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The Effect of Business Intelligence (BI) on Organizational Agility and Innovation Using SEM

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Abstract

Introduction: In recent years, Business Intelligence (BI) has become an obvious necessity and an important element for the survival of any business. This study aimed to investigate the effect of BI on organizational agility and innovation.

Methods: This research is quantitative in terms of paradigm and descriptive-correlational in terms of the type of study. The population of this study was the IT experts in Kermanshah hospitals (375 people); they were selected using total number method, but after distributing the questionnaires among all of them, only 97 complete questionnaires were collected and used for data analysis. Data were collected by a researcher-made questionnaire. Data analysis was performed by Partial Least Squares (PLS) structural equation modeling using Smart PLS software.

Results: There was a positive and significant relationship between BI and organizational agility and innovation in hospitals. In other words, if BI is used in a hospital, it will lead to organizational agility, which will increase the ability of hospitals to respond to environmental changes and turn environmental threats into opportunities. Further, BI leads to more organizational innovation, i.e. the hospital will be able to deliver innovative services to the target community and gain more market share than its competitors.

Conclusion: Since hospitals are facing increasing pressure to find new ways to compete and deal with increased operating overhead costs, they need to establish BI to cope with these changes, which will reduce the costs, increase the speed and efficiency, enhance the effectiveness, and gain competitive advantage by promoting organizational agility and innovation.

Keywords: Business intelligence, Hospital information systems, Hospitals, Organizational innovation

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Introduction

In today's fast-paced world, organizations with a higher degree of Business Intelligence (BI) are successful. Increased environmental complexity and ambiguity have brought the organizations into today's ambiguous world, and transition from this situation will not be possible unless organizations are equipped with intelligent technological tools. Today, we have to accept the fact that along with the effort to make the information systems smarter, the employees of organizations must also be intelligent to strengthen their efficiency and effectiveness (1).

Many organizations have turned to BI programs as a tool to improve organizational decision-making in response to abundant data for analysis and increasing pressure to provide better and faster responses to customers. Highlighting the importance of decision-making, Herbert Simon maintains that management should be considered equivalent to decision-making, and all management activities end up in a decision-making activity (2). All these points together have required organizations to ensure their survival and reduce the burden of managers' duties as much as possible by making their business smarter proportional to such environments by making quick and timely decisions (3, 4).

The existence of staggering operating costs and fierce market competition has forced the organizations to use BI. BI makes activities more efficient; through it, costs are greatly reduced and are spent more intelligently. BI is a tool for generating knowledge from a vast amount of data and information to provide the desired information at the right time and with the best form for users. This system includes a wide range of technologies that gather information and knowledge in an organization and contributes to the decision-making process. In other words, BI has a direct effect on increasing the speed and efficiency of decision-making in organizations (5).

This innovation is the use of mental abilities to create a new concept and the ability to combine the ideas uniquely or create connections between ideas (6). Further, organizations with high innovation capacity will be able to respond to environmental challenges more quickly and efficiently (7). Organizational innovation is a management system that emphasizes the mission of the organization, seeks exceptional and new opportunities, and determines the indicators of organizational success (8, 9). Organizational innovation is the acceptance of an idea or behavior that is new to an industry, market, or the general environment of the organization (10).

In a comprehensive classification, the most important components of organizational innovation are divided into three categories, including service innovation (providing new services or responding to the market or external customer), administrative innovation (making innovative changes in organizational strategy and structure and administrative processes and procedures), and innovation culture or space (directing the organizational space to easily carry out innovative activities and provide necessary conditions for creativity and ideation of employees). The need for innovation in organizations is so critical that some sources consider its absence a factor for the destruction of the organization in the long run. An organization that lacks innovation cannot survive and disappears from the scene over time. Therefore, organizations are constantly looking for ways to strengthen innovation and remove barriers to their development (11). Organizations have to take agile steps to compete in the 21st century because today's organizations are under increasing pressure to find new ways to compete in dynamic global markets.

To cope with these changes, organizational agility helps the organization through initiative, skills, knowledge, and quick access to information (12). Although agility allows the organization to react to environmental changes faster than before, the strength of agile competitors is in anticipating customer needs and leadership in creating new markets through innovation (13). The concept of organizational agility was first introduced by researchers at Yakuka Institute in 1991. Since then, in addition to researchers, it has attracted a great deal of attention from industrial associations. Since the 1990s, many articles have been published on this concept, trying to provide a comprehensive definition for it (14).

Some researchers have introduced organizational agility as the ability to face unwanted challenges to overcome new and unexpected threats to the business environment and take advantage of existing opportunities arising from these developments (15, 16). Agility is defined as the need to respond quickly to an organization. It is one of the keys to solving a problem when there is confusion in an organization. Agility enhances the ability of the organization to provide quality products and services and make the organization effective (13). The four most important capabilities of agile organizations are accountability, competence, flexibility, and speed (17).

Materials and Methods

This research is quantitative in terms of paradigm and descriptive-correlational in terms of the type of study. The population of this study was the IT experts in Kermanshah hospitals (375 people) who were selected using total number method, but after sending the questionnaires to all of them, only 97 complete questionnaires were collected and used for analysis of the data. The Likert scale questionnaire was used to collect the data. The questionnaire was designed based on 5-point Likert scale, ranging from strongly agree (1), disagree (2), somewhat agree (3), agree (4), and strongly agree (5). The structural equation modeling and path analysis, using SmartPLS software, was used to analyze the data and test the hypotheses.

Research Hypotheses

Hypothesis 1: BI has a positive and significant effect on organizational agility in the hospitals of Kermanshah.

Hypothesis 2: BI has a positive and significant effect on organizational innovation in the hospitals of Kermanshah (Figure 1).

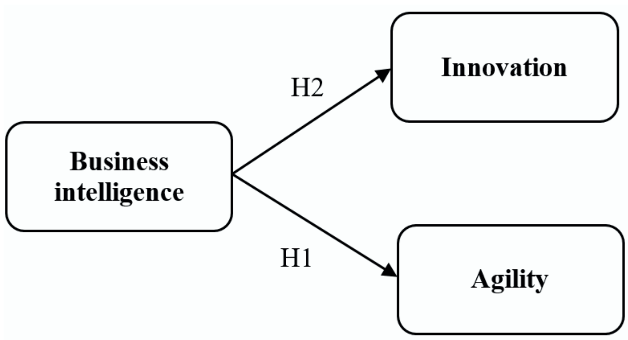

Figure 1: Conceptual model of the research

Structural Equation Modeling

Partial least squares structural equation modeling, unlike the covariance-based method (LISREL, AMOS software) has a model fit and variance-based indicators. In partial least squares structural equation modeling, SmartPLS software is used to evaluate the measurement model (reflective or hybrid). For evaluating the appropriateness of measurement models, three criteria of reliability, convergent validity, and divergent validity are used.

Reliability

Reliability indicates the extent to which the measurement tool achieves the same results under the same conditions. That is, if the researcher runs the questionnaire again or in parallel, the results of both questionnaires are the same, so the questionnaire was completely reliable. This is done by examining the factor load coefficients, Cronbach's alpha coefficients, and combined reliability. The rho_A coefficient is also one of the reliability coefficients that is stronger than Cronbach's alpha. Since the value obtained for all these coefficients is higher than the minimum standard coefficient (0.7), the reliability of the data collection tool is confirmed.

The second criterion to study the measurement models is convergent validity, which examines the correlation of each factor with its questions. The Average Variance Extracted (AVE) criterion or the mean variance extracted is the criterion used to measure the convergent validity. The AVE indicates the mean common variance between each factor and its questions. In simpler terms, AVE shows the degree of correlation of a factor with its questions, and the higher this correlation, the greater the model fit. This criterion is defined as the total mean of the second power of the factor loadings corresponding to each construct. The mean extracted variance was 0.5 or higher, and the value obtained for all variables was higher than this value, so convergent validity was confirmed. Cronbach Alpha for Innovation, Business Intelligence, and Agility was 0.891, 0.930, and 0.906, respectively. Also, Composite Reliability(rho_A) for Innovation, Business Intelligence, and Agility was 0.901, 0.934 and 0.913 respectively. Finally, Composite Reliability (CR) for Innovation, Business Intelligence, and Agility was 0.913, 0.941 and 0.925 respectively.

Divergent Validity

Divergent validity is the third criterion for examining the fit of measurement models. It covers two aspects: 1) comparing the degree of correlation between the questions of one factor with that factor versus the correlation of those questions with other factors, and 2) comparing the correlation of one factor with its questions versus the correlation of that factor with other factors.

HTMT Index

HTMT criterion for discriminant validity assessment in variance-based structural equations modeling is proposed by Henseler, Ringle, and Sarstedt (2015); as shown in Table 1, because all the results are less than 0.9, the divergent validity is acceptable.

Table 1: Heterotrait-Monotrait (HTMT) index

	Innovation	Business Intelligence
Business Intelligence	0.679	
Agility	0.624	0.537

Model fit Evaluation Indices

The model fit shows how much the model designed by the researcher is supported based on factual information. In other words, it shows the compatibility of the experimental model with the theoretical model. A theoretical model is developed by a researcher based on research literature or qualitative content analysis. An experimental model is based on the data collected by the researcher. As shown in Table 2, the model fit is confirmed when the value obtained for the four indices specified in the table (SRMR, d_ULS, d_G, and NFI) is at the standard level.

Explained R^2 Variance

This coefficient, as the most important analysis index, shows what percentage of the changes in the independent variables is explained. As indicated, BI explains 40.2% and 25.4% of changes in the innovation and agility variables, respectively, which is an acceptable value.

Q^2 Index

The next criterion to examine the structural model is Q-Square (Q^2) (Table 3). This criterion determines the predictive power of the model

Table 2: Model fit evaluation indices

Index	Obtained value	Standard coefficient
Standardised Root Mean Residual (SRMR)	0.068	<0.10
Squared Euclidean Distance (d_ULS)	1.49	>0.05
Geodesic Distance (d_G)	0.87	>0.05
Normed Fit Index(NFI)	0.86	>0.80

Table 3: Q-Square (Q^2) structural model

	Sum of Squares of Observations(SSO)	Sum of Squares Error(SSE)	Q-Square (=1-SSE/SSO)	Prediction
Innovation	736.000	421.264	0.428	Strong
Business intelligence	920.000	459.737	0.500	Strong
Agility	644.000	320.965	0.502	Strong

Table 4: Model of relationship analysis of hypotheses and t statistic model

	Path coefficient	Relationship	Mean sample	Standard Deviation(SD)	t statistic	P value	Result
Business Intelligence ->Innovation	0.634	Direct	0.641	0.076	8.384	0.000	Acceptable
Business Intelligence ->Agility	0.504	Direct	0.518	0.084	5.987	0.000	Acceptable

among the dependent variables. Models with an acceptable structural fit should be able to predict the characteristics of the endogenous constructs of the model. Three values of 0.2, 0.15, and 0.35 are defined as low, medium, and strong predictive power. Since the obtained value for all research variables is higher than 0.35, the model has a strong predictive power in terms of the Q-Square (Q^2) index.

Results

Analysis of the Relationship between Hypotheses

In this section, the path coefficients are assessed. The path coefficient is a value between +1 and -1 which determines the type of relationship, including directly (+), inversely (-), and no relationship, which is determined by zero coefficient.

The t-statistic is the main criterion for accepting or rejecting the hypotheses. If this statistic is higher than 1.64, 1.96, and 2.58, the hypothesis is confirmed at 90, 95, and 99% levels, respectively. In this study, a 95% confidence level and coefficient of 1.96 were considered for the rejection and acceptance of hypotheses. The model of relationship analysis of hypotheses and t statistic model is presented in Table 4.

Since the t-statistic in both relations is higher than 1.96, both research hypotheses are accepted. Figure 2 shows the structural model of the research in path coefficients and factor loadings.

Discussion

This study aimed to determine the relationship between BI and organizational agility and innovation in hospitals. The results indicated that both research hypotheses were confirmed, and BI affected both organizational agility and organizational innovation in the hospitals. BI has a positive and significant effect on hospital agility. In other words, the existence of BI-based information systems in hospitals makes the

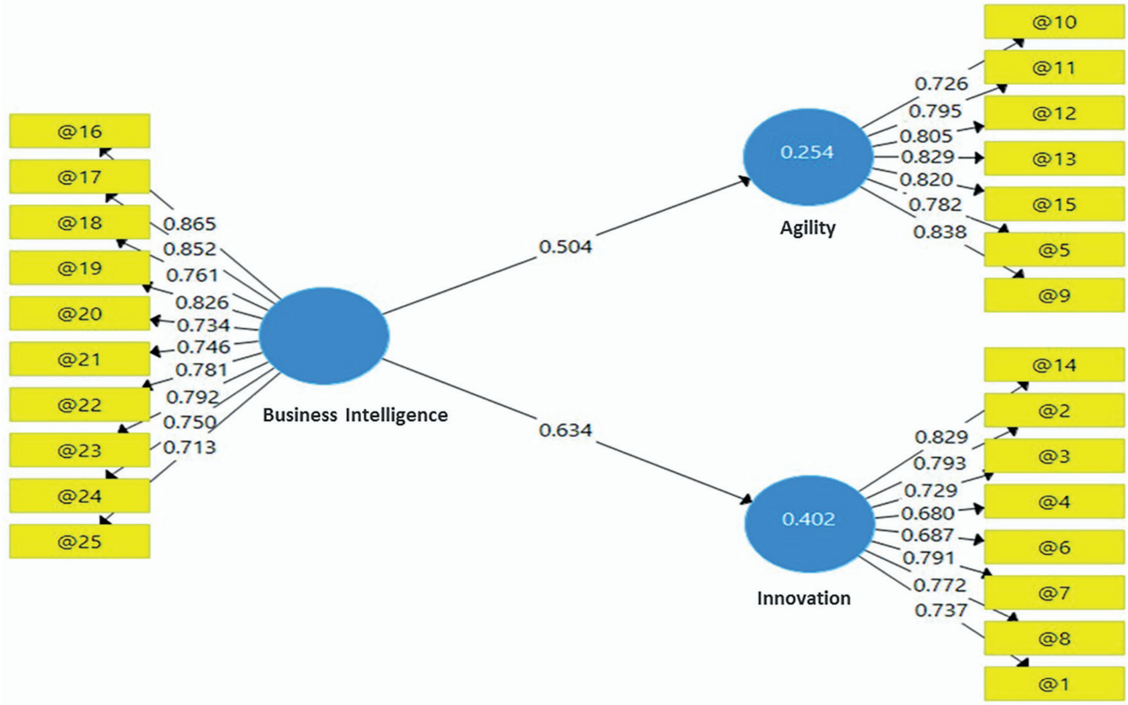

Figure 2: Structural model of research in path coefficients and factor loadings

hospitals more agile, which is the goal of many of them.

Hospital agility makes the hospitals more flexible and enables them to achieve success faster. Due to rapid changes in the hospital environment, such as the speed of technology growth, increasing competition between hospital competitors, increasing hospital overhead costs, and increasing costs related to raw materials and medical and hospital equipment, hospital agility is a method used to respond to these changes. This result is in line with the findings of Ajdari et al. (18).

The results also indicated that BI had a positive and significant effect on organizational innovation. Because organizational innovation enables the organization to offer new products and services daily, it will be able to gain a good market share. Hospitals that are unable to provide innovative services can best maintain their market share, but innovation enables them to gain more market share and discover new ways to serve the community. This result is in line with those of the studies conducted by Ajdari, Soltani Tirani, and Goldman et al. (18-20).

Because previous studies have examined the relationship between BI and innovation or agility variables separately, the present study considered this relationship simultaneously. Therefore, with the deployment of BI systems in health care settings, hospitals are expected to be more agile and have higher innovation. In other words, agility and innovation can be expected to make the hospitals more successful than their competitors. However, since the information systems available in Iranian hospitals are often traditional and are not BI-oriented, they are suggested to be replaced with new systems to take advantage of BI. Yet, since this is costly for hospitals, it is suggested that small and lower-income hospitals should connect older information systems by setting up a data center and service-oriented architecture and simulate BI capabilities by developing a knowledge management system.

Conclusion

Business intelligence has a significantly positive effect on the two variables of agility and innovation, and both hypotheses were confirmed. The existence of information systems leads to agility and innovation in hospitals. Agility in hospitals provides good solutions to reduce the overhead costs of medical supplies and equipment in the hospital. Therefore, with the establishment of business intelligence systems in hospitals, hospitals are expected to be more agile, followed by innovation in them.

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Authors' Contribution

MJJ conceived of the presented idea. MM developed the theory and performed the data gathering. MH verified the analytical methods. All authors discussed the results and contributed to the final manuscript.

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Ethics Approval and Consent to Participate

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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