkages	-0.1	1.0	0.0	0.0	0.0	0.0	1.0					
20	Innovation	0.5	0.1	0.0	0.0	0.0	0.1	0.0	1.0				
21	Labour productivity	0.1	0.0	-0.2	0.1	0.0	0.1	0.0	0.0	1.0			

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