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# Intellectual Capital, Innovation and Firm Performance of Pharmaceuticals: A Study of the London Stock Exchange

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**Abstract.** The objective of this study is to explore the empirical structural links among intellectual capital (IC), innovation and firm's financial performance, furthermore, the impact of IC and innovation on firm's financial performance has also been measured. Value added intellectual coefficient model (VAIC) has been used for the measurement of IC. Innovation is measured through research and development (R&D), products development and products in pipeline, whereas, financial performance is measured through traditional financial measures such as return on assets (ROA), return on equity (ROE), earnings per share (EPS), assets turnover ratio (ATO) and market-to-book ratio (MB). The study was based on secondary data, and it has been collected from the published annual reports of listed pharmaceutical firms in London Stock Exchange. The research was carried for the three year period of 2012–2014 and our sample consists of 207 firm-year observations. Structural Equation Modelling (SEM) technique is used to address cause–effect relationships among endogenous and exogenous constructs. Empirical results of SEM analysis support that IC and its components have positive and significant impact on innovation and firms' financial performance. Moreover, innovation also has significant impact on firms' financial performance. The study is valuable for the manager, decision makers and policy makers to recognise the value of IC and its philosophy to obtain and sustain competitive advantage through innovation.

*Keywords*: Intellectual capital; innovation; financial performance; pharmaceutical; research and development; structural equation modelling; partial least square; London stock exchange.

## 1. Introduction

In the modern era of technology, businesses have to compete globally for which intellectual capital (IC) is recognised as a key source of competitive advantage due to the fact that financial capital is not only a sufficient tool for strategic growth and sustainable competitive advantage of a company (Drucker, 1993; Kianto *et al.*, 2010; Sveiby, 1997). In today's knowledge economy, IC is considered as the most important strategic intangible asset to achieve superior performance (Serenko *et al.*, 2010). It is observed that the market value of the knowledge intensive industries is higher

than their book value (Dumay, 2009). This overvaluation is the result of the IC, which is not reflected in the financial profitability reports. The stakeholders of the company use simple and traditional evaluation methods of financial statements which may not be sufficient, as it might show only accountant angle towards firm performance. Conventional or traditional methods of evaluating financial statements are not exclusively adequate to measure the performance of knowledge intensive firms (Bontis, 2001; Edvinsson and Malone, 1997). However, IC forms an important part of firm's assets which replaced the conventional production factors to become strategically important to create value. Moreover, there is an extensive acknowledgement that IC is a powerful tool to obtain and sustain economic growth in the era of globalised competition (Bontis *et al.*, 2005).

In intensifying global and knowledge economy, innovation becomes most important factor for sustainable business growth. IC is a key driver of innovation, strategic renewal, growth and firm performance, at both micro-economic and macro-economic levels (Bontis, 1999; Webster, 2000). Innovative firms use IC efficiency to develop both product and process innovation. Furthermore, innovation in the marketing activities is also a result of IC. It is also known as knowledge intensive resource, and the competitive businesses put more resources on innovation through research and development (R&D) activities. In addition to the fact that previous studies suggest that innovation is fundamental for the future development, numerous nations have characterised the development strategies in which one of the priorities has been transformation of economy into an innovation-driven one. This transformation is mainly based on productivity and utilisation of IC.

Twenty-first century is the era of knowledge in which production-based economy has been transformed into knowledge-based economy. In the knowledge-based economy, the role and importance of high technology industries is highly recognised because almost all activities rely on knowledge and it has become the most important strategic economic resource. Among the high technology industries, pharmaceutical sector is one of the most important knowledge intensive segments and has a great source of IC because it has high human intervention and innovative technology (Daum, 2005). Pharmaceutical firms are consistent in making more investment to protect their intellectual property rights and enhance R&D activities (Wang *et al.*, 2011). Along with that, pharmaceutical sector is rich in IC, highly innovative and has a great ability to face global completion due to high regulatory environment and enhanced involvement of human experts in R&D activities which leads to generation of new drugs, molecules and patents. Considering all these factors, pharmaceutical industry is an ideal project to evaluate the relation among the IC, innovation and firm performance. Pharmaceutical sector is preferred for the study due to its extensive dependency on IC as a key source of innovation and business performance (Mehralian *et al.*, 2012).

In spite of the fact that IC is a strategic resource that increases the performance and creates value, there is still problem with measuring, managing and controlling of IC in an organisation. It is not easily available in the financial reports of a business. In response to the need for the IC measurement, several methods have been developed by

different scholars such as Skandia IC Report Method (Edvinsson and Malone, 1997), Value Added Intellectual Coefficient (VAIC) Model (Pulic, 1998, 2000, 2004), and Intangible Asset Monitor Approach (Sveiby, 1997). Pulic's VAIC method of IC measurement is extensively used by academics and practitioners because it has less criticism and data easily available from the audited published annual reports. Moreover, it affords a standardised and unified measure, which allows a researcher to make comparison analysis of different organisations (Young *et al.*, 2009; Zéghal and Maaloul, 2010). In the literature, there are many research articles that analyse the relationship of IC efficiency and firm performance by using VAIC (Amin *et al.*, 2014; Chen *et al.*, 2005; Clarke *et al.*, 2011; Ghosh and Mondal, 2009; Kamath, 2008; Vishnu and Gupta, 2013). In this study also, VAIC is used to examine the IC efficiency.

Zambon and Monciardini (2015) found that complexities exist in the relationship between IC and innovation and still it is an open research question. Many studies try to explore the impact of intangibles on technological and non-technological innovation, but no proper conclusion has been drawn. The research agenda of IC ought to move from its measurment and reporting to the investigation of how IC contributes towards achieving superior value creation. Nowadays, it is important to link the IC with the innovation and value creation process through IC-driven innovation (Zambon and Monciardini, 2015). Extensive literature is available regarding both concepts (IC and innovation) separately, and the effects of IC or intangibles on innovation and firms' performance. However, in the literature there is no unified conceptual framework available for the combination of IC, innovation and firms' performance. In the context of above stated backgroud, the objective of the current study is to explore the structural links among IC, innovation and firms' financial performance of pharmaceutical firms listed in London Stock Exchange.

This study would be able to address the following research questions:-

"How the IC efficiency links with innovation and firms' performance? How the innovation links with firms' performance? How companies use IC efficiency and innovation to sustain superior business performance?"

## 2. Literature Review and Hypotheses Development

According to resource-based view (RBV), internal resources and capabilities are more important than the external resources because internal resources are valuable, unique, rare, hard to imitate and not substitutable (Barney, 1991). Business organisations use internal resources and capabilities to obtain and sustain competitive advantage. As per the knowledge-based view (KBV), competitive advantage and superior business performance of a firm depends upon knowledge capabilities and knowledge resources (Bontis, 1998; Chen *et al.*, 2004). IC is different from the tangible assets and financial capital such as land, building. Moreover, tangible assets are available easily, thus every firm can obtain it through purchasing. But on the other hand IC is a unique knowledge-based strategic asset that cannot be traded.

IC is a broader concept of the knowledge-based economy but still no consensus has been developed about its definition (Bhartesh and Bandyopadhyay, 2005). IC is something that cannot be visible but can have great contribution towards superior financial performance (Edvinsson and Malone, 1997). Therefore, IC is the sum of all knowledge resources or set of intangibles that a firm uses to conduct business and to enhance its business value (Nahapiet and Ghoshal, 1998; Ross and Roos, 1997; Subramaniam and Youndt, 2005). Literature provides different classifications of IC but the consensus is that IC has three components: Human Capital, Relational Capital and Structural Capital (Bontis, 1999; Curado, 2008; Martín-de-Castro *et al.*, 2011; Subramaniam and Youndt, 2005; Sveiby, 1997). Human capital is sum of employees experience, skills, capabilities, knowledge, attitudes, morals and creativity (Bontis *et al.*, 2000). According to the Bontis (1999), human capital is an important source of strategic renewal and innovation. The human capital theory (Becker, 1962) concludes that generation of new ideas and techniques are the function of employees knowledge and abilities. Relational capital refers to the knowledge rooted in external relationships. It includes the relations with customers, suppliers, competitors, governments, market channels and industrial networks (Bontis, 1999; Bontis *et al.*, 2000; Wang and Chang, 2005). In the modern knowledge economy, relational capital is the most powerful dimension of IC to generate value (Edvinsson, 2013). Lastly, structural capital is related to the internal resources that remain in the company when employees go back to their homes (Ross and Roos, 1997). It consists of the organisational infrastructures, processes, procedures, manuals and databases. Furthermore, it also includes the innovative capital such as software, patents, copyrights and trademarks (Tayles *et al.*, 2007). Superior business performance can be achieved by the combination of all these three components of IC (explained above) (Giuliani, 2013).

In the literature, there is no unified consensus about the definition of innovation, it has different meanings and interpretations in different areas (Ordaz *et al.*, 2005; Pandit *et al.*, 2011). Innovation is process that identifies opportunities to create new products or services (Subramaniam and Youndt, 2005). More specifically, innovation is a process to adopt new ideas for the new product development or process innovation. In the 21st century, the velocity and quality of innovation is used to sustain growth and to generate competitive position, hence, knowledge resources are required to generate innovation for the better firm performance (Han, 2001). The victory of a business is the function of quality of knowledge that is available in an organisation for the development of products and services. RBV states that innovative capabilities are critical for a firm to achieve strategic competitiveness (Conner, 1991) and innovation supports a firm to offer larger quantity of differentiated, rare and inimitable products that leads to higher business value (Barney, 1991).

According to the growth theory of a firm, higher investment in innovation activities and R&D leads to obtainment of competitive advantage and superior business value (Penrose, 1995). Investment in intangibles have positive and direct link with the innovation and firm performance (Chauvin and Hirschey, 1993; Goyal, 2012; Hirschey, 1982). Pandit *et al.* (2011) explored the impact of innovation on the

future operating performance by using the R&D as a proxy of input innovation and patent citations as a proxy of output innovation and concluded that positive relationship exists between the innovation and future performance.

IC has a greater influence on a firm's innovation (Carmona *et al.*, 2010; Subramaniam and Youndt, 2005; Wang and Chen, 2013). Specifically, structural capital, the component of IC is a key factor for the higher level of innovation. Moreover, IC also has a significant and positive impact on firm's financial performance (Amin *et al.*, 2014; Han and Li, 2015; Komnenic and Pokrajcic, 2012; Mehralian *et al.*, 2012). Pharmaceutical industry is a knowledge intensive industry, it has greater IC efficiency which leads to greater business performance and higher level of innovation. Previous IC related studies on pharmaceuticals conclude that IC is a key source of firm performance and competitive advantage (Kamath, 2008; Mehralian *et al.*, 2012; Pal and Soriya, 2012; Sharabati *et al.*, 2010; Vishnu and Gupta, 2013; Xinyu, 2014).

This is a unique study because as per the known literature, no prior study has been conducted to examine the unified structural links among IC, innovation and firm's financial performance. In this background, the following research hypotheses have been developed:

$H_1$: IC has direct and positive effect on innovation.
$H_2$: IC has direct and positive effect on firm's financial performance.
$H_3$: Innovation has direct and positive link with the firm's financial performance.
$H_4$: IC and Innovation, jointly, have positive and significant impact on firm's financial performance.

## 3. Development of Research Model

From the literature review, we conclude that a firm rich in IC efficiency has greater ability to adopt innovation and achieve superior performance. Innovation also plays a vital role to achieve superior performance and to obtain the competitive advantage. On the basis of above stated fact, the following research model has been developed to test the hypothesis.

### 3.1. *Measurement model*

On the basis of Fig. 1, we develop following equations of measurement model.

$$\eta_1 = \gamma_1 \mathbf{X}_1 + \gamma_2 \mathbf{X}_2 + \gamma_3 \mathbf{X}_3 + \zeta$$
$$\eta_2 = \gamma_4 \mathbf{X}_4 + \gamma_5 \mathbf{X}_5 + \gamma_6 \mathbf{X}_6 + \gamma_7 \mathbf{X}_7 + \gamma_8 \mathbf{X}_8 + \zeta$$
$$\eta_3 = \gamma_9 \mathbf{X}_9 + \gamma_{10} \mathbf{X}_{10} + \gamma_{11} \mathbf{X}_{11} + \gamma_{12} \mathbf{X}_{12} + \gamma_{13} \mathbf{X}_{13} + \zeta$$

### 3.2. *Structural model*

To examine the hypotheses of the study, we develop following mathematical equations on the basis of the Fig. 1:

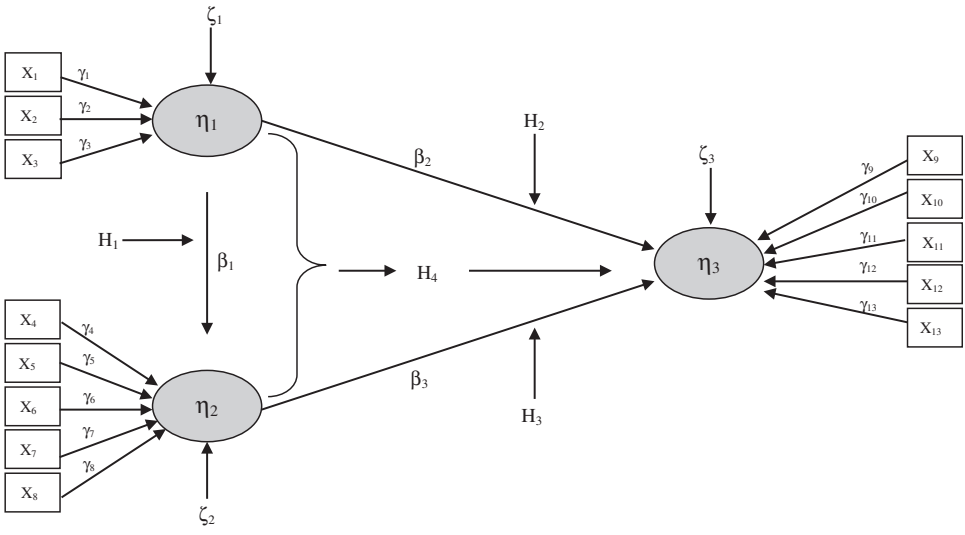


Fig. 1. Measurement and structural model of IC, INV and FP.

Our first hypothesis is to measure the impact of IC on INV.

$$\boldsymbol{\eta_2} = \boldsymbol{\beta_1}\boldsymbol{\eta_1} + \boldsymbol{\zeta}. \tag{H$_1$}$$

Second hypothesis to measure the impact of IC on FP

$$\boldsymbol{\eta_3} = \boldsymbol{\beta_2}\boldsymbol{\eta_1} + \boldsymbol{\zeta}. \tag{H$_2$}$$

Third hypothesis measure is related to INV and FP

$$\boldsymbol{\eta_3} = \boldsymbol{\beta_3}\boldsymbol{\eta_2} + \boldsymbol{\zeta}. \tag{H$_3$}$$

The fourth hypothesis of the study measures the joint effect of IC and INV on FP

$$\boldsymbol{\eta_3} = \boldsymbol{\beta_3}\boldsymbol{\eta_2} + = \boldsymbol{\beta_3}\boldsymbol{\eta_2} + \boldsymbol{\zeta}. \tag{H$_4$}$$

## 4. Research Methodology

### 4.1. *Sample and source of the data*

The objective of this study is to explore the structural links among IC, innovation and financial performance of listed pharmaceutical sector of London Stock Exchange. London Stock Exchange is the third largest stock exchange of the world having marketing capitalisation more than £4,335,385 million of more than 2,400 listed companies that consists of 48 main sectors, 115 subsectors. Sixty-nine companies are listed under the head of pharmaceutical and biotechnology sectors and

we selected all these companies for this study due to several reasons. Firstly, pharmaceutical firms are rich in human capital due to skilled manpower and huge investment in training and development of the staff (Kamath, 2008). Secondly, this sector is more innovative as compared to other high technology sectors because the core activities of the pharmaceutical sector are to develop new drugs or significantly improve the existing products. Thirdly, greater investment in R&D improves structural capital and innovation. Finally, pharmaceuticals are rich in IC; possess greater innovation and deliver significant contribution in UK's economy and the population as a whole due to their rapid growth.

The study is based on positivist research paradigm. It explains the idealistic outline of the subject being contemplated and connotations for research design and methodology of the study (Johnson and Onwuegbuzie, 2004; Wahyuni, 2012). According to Crossan (2003) positivist approach is being used to deduct inferences, for hypotheses testing and to investigate causal relationships of quantitative data. As per this research paradigm, quantitative data of IC, innovation and firm performance has been collected from the published annual reports of listed pharmaceutical companies of London Stock Exchange. The annual reports are publically available on the company's websites and missing reports were collected through email communication. The research was carried for the three year period of 2012–2014 and our sample consists of 207 firm-year observations.



## 5. Measurement of Variables

### 5.1. *Measurement of IC*

There are several methods to measure the IC such as Tobin's Q, EVA and MVA, Skandia Navigator, Balance Scorecard, The Intangible Assets Score Sheet and VAIC. In this study, we use VAIC to assess the value of IC. The VAIC model was developed by (Pulic, 1998, 2000, 2004) to examine the efficiency and size of IC. VAIC is most popular model of IC measurement because it is based on audited financial reports (Amin *et al.*, 2014). It is the combination of three IC efficiency measures: Human Capital Efficiency (HCE), Structural Capital Efficiency (SCE) and Capital Employed Efficiency (CEE). Following is the equation of VAIC and three IC efficiencies:

$$\text{VAIC} = \text{HCE} + \text{SCE} + \text{CEE},$$

where

VAIC = Value Added Intellectual Coefficient,
HCE = Human Capital Efficiency, Calculated as HCE = VA/HC,
SCE = Structural Capital Efficiency, Calculated as SCE = SC/VA,
CEE = Capital Employed Efficiency, Calculated as CEE = VA/CE,
VA = Value Added, it is the sum of operating profit, depreciation, amortisation and salaries and wages of all employees

$$\text{VA} = \text{OP} + D + A + \text{EC},$$

where

VA = Value Added,
$D$ = Depreciation,
$A$ = Amortisation,
EC = Employee Cost or the salaries and wages of all the employees,
HC = Human Capital, salaries and wages of all the employees,
SC = Structural Capital, it is the difference of HC and VA,
CE = Capital Employed, it is equal to the book value of net assets of a firm.



### 5.2. *Measurement of innovation*

Innovation is a process to transform products, services and ideas that can increase the success of a business. The businesses that are innovative are more efficient and productive as compared to others. Innovation is the fruit of investment in R&D. In literature, different methods are used to measure the innovation. Some studies use questionnaires to measure innovation (Han and Li, 2015; Kalkan *et al.*, 2014) and some studies extract data from published annual reports to measure it (Huang and Liu, 2005; Sher and Yang, 2005; Silva *et al.*, 2015). This study has focused on secondary data that are available in audited financial reports.

The core activity of pharmaceutical firms is to introduce new drugs or improve in existing products. The development of new products is only possible with the help of R&D. Pharmaceutical firms are rich in R&D and more innovative as compared to other high technology businesses. Following are the measures of innovation:-

**R&D Intensity (RDI):** RDI is used as the proxy of innovation input because development of new products or improvement in existing products are positively correlated with the measure of innovation output (Hitt *et al.*, 1997). It is measured as the ratio of investment in R&D divided by sales.

$$\text{RDI} = \frac{\text{R\&D}}{\text{Sales}}.$$

**R&D Output (RDO):** Pharmaceutical firms are rich in patents rights, copyrights and other precious intangibles and all these intangibles are outcome of R&D. Valuable intangibles of pharmaceuticals reflect both the quality and quantity of innovation. RDO is the ratio of net book value of intangibles excluding goodwill divided by R&D investment.

$$\text{RDO} = \frac{\text{Net Book Value of Intangibles Excluding Goodwill}}{\text{R\&D}}.$$

**R&D Density (RDD):** RDD is the proxy of innovation capital (Tseng *et al.*, 2015). R&D used input to generate the superior profit. It is calculated as investment in R&D divided by the operating revenue of current year.

$$\text{RDD} = \frac{\text{R\&D}}{\text{Operating Profit}}.$$

**Product Development (PD):** Product Development is also the proxy of innovation. The current study has used binary coding to measure product development. Use 1 if a firm introduce new product or significant change in existing product, otherwise 0.

**Products in Pipeline (PP):** Future Developments is also a measurement of innovation. This is also a dummy variable, measured through binary coding use of 1 if a company discloses its likelihood development or future developments in annual reports, otherwise 0.



### 5.3. *Measurement of firm performance*

Firm Performance is measured through traditional accounting measures such as return on assets (ROA), Return on Equity (ROE), Earnings Per Share (EPS), Assets Turnover Ratio (ATO) and Market-to-Book Ratio (MB) used in different previous IC studies (Amin *et al.*, 2014; Antonio Lerro *et al.*, 2014; Kamath, 2008; Makki and Lodhi, 2014; Nimtrakoon and Chase, 2015). ROA, ROE and EPS are the indicators of profitability. ATO is used to measure the assets productivity, whereas MB is an indicator of market value or market performance. The calculations of these measures are as follows:

ROA = Net Profit after Tax and Preferred Dividend/Total Assets,
ROE = Net Profit after Tax and Preferred Dividend/Book Value of Common Stock Equity,
EPS = Net Profit after Tax and Preferred Dividend/Number of Common Shares Outstanding,
ATO = Total Revenue/Total Assets,
MB = Market Capitalisation/Shareholders' Equity.

## 6. Data Analysis and Discussion

Partial Least Squares (PLS) is a variance-based SEM technique characteristically used to address cause–effect relationships among endogenous and exogenous constructs, moreover, it measures the measurement and structural model concomitantly. PLS is a second generation powerful tool in the field of social sciences because it regresses the multiple dependent and multiple independent variables simultaneously. It has been used as a research tool in a variety of IC studies to explore

the cause–effect relationships between IC and firm performance (Amin *et al.*, 2014; Ryoo and Kim, 2015). The primary objective of PLS is to maximise the amount of variance explained because it assumes that all the measured variance is useful to variance to be explained and minimise of error (Hulland, 1999). SMARTPLS 3.2 is used in this study because SMARTPLS has some advantages over other PLS software like LISREL and AMOS. Firstly, it is used for small data sets; secondly, it does not require normality assumption of the data; and thirdly, it handles both formative and reflective measurement models whereas other software may handle only reflective models.

The output of PLS is interpreted at two stages: First one is measurement model and the second one is the structural model. Measurement model is assessed on the basis of validity and reliability, whereas the structural model is assessed on the basis of path coefficients ($\beta$) along with the explanatory power ($R^2$) and predictive relevance ($Q^2$). The validity and reliability of reflective measurement model is examined through convergent validity, discriminant validity, principal component factor analysis, internal consistent reliability and indicator reliability by applying standard decision rules (Urbach and Ahlemann, 2010). However, the statistical analysis of formative measurement model is different form reflective model. Conventional validity measures such as factor analysis, indicators loading, average variance extracted and cross loadings are meaningless in formative measurement model (Bollen, 1984, 2014; Hair *et al.*, 2013). So, the validity of formative indicators is examined on the basis of significance of the weight which is calculated through bootstrapping technique of PLS (Chin, 2010; Efron, 1979; Efron and Tibshirani, 1994). In addition, the multicollinearity among formative indicators should also be assessed by calculating the variance inflation factor (VIF) (Cassel *et al.*, 2000; Fornell and Bookstein, 1982). The VIF lesser than 10 indicates that multicollinearity is not a problem (Gujarati, 2012; Shieh, 2010). Furthermore, it is assumed that formative indicators are error free, which means internal consistency reliability is irrelevant (Diamantopoulos and Siguaw, 2006; Hair *et al.*, 2013).



## 7. Measurement Model

Table 1 encompasses the VIF, weight, $t$-values and $p$-values of measurement model. VIF value of all the indicators is lesser than 10, which indicates multicollinerity is not an issue. To confirm the validity, $t$-values of weights are calculated through bootstrapping technique using 5,000 resampling. HCE and CEE the components of IC are significant at 1% as the $t$-value is greater than 2.57 ($^*p < 0.01$), whereas, SCE is significant at 5% because $t$-value is greater than 1.96 critical value ($^*p < 0.05$). The weight of CEE is negative but significant, this implies CEE has a negative relationship with IC construct. The $t$-value of HCE ($t$-value = 5.410) is higher than the CEE and SEC which implies that human capital is a major component of IC and it is consistent with previous IC studies (Kamukama *et al.*, 2010; Komnenic and Pokrajcic, 2012; Leitner, 2011).

Table 1. Descriptions of variables and symbols.

| Sl. No. | Constructs name | Symbol | Abbreviation | Description |
|---|---|---|---|---|
| 1 | Intellectual Capital (IC) | $X_1$ | HCE | Human Capital Efficiency |
| 2 | | $X_2$ | SCE | Structural Capital Efficiency |
| 3 | | $X_3$ | CEE | Capital Employed Efficiency |
| 4 | Innovation (INV) | $X_4$ | RDI | Research and Development Intensity |
| 5 | | $X_5$ | RDO | Research and Development Output |
| 6 | | $X_6$ | RDD | Research and Development Density |
| 7 | | $X_7$ | PD | Product Development |
| 8 | | $X_8$ | PP | Products in Pipeline |
| 9 | Financial Performance (FP) | $X_9$ | ROA | Return on Assets |
| 10 | | $X_{10}$ | ROE | Return on Equity |
| 11 | | $X_{11}$ | EPS | Earnings Per Share |
| 12 | | $X_{12}$ | ATO | Assets Turnover Ratio |
| 13 | | $X_{13}$ | MB | Market-to-Book Ratio |
| 14 | | $\eta_1$ | IC | Latent Variable: IC Efficiency |
| 15 | | $\eta_2$ | INV | Latent Variable: Innovation |
| 16 | | $\eta_3$ | FP | Latent Variable: Firm Performance |
| 17 | | $\zeta$ | Zeta | Disturbance term |
| 18 | | $\gamma$ | Gamma | $\gamma$'s are the coefficients capturing the effect of indicator $x$'s on the latent variable $\eta$'s |



All the indicators of INV except PP are significant. RDI, RDO, RDD are significant at 1% ($*p < 0.01$) whereas, PD is significant at 5% ($*p < 0.05$) and PP is not significant at any level. The weight of PD and PP is negative, which implies these two variables have negative relationship with INV. RDO and RDD are the major components of INV, as their $t$-values are highly greater than $t$-values of RDI, PD and PP.

Firm Performance is assessed through different financial ratios. ROA and ROE are the main indicators to measure the firm's financial performance. These two indicators are significant at 1% ($*p < 0.01$). The findings are analogous with the results of Kamath (2008) in India, Sharabati *et al.* (2010) in Jordan, Mehralian *et al.* (2012) in Iran and Amin *et al.* (2014) in Pakistan. EPS is also considered as the financial performance indicator and it is significant at 5% ($*p < 0.05$). ATO which is an indicator of assets productivity is not significant at any level because $t$-value is lesser than minimum critical value ($p > 0.1$). Komnenic and Pokrajcic (2012) also concluded that ATO is not associated with firm's performance and it misleads in measuring the business productivity (Morariu, 2014). MB ratio is used measure the market firm's performance, and it is significant at 10% ($*p < 0.1$) and confirms the validity.

There are contradictory views regarding the insignificant variables. Some studies suggested that insignificant variables should be removed from the construct to obtain the meaningful results of other significant variables (Diamantopoulos

Table 2. Measurement model.

| Indicators | VIF | Weight | *T*-statistics | Significance level | *P*-values |
|---|---|---|---|---|---|
| IC<- HCE | 1.180 | 0.818 | 5.410 | *** | 0.000 |
| IC<- SCE | 1.263 | 0.747 | 2.174 | ** | 0.030 |
| IC<- CEE | 1.292 | −0.673 | 3.839 | *** | 0.000 |
| INV<- RDI | 1.306 | 0.411 | 2.973 | *** | 0.027 |
| INV<- RDO | 1.407 | 0.970 | 9.337 | *** | 0.000 |
| INV<- RDD | 4.929 | 0.966 | 9.235 | *** | 0.000 |
| INV<- PD | 1.188 | −0.310 | 2.154 | ** | 0.031 |
| INV<- PP | 1.270 | −0.081 | 0.287 | NS | 0.774 |
| FP<- ROA | 1.983 | 0.912 | 11.941 | *** | 0.000 |
| FP<- ROE | 2.015 | 0.911 | 12.758 | *** | 0.000 |
| FP<- EPS | 1.089 | 0.344 | 2.040 | ** | 0.041 |
| FP<- ATO | 1.052 | 0.096 | 0.421 | NS | 0.674 |
| FP<- MB | 1.038 | 0.149 | 1.682 | * | 0.098 |

*Notes*: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$, NS = not significant; 1% = 2.57, 5% = 1.96, 10% = 1.65.

and Winklhofer, 2001). On the other hand, some scholars suggested that insignificant variables should not be removed from the formative constructs due to the issue of content validity (Bollen and Lennox, 1991; Roberts and Thatcher, 2009). In this study we follow the second opinion, and do not remove the insignificant indicators due to the issue of content validity and model misspecification.

## 8. Structural Model

Four structural combinations were analysed to ascertain the hypotheses. Structural model is evaluated on the basis of path coefficients ($\beta$) along with $R^2$ and $Q^2$. Table 3 shows the values of $\beta$'s, $t$-values, $p$-values, $R^2$ and $Q^2$ of structural models. Path coefficients show the strengthening of the relationship among the constructs. Our first hypothesis is related to the impact of IC on INV. The calculated value of path coefficients ($\beta = 0.91$, $t$-value = 41.854, *$p < 0.01$) is highly significant at 1%, which confirms $H_1$, IC is related to the INV and has significant positive impact on INV. Prior IC and INV literature also concluded that IC has positive and logical impact on innovation, greater IC efficiency leads to more innovation in products and

Table 3. Structural models.

| | Path coefficients ($\beta$) | *T*-statistics | *P*-values | $R^2$ | $Q^2$ | Results |
|---|---|---|---|---|---|---|
| Model – 1 ($H_1$): IC →INV | 0.910 | 41.854*** | 0.000 | 0.825 | 0.242 | Supported |
| Model – 2 ($H_2$): IC →FP | 0.783 | 17.342*** | 0.000 | 0.606 | 0.150 | Supported |
| Model – 3 ($H_3$): INV →FP | 0.806 | 23.442*** | 0.000 | 0.650 | 0.185 | Supported |
| Model – 4 ($H_4$): IC →FP | 0.776 | 4.368*** | 0.000 | 0.693 | 0.168 | Supported |
| INV →FP | 0.560 | 2.787*** | 0.000 | | | |

*Notes*: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$, NS = not significant; 1% = 2.57, 5% = 1.96, 10% = 1.65.

services (Dumay *et al.*, 2013; Han and Li, 2015; Sumita, 2008). $H_2$ is also supported because the path coefficients ($\beta = 0.783$, $t$-value $= 17.342$, $^*p < 0.01$) of IC and FP are also significant. It is also summarised that pharmaceutical companies are rich in IC efficiency and this IC efficiency leads to obtainment and sustaining of competitive advantage and superior financial performance (Alinaghian, 2013; Azad and Mohajeri, 2002; Boekestein, 2006; Bramhandkar *et al.*, 2007; Kamath, 2008; Mehralian *et al.*, 2012; Peng *et al.*, 2007; Sharabati *et al.*, 2010). INV is also associated with the firm's performance. The path coefficients of INV and FP are significant at 1% ($\beta = 0.650$, $t$-value $= 23.442$, $^*p < 0.01$) and strongly support $H_3$. Product innovation, process innovation and business innovation lead to improvement of the future performance of a business (Lee *et al.*, 2015; Sher and Yang, 2005; Silva *et al.*, 2015). Moreover, in the era of knowledge economy the strategic existence of a business is risky if it fails to adopt innovation. The last hypothesis is developed to measure the joint impact of INV and IC on firm's performance. The calculated statistical values strongly supports $H_4$. Both path coefficients ($IC \rightarrow$ FP $\beta = 0.776$, $t$-value $= 4.368$, $^*p < 0.01$ and INV $\rightarrow$ FP $\beta = 0.560$, $t$-value $= 2.787$, $^*p < 0.01$) are significant at 1% which implies that there is a strong association among IC, INV and FP constructs.

After the measurement of path coefficients it is essential to evaluate the coefficients of determination or explanatory power ($R^2$) of endogenous construct. $R^2$ measures the relationship of latent variables explained variance to its total variance. It is suggested that the values ought to be adequately high for the model to have a minimum level of explanatory power (Chin, 1998). Furthermore, Chin (1998) deliberates that the $R^2$ values nearly 0.670 have extensive explanatory power, values around 0.333 have average explanatory power, and values of 0.190 and lower have weak explanatory power. $R^2$ of the first model is 0.825 (82.5%), it means IC has 82.5 % explanatory power to explain the innovation. The value is extremely higher from the suggested value ($R^2 = 0.825 > 0.670$). IC has extensive ability to promote innovation in the listed pharmaceutical firms of London Stock Exchange. The calculated value of $R^2$ is remarkably higher from the results of Dumay *et al.* (2013); Han and Li (2015) and Sumita (2008). Second and third models have $R^2$ values 0.606 and 0.650, respectively. These values are slightly lesser than the porposed value extensive explantory power but significantly greater than the average suggested value of expalnatory value ($R^2 = 0.606$ and $0.650 > 0.333$). IC efficiency solely explains the firm performance (60.6%) and innovation explains firm performance (65%) individually. Fourth model has been proposed to examine the joint impact of INV and IC on firm's performance of listed pharmaceutical companies of London Stock Exchange. The calculated $R^2$ of 0.693 ($R^2 = 0.693 > 0.670$) allows us to infer that IC and INV have jointly 69.3% explanatory power of firm's performance. This value is higher than the model 2 and model 3. So, we conclude that IC efficiency and innovation have a joint effect on the firm performance because $R^2$ has extensive explanatory power in this case.

Finally, non-parametric Stone Geisser test of predictive relevance ($Q^2$) is applied to measure the predictive relevance of exogenous construct towards the endogenous. This test can be used for additional assessment of model fit in PLS analysis (Geisser, 1975; Stone, 1974). $Q^2$ values greater than zero ($Q^2 > 0$) of formative endogenous latent variable indicates that the model has predictive relevance for this specific construct (Chin, 2010; Hair *et al.*, 2013). Blindfolding procedure of PLS is used to calculate the value of $Q^2$. Cross-validated Redundancy values are used as the measure of $Q^2$ because it includes both path model and structural model. (Hair *et al.*, 2013). All the models possess $Q^2$ greater than zero (0.242, 0.150, 0.185 and $0.168 > 0$), which indicates entire model is good to fit and has predictive relevance of their respective constructs.



## 9. Conclusion

In the 21st century, knowledge productivity is a big challenge for the knowledge-based economy. Nowadays, IC is a most distinctive knowledge-based strategic asset that is used to obtain and sustain competitive advantage. Moreover, the firms which are rich in IC efficiency have a great ability to make innovation in its product and process, which may also lead to competitive advantage. The objective of this study is to explore the structural links among IC, innovation and financial performance of listed pharmaceuticals in London Stock Exchange. For this purpose structural model has been developed and tested through SMARTPLS. Empirical outcomes of SEM analysis support that IC and its components have positive and significant impact on innovation and firms' financial performance. Moreover, innovation also has a significant impact on firms' financial performance. From these findings we conclude that IC has a greater ability to generate product and process innovation and it also plays a significant role to achieve technological and non-technological innovation. Furthermore, empirical results support that the firms achieve superior business performance which are more innovative. Therefore, it is concluded that both IC and innovation are the key drivers of competitive advantage, value creation and lead to strategic survival of a business.

According to KBV of knowledge economy, knowledge is a power that has been used to obtain competitive advantage and superior business performance. A few studies have been conducted on the importance of knowledge. Due to this reason, the impact of IC and innovation on firm performance is studied. This is a unique study because for the first time we explore empirically the impact of IC using VAIC on innovation and then the joint impact of IC and innovation on the firm's financial performance. Theoretically this paper supports the RBV and KBV of knowledge economy. Moreover, the study contributes to the existing knowledge about IC and its effects. Academic research about IC and its outcome on business performance has been quite rich, but limited research is available upon the innovation and IC. This is the extension of prior research and concluded that innovation is related to IC efficiency in pharmaceuticals of London Stock Exchange,

and empirical results support that IC has a significant impact on innovation and firm's financial performance.

The study has implications for the manager, decision makers and policy makers to recognise the value of IC and its philosophy to obtain and sustain competitive advantage through innovation. Greater IC efficiency also contributes to achieve superior business performance. It is suggested that managers and decision makers should focus on the training of personnel and enrich their skills to escalate the human capital because statistical results showed that human capital is a major component of IC which leads to innovation, growth and greater business performance. Moreover, this study is also beneficial for the investors to make appropriate investment decisions.

This study has some limitations. Firstly, it cannot be generalised due to the sample used. The reason for this is because that we focus only pharmaceutical firms of London Stock Exchange. To overcome this limitation, future research may be conducted on different industries by using the data of various nations. Secondly, we include limited variables of innovation that are available in full sample annual reports, but there are some other variables of innovations like per employee R&D, number of R&D employees, revenue from new products and innovative organisational culture, these may be covered in future research through survey or questionnaire approach. Thirdly, only quantitative aspects of research are covered in this paper, however qualitative research should be carried out to cover other dimensions and to provide a detailed understanding of this study. Finally, VAIC model of IC is used in this study that covers only financial magnitude of a business, future research should be conducted by using other approaches/methods of IC.



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