Comprehensive model of business intelligence: A case study of Nano’s companies

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Abstract
The implementation of business intelligence (BI) system is a complicated undertaking requiring considerable resources. This research tries to identify the critical success factors that affect the Business intelligence Implementation. The study develops a CSF’s framework crucial for BI systems implementation. Next, the framework and the associated CSF’s are delineated through a series of NANO’s Organization. The empirical findings demonstrate the construct and applicability of the frame work. This study from the aiming view point is practical and from method of data collection and analysis view point is descriptive and is of correlative type. The model of the research has two parts that includes: Critical success factors of business intelligence and system success. Through this model, eight hypotheses were developed that six of them were confirmed. Base on the results of this research, it is recommended that Nano’s companies must empower their information technology capacity to have better chance to be the winner of the competitive world.

Keywords: Business intelligence system, Critical success Factors, NANO ‘s Industry

Introduction
Davenport et al. (2007) argued that BI is a set of technologies and processes that use data to understand and analyze organization performance and includes using of information to stimulate business insight (Platon, 2009). In another words, BI is an interactive process for exploring and analyzing structured, domain-specific information (often stored in a data warehouse) to discern trends or patterns, thereby deriving insights and drawing conclusions in organization (Markarian et al., 2007).

With developing technology in particular IT, many researchers understood the importance of BI as an inseparable part of new businesses, which can link strategic objectives and operational goals in each organization. For example, Salegro et al (2008) investigated the applications of business intelligence systems in personalizing tourism services or Nadeem et al. (2003) did a research, with regarding to the applications of business intelligence systems in Pakistan’s banks and Sharaki and Esmaeil poor (2010) used a business intelligence-based system in order to support sugar markets in Iran. These studies show emerging the demand for using BI in organizations to enhance IT-based systems of business towards new patterns of knowledge management, which it is the main aim of developing BI in organizations. It means that organizations try to access to newest market information without spending huge expenses. Is it an inaccessible dream? The answer to this question has in fact been hidden at concept of BI.

Furthermore, various researches have been done to explore the critical success factors of business intelligence. Vodappalli (2009) determined the key success factors of business intelligence through three dimensions: organization, technology, process. In other investigation, Olszak and Ziamba (2003) developed four dimensions: Organization, function, technology and business as the effective factors on BI.

In this paper, researchers introduce the critical success factors of business intelligence systems in Nano’s companies in IRAN. To do this, in the first place, research variables would be placed in a conceptual model of business intelligence. This model is analyzed by using structural equation modeling to show that the factors determined have well been located. As for this, researchers try to identify critical success factors of business intelligence in form of a comprehensive model and with providing eight hypotheses designed which describe the role of BI in achievement of organizational systems. Thereafter, it would be discussed the hypotheses rejection and confirmation. Finally, the result of the research would be concluded by providing essential solutions for improving the organizational systems. In another word, in this case, the researchers try to answer these questions: What are the critical success factors of business intelligence system implementation in NANO technologies area in Iran? What are the challenges of business intelligence implementation in NANO’s companies in Iran? What are the requirements of business intelligence system implementation in NANO's companies?

So it can be said that the strength of this research is reviewing of the new resources and combination and incorporation of existing model and developing the new frame of BI factors and system success in NANO's area. It is noteworthy that no similar research has been done in this era in Iran.

Critical success factors
According to Saraph et al (1989) CSFs consists of critical areas of managerial planning and action that must be practiced in order to achieve effectiveness. He added that they are a broad range of factors which can be effective on the success of BI implementation mentioned...
in the literature. For example, Yeoh (2011) developed a framework of critical success factors of BI system which are divided to three dimensions: Organization, including factors based on vision & business and also management & championship, Process which includes team -based factors, project management and methodology-related factors, change management-related factors, Technology which contains data-related factors and infrastructure-based factors.

Moreover, Rud (2009) specified 5 factors in his book, called under title: "Business Intelligence Success Factors". Effective communication, Collaboration, Innovation, Adaptability, Leadership were factors which Rud determined them as CSFs in IB.

As it was mentioned before, numerous studies have been done around the critical success factors of Data Warehouse, Data Mining, ERP and Knowledge Management as the information-based technologies which have high convergence towards BI systems. In this case, Xu and Hwang (2008) identified Operational, Technical, Economic, Schedule factors as the critical success factors of data warehouse. These factors were studied by a systematic approach to system quality and information quality and were concluded in individual and organizational contexts. In another research by Valmohammadi (2010 ), discussed about critical success factors of Knowledge management as follows: management leadership and support, organizational culture, information technology, KM strategy, performance measurement, organizational infrastructure, process & activities, rewarding & motivation, training & education, removal or resource constraints, human resource management, benchmarking. These components show a common link between organization, knowledge gained from markets and BI. Study of various researches describes that IB can be caused of different variables, shown in the Table 1.

**System success**

Researchers have investigated the success of information technologies as DW, DM, BI, KM in myriad ways (Garnity & sanders, 1998 ) such as by measuring the satisfaction of users (Melone, 1990), service quality (Pitt et al., 1995) and the perceived usefulness of specific applications (Davis, 1989;Moore & Benbasat,1991).Or in another study Abu Ali and Abu Addose (2010) developed a framework to describe the system success by easy to use, speedy information retrieval, more information, better quality information, improved productivity, better decision for data warehouse and Watson and Ariyachandra (2005) stated the accuracy, completeness, consistency, flexibility, integration, scalability, individual impact, organizational impact, development time and cost as the measures of system success.

So by reviewing the literature, we categorized these measures as follows in two dimensions: Improved productivity that would be measured by effectiveness improvement, efficiency improvement, improvement of system’s performance. Improved decision making that would be measured by data validity, data accessibility and processing capacity of data.

Hence, in this study, research framework consists of two parts: CSFs of business intelligence and system success, measured by 8 hypotheses which is shown in figure 1:

H1 : Human force factor is effective on improvement of productivity
H2: Human force factor is effective on improvement of decision making
H3: IT factor is effective on improvement of productivity
H4: IT factor is effective on improvement of decision making
H5: Organizational factor is effective on improvement of productivity
H6: Organizational factor is effective on improvement of decision making
H7 : Environmental factor is effective on improvement of decision making
H8 : Environmental factor is effective on improvement of decision making

**Methodology**

This study because of dealing with identifying the critical success factors of business intelligence system in NANO’s companies, and developing practical knowledge about relations of these CSF’s and system success , from the aiming view point is practical and from method of data collection and analysis view point is descriptive and is of correlative type (Kumar, 2005; Yin, 2003a).

**Data collection and analysis**

The Questionnaire comprised 2 different sections. The questions of the first section have been used 3 questions are related to personal information of the respondents. The second section contains 84 statements measuring the 4 Success factors: human force factors, IT factors, Organizational factors, Environmental factors and 2 system success measures: Improvement of productivity and improvement of decision making. Respondent were asked to indicate their extent of agreement using a five point likert scale (with 5 = completely agree, to 1 = completely disagree). For analyzing data derived from questionnaire Structural Equation Modeling / Path Diagram has been used and the software’s which have been used for analyzing the data are LISREL 8.54 and SPSS 17.

**Reliability and validity**

For determining reliability of the study Cronbach’s Alpha method has been used. Table 2 shows reliability of the study. For determining validity of the questionnaire content credit has been used (Kumar, 2005; Yin, 2003). Content credit of this questionnaire has been justified by guide professors and co-guides and also initial distribution of questionnaire among number of experts, scholars and considering their corrective comments, it has the necessary credibility.
<table>
<thead>
<tr>
<th>Dimension</th>
<th>Description</th>
<th>Authors</th>
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<tbody>
<tr>
<td>Human Factors</td>
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<tr>
<td>Yeoh (2011) addressed that the use of consultants greatly enhanced the success of the system implementation. A balanced BI team should comprise a quality consultant who possesses adequate business knowledge and project teams that consist of both business and technical personnel.</td>
<td>Yeoh (2008), Yeoh (2011), Howson (2008), Howson (2008), Williams &amp; Williams (2007), Vedappali (2009), Knightbridge (2006), Schrewel (2005), Bhatti (2003)</td>
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<tr>
<td>IT Factors</td>
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<tr>
<td>A Primary purpose of BI systems is to integrate silos of data for advanced analysis. So as to improve the decision – making process. Corporate Data can only be fully integrated and exploited for greater business value once their quality and integrity are assured. Therefore Effective Data Management plays critical role for success of BI system (Yeoh, 2010)</td>
<td>Yeoh (2008), Yeoh (2011), ESCC (2009), Vedappali (2009), NeilmcMurphy (2008), Dehenny (2009), Makanian et al. (2007), Meister (2009), Schrewel (2005), Arrott (2008), Manfield (2006), Briggs (2002)</td>
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<tr>
<td>Training provides skills and information for employees and managers to fulfill their responsibilities. Improved performance is a strategic goal for organizations in order to achieve the bottom line purpose through training and development. For the same reason, a number of organizations are striving to become learning organizations.</td>
<td>Knightbridge (2006), Bhatti (2003), Vedappali (2009), Tocan (2009), Moffett et al. (2003)</td>
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<td>Organizational Factors</td>
<td>Organization size has often been viewed as a predictor of the adoption of administrative innovations, including computerization or information system use. Increasing size is said either to necessitate IS use to solve communications and integration problems which arise from increasing size or at least to facilitate such use by providing greater opportunity to achieve benefits through organizations (Gremillion, 1984).</td>
<td>Gremillion (1984), Al-Hudhail (2010), Ellis and Webster (1998), Lawler (1999), Sayal et al. (2000)</td>
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<td>Organizational structure explain the relation between individuals and groups those are trying to achieve organizational goals. In order to study the structure of organization, three dimensions must be pursued that are: Centralization (the point decisions are made), Formality (the degree and extent of regulation in organization) and Complexity (the degree of separation).</td>
<td>Hayen (2007), Zannetos and Sertel (1970), Hassanal (2002), Chang and Harrinton (2000), Akhavan and et al. (2010), Reimann (1974), Yarmohammadzadeh p et al (2011), Kumarasinghe et al. (2003), Buckman (1999), Hsieh et al. (2002), Moffett et al. (2003)</td>
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<tr>
<td>Environmental Factors</td>
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<tr>
<td>Apart from the advantages of business intelligence systems, lack of attention to cost and infrastructure and requirements of BI systems and blind imitation of competitors can lead to irreparable loss for the organization. So the choice of business intelligence system must consider the benefits and costs of implementation of this information technology.</td>
<td>Drew (1997), O’Dell and Grayson (1998), Day and Wender (1998), Moffett et al. (2003), Hung et al. (2005), Chong (2006) Akhavan et al. (2006), OCS (2003)</td>
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<td>Stakeholders are any individual or group that may affect or may be affected by the company’s activities. They have the ability to influence the success or failure of the business at various levels (e.g. affecting the company’s license to operate, eroding levels of trust of the company etc.). In this framework researchers considered stakeholder as the group that may be affected by business intelligence system like customer, buyer, supplier, employee, publics.</td>
<td>Yeoh (2011), Katsoulakos &amp; Katsoulacous (2007), Simmers (2004)</td>
<td></td>
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<tr>
<td>Government refers to the legislators, administrators, and arbitrators in the administrative bureaucracy who control a state at a given time, and to the system of government by which they are organized (Oxford dictionary, 2010). Government is the means by which state policy is enforced, as well as the mechanism for determining the policy of the state. A form of government, or form of state governance, refers to the set of political institutions by which a government of a state is organized. This framework we considered government as the important stakeholder that affect the performance of the organizations by making and performing and controlling the policies and decisions.</td>
<td>Bell (2002), Bhaltanagar (2003), Adelman &amp; Yeidan (1999), Saich (2004), Albareda et al. (2008)</td>
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Statistical population and statistical samples

The data were collected from employees in Nano’s companies in Iran. All respondents were full-time employees and volunteered to participate in the study. Total number of established Nano’s companies according to the report of Nano staff of technological cooperation office of presidency of Iran is about 30 companies. 245 questionnaires were delivered to employees by a researcher and 210 useful questionnaires were returned. Usable questionnaires entered into Excel datasheet and analyzed with the use of SPSS 17 and Lisrel 8.54. We computed our samples based on Morgan’s table. Male employees accounted for 64.3% of the total participants, while female employees accounted for 35.7%. From 210 respondents, 131 people with bachelor degree, 64 people with master degree, and 15 people have phd degree. This is while the age of 41 of these people were 20 - 30, 82 people between 31- 40, 73 between 41 - 50, 14 people between 51 - 60 years old.

Goodness of fit tests

Structural Equation Modeling (SEM) with LISREL 8.54 (Petroutsatou & Lambropoulos, 2007) was used to test and analyze the hypothesized relationships of the research model. SEM aims to examine the inter-related relationships simultaneously between a set of posited constructs, one measures each of those or more observed items (measures). The goodness of fit of a statistical model describes how well it fits a set of observations. Measures of goodness of fit typically summarize the discrepancy between observed values and the values expected under the model in question. Such measures can be used in statistical hypothesis testing. Generally, in this study to assess the goodness

Table 2. Reliability of the study

<table>
<thead>
<tr>
<th>Questions</th>
<th>Cronbach’s Alpha</th>
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<tbody>
<tr>
<td>Critical success factors</td>
<td>0.91</td>
</tr>
<tr>
<td>System success</td>
<td>0.89</td>
</tr>
<tr>
<td>All</td>
<td>0.91</td>
</tr>
</tbody>
</table>
of fit of the entire model measures such as $\chi^2$/df, RMR, GFI, AGFI, RMSEA, NFI, NNFI, CFI has been used. The relative chi-square (chi-square/degree of freedom; $\chi^2$/df), standardized root mean square residual (standardized RMSR), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), normed fit index (NFI), and comparative fit index (CFI) were used as goodness-of-fit measures.

Due to the sensitivity of the chi-square test to sample size, the relative chi-square was used (it should be 3 or less for an acceptable model (Tomer & Pugesek, 2003)). Standardized RMSR should not be greater than 0.10 and $GFI$, AGFI, NFI, and CFI should exceed 0.90 to be acceptable (Hair et al., 2006). The rate of each index has come in the Table 3.

The measurement model with all six constructs was using confirmatory factor analysis (Petroutsatou & Lambropoulos, 2007). Table 4 presents factor loading and the corresponding t-values of indicators in the measurement model. All loading exceed 0.4 and each indicator is significant at 0.05 levels. The measurement model exhibited a good level of model fit.

**Testing hypotheses**

The specification of the model consists of the translation of the verbal hypotheses into a series of equations previously represented in the form of a causal or a path diagram. The path diagram shows the causal relationships among all variables in the system. It should be based upon a priori knowledge of such relationships which are ultimately related to previous experience or theoretical basis (Fox, 2003). Thus, the path diagram represents the working hypothesis about the causal relationships among variables.

Fig. 2&3 shows structural model of the study for confirming first secondary hypotheses of the study in standard estimation state and structural model to test the research hypotheses in a meaningful parameter. Based on analysis done using path analysis, results of testing hypotheses of the study can be seen in Table 5. Standard estimation test and significance value in confirming or rejecting considered hypotheses (significance of hypotheses) has been used.

**Discussion and conclusions**

In terms of the literature of Critical Success Factors and mainly in Yeoh articles (2008, 2009, 2011) about business intelligence, some of critical success factors such as management commitment, consultant support, constant education, employee involvement and proper infrastructure were stressed. But in this study researchers emphasize on environmental factor that is the

![Table 3. The result of Goodness of Fit Tests](image-url)

<table>
<thead>
<tr>
<th>Construct / Indicator</th>
<th>Factor loading</th>
<th>t-value</th>
<th>Goodness of Fit Index (GFI)</th>
<th>Adjusted Goodness of Fit Index</th>
<th>Root Mean Square Error of Approximation</th>
<th>Root Mean square Residual (RMR)</th>
<th>Normed Fit Index (NFI)</th>
<th>Non-Normed Fit Index</th>
<th>Comparative Fit Index (CFI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support</td>
<td>0.42</td>
<td>10.59</td>
<td>0.91</td>
<td>0.92</td>
<td>0.070</td>
<td>0.049</td>
<td>0.96</td>
<td>0.94</td>
<td>0.94</td>
</tr>
<tr>
<td>Data</td>
<td>0.41</td>
<td>8.93</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infrastructure</td>
<td>0.42</td>
<td>6.29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human Force Factors</td>
<td>0.21</td>
<td>4.38</td>
<td></td>
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<tr>
<td>Organizational Factors</td>
<td>0.38</td>
<td>6.80</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Environmental Factors</td>
<td>0.56</td>
<td>6.71</td>
<td></td>
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<td></td>
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<tr>
<td>Efficiency</td>
<td>0.61</td>
<td>5.61</td>
<td></td>
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<tr>
<td>Improvement of Productivity</td>
<td>0.61</td>
<td>7.22</td>
<td></td>
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<tr>
<td>Improvement of Decision Making</td>
<td>0.46</td>
<td>3.66</td>
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<td></td>
</tr>
<tr>
<td>Releabil</td>
<td>0.25</td>
<td>2.97</td>
<td></td>
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<tr>
<td>Access</td>
<td>0.43</td>
<td>4.08</td>
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</table>

![Table 4. Factor loading and the corresponding t-values of indicators in the measurement model](image-url)

<table>
<thead>
<tr>
<th>Construct / Indicator</th>
<th>Factor loading</th>
<th>t-value</th>
<th>Human Force Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support</td>
<td>0.42</td>
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<tr>
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<tr>
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<td>0.21</td>
<td>4.38</td>
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<tr>
<td>Organizational Factors</td>
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<td>0.46</td>
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<td>Releabil</td>
<td>0.25</td>
<td>2.97</td>
<td></td>
</tr>
<tr>
<td>Access</td>
<td>0.43</td>
<td>4.08</td>
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</tbody>
</table>

![Table 5. Results of testing the hypotheses of the study using path analysis](image-url)

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Path</th>
<th>Standardized estimated</th>
<th>The Significance of Parameters</th>
<th>Testing Hypotheses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HUM</td>
<td>PROD</td>
<td>0.87</td>
<td>3.43</td>
</tr>
<tr>
<td>2</td>
<td>HUM</td>
<td>DECIS</td>
<td>0.54</td>
<td>5.42</td>
</tr>
<tr>
<td>3</td>
<td>INFO</td>
<td>PROD</td>
<td>0.23</td>
<td>1.34</td>
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<tr>
<td>4</td>
<td>INFO</td>
<td>DECIS</td>
<td>0.29</td>
<td>1.11</td>
</tr>
<tr>
<td>5</td>
<td>ORGA</td>
<td>PROD</td>
<td>0.65</td>
<td>4.45</td>
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<td>6</td>
<td>ORGA</td>
<td>DECIS</td>
<td>0.78</td>
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<td>7</td>
<td>ENVI</td>
<td>PROD</td>
<td>0.52</td>
<td>6.32</td>
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<td>8</td>
<td>ENVI</td>
<td>DECIS</td>
<td>0.87</td>
<td>5.77</td>
</tr>
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</table>
Fig. 2. Structural model to test the research hypotheses in standard estimation state

![Diagram of structural model]

Chi-Square = 324.22, df = 121, P-value = 0.00000, RMSEA = 0.070

Fig. 3. Structural model to test the research hypotheses in a meaningful parameter

![Diagram of structural model]

Chi-Square = 324.22, df = 121, P-value = 0.00000, RMSEA = 0.070
required by any industry and business (Porter, 1979) and combine it with previous factors with some modification. Many similar researches independently have been done around the role of competitor and benchmarking in implementation of knowledge management like Akhavan et al. (2006) or the contribution of stakeholder (customers, buyer, suppliers, employee and public) in business intelligence model (Simmers, 2004). The research result is divisible in 3 parts which would be mentioned as follow.

In the first place, in this research it is shown a comprehensive model about BI and its role in integrating knowledge obtained from inside and outside of organizations, regarding to the use of IT-based systems with humans factors especially culture and competition based approach of people. Alongside of this, the model describes the importance of this integration towards using BI for reaching the success of systems which copes with the survival of each organization in context of learning organization. In this case, the model can use for all leading organization in establishing newest BI systems in particular companies which provide products of NANO.

Secondly, the hypotheses presented in this study were based on the conceptual model. From 8 hypotheses, 6 ones were confirmed. These were associated with people, organization and environment factors which had considerable effect on improving decision and productivity of organization. They showed that NANO’s companies in Iran can prepare excellent conditions to step towards using BI systems, irrespective of IT infrastructures. About this, the results illustrated that H3 and H4 hypotheses are rejected. In another word, lack of adequate bandwidth, low speed of the internet and lack of access to all market knowledge because of being unreliability in internet-based systems would create likely problems which can endanger success of BI systems. Therefore, it is better that authorities try to improve IT infrastructures at least in Knowledge-founded organizations in order to prepare good occasions towards providing the productions in markets and sharing the knowledge with other companies.

Finally, Since the system success depends on Human, IT, Structural and Environmental factors, So it is better that researchers have been more centralization on these factors to improve performance and effectiveness and efficiency of system which have direct relation to productivity and can reinforce data processing and accessibility and validity of data to improve the decision making capacity of organizations.

According to the implementation of this model in NANO technology area and obtaining valid results, it is recommended to have greater investigation in other industry and era and providing required infrastructure in order to perform business intelligence system. Therefore, it is suggested to empower the cooperative atmosphere between management and employees and emphasize on the supportive role of consultant and invest in training of the employee and improve the effective management of data and adapt the size and structure with the innovative and learning culture of the organizations and better observation of the effect of governmental regulation and support and being tender to the movement of the competitors and considerate the needs of the stakeholders in select and implementing high technologies systems like business intelligence.

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