

Critical Factors of Business Intelligence: [(Case of an It-Based Company)

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Abstract: Purpose- This paper aims to identify the effective components of Business Intelligence (BI), in order to facilitate the evaluation of the Business Intelligence in an IT- based Company in Iran. *Design/methodology/approach-* This paper has identified the effective components of business Intelligence through the case study Company based on a comprehensive review of recent literature. For this purpose, a questionnaire was designed, validated by some BI experts and then analyzed by some statistical methods. The results discussed various perspectives from the business Intelligence[point of view to provide some effective and essential components of BI. *Findings-*The statistical analysis determined five components as effective issues in this case study. These components are "strategy", "Information Technology", "environmental analysis", "Human resource" and " supporting-executive factors" and at least a conceptual pattern of BI is introduced. The overall results from the case study were positive as well, thus reflecting the appropriateness of the experts and managers of the case study Company. *Research limitations/implications-* The extracted components can act as a guideline for BI adoption in the case study Company. This helps to ensure that the essential issues are covered during design and implementation phase of BI program. For academics, it provides a common language to discuss and study the components crucial for business Intelligence[. *Originality/value-* The paper may present high value to researchers in the business Intelligence [field and to practitioners involved with BI program in the case study Company, this paper gives valuable information and guidelines that hopefully will help the leaders to consider the important issues during business Intelligence [establishment in the organization. *Paper type:* Case study

Key words: Business environment • Business Intelligence • Factor analysis • BI components

INTRODUCTION

In today's rapidly changing business environment, the need for timely and effective business information is recognized as essential for organizations not only to succeed, but even to survive. Business intelligence (BI) aims to support better business decision-making [1]. Thus a BI system can be called a decision support system¹ [2].

The Company which is worked on in this paper as a case study is working on IT field; This Company is one of the successful companies that focus on software projects, even military or nonmilitary. One of the main departments in this company is working on business Intelligence projects[, this department needs to make sure about

establishing the BI for itself and its customers, so it's necessary to evaluate and therefore measure the BI components in the related companies.

For managing the business Intelligence, it's necessary to evaluate the BI's process, As there are so many methods to evaluate the [BI, in this paper by using extensive literature review, the essential factors of business Intelligence were gathered and by having a survey in the case study Company, the importance of the factors were questioned, then by using the statistical methods such as factor analysis, the main components were determined in five items, as: "strategy", "Information Technology", "environmental analysis", "Human resource" and "supporting- executive factors", at least by

using the components and related factors, a conceptual pattern of BI is introduced and validated by the BI experts.

Business Intelligence [7]: Wikipedia list BI as “Business intelligence”, it refers to skills, technologies, applications and practices used to help a business acquire a better understanding of its commercial context. The term BI can be used to refer to:

- Relevant information and knowledge describing the business environment, the organization itself and its situation in relation to its markets, customers, competitors and economic issues
- An organized and systematic process by which organizations acquire, analyze and disseminate information from both internal and external information sources significant for their business activities and for decision making.

The purpose of BI is to aid in controlling the vast stocks and flow of business information around and within the organization by first identifying and then processing the information into condensed and useful managerial knowledge and intelligence. As such, the BI task includes little that is new and addresses very old managerial problems; it is one of the basic tasks of many management tools; that is, analyzing the complex business environment in order to make better decisions. As [3] have stated, organizations have: Collected information about their competitors since the dawn of capitalism. The real revolution is in the efforts to institutionalize intelligence activities.

BI presents business information in a timely and easily consumed way and provides the ability to reason and understand the meaning behind business information through, for example, discovery, analysis and ad hoc querying [4].

The BI literature suggests that much benefit can be derived from using BI [5], however, applying BI takes resources and the benefits actually occurring in practice are not always clear. There are so many articles that examine the measurement of BI for assessing the effects of BI activities as well as for assessing an organization's BI process.

Measurement of Business Intelligence: The measurement of business performance has long traditions in organizations. In the BI literature, authors have identified BI measurement as an important task [6], but a common view among scholars is that it is

difficult to carry out [7-9]. According to a recent survey, only a few organizations have any metrics in place to measure the value of BI [10].

An important issue in determining how and what to measure knows the purpose of the measurement [11, 12]. According to [13], performance measurement can be used for the following purposes: decision making, control, guidance, education and learning and external communication. The user of the measures should also be taken into account.

According to the literature, BI measurements serve two main purposes. The first and most common reason for measuring BI is to prove that it is worth the investment [14].

[15] Points out that CI manager need measures to justify their department's existence. Similarly, executives need to know whether it is rational for them to invest in BI, because it is still a rather new managerial discipline. Moreover, the BI literature includes a lot of unverified assumptions about the effects of BI. For example, [16] obtained empirical evidence regarding the value of BI as estimated by practitioners. According to his study, the estimated average payback of all BI projects is 310 percent of cost, which seems quite high.

The second main purpose for the measurement of BI activities is to help manage the BI process; that is, to ensure that the BI products satisfy the users' needs and that the process is efficient [17]. Namely, a BI process can be costly if the information gathered is not accurate or does not match the information needs. The users of a BI process measurement are likely to be the BI professionals in an organization and the typical measurement intent (e.g., guiding activities and learning) is to continually improve the BI products and services.

Table 1 provides a summary comparison of BI measurement for these two different purposes [18].

As the Table 1- shows, for managing the BI processes, it's necessary to evaluate and measure the factors of Business Intelligence. In the next sessions by using literature review, the recent factors that have more effects on BI are being shown.

Effective Factors of Business Intelligence: By using the famous papers on the effective, important and critical success factors of BI, about 70 factors were recognized, as there were so many repeated factors in these reviews, the authors tried to merge them as possible; at least by using Delphi method (with the experts of BI in the case study company), 25 applicable factors are listed in the Table 2-with referring to the names of the authors.

Table 1: Two Types of BI Measurement

Purpose for Measurement	Main Users of Measurement Information	Expected Benefits
Determining the value of BI	Executives justifying BI investments	Ability to cost-justify BI services and demonstrate the actual effects of BI
	BI professionals	
	BI service providers	Increased credibility of BI as a managerial tool
	Researchers	Improved rigor in BI research
Managing the BI process	BI professionals	
	BI service providers	Continuous improvement of BI products and services

Table 2: effective factors on BI

Author											
NO.	Factor	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	
1	Clear link with business objectives, vision and strategies				*		*	*	*	*	
2	BI projects as cross-organizational business initiatives	*									
3	Available or willing business representatives.	*									
4	choosing the areas of services	*									
5	Functioning IT/ business partnership		*							*	
6	Widespread management support		*				*	*			
7	Providing adequate governance for the BI program management	*			*		*	*			
8	Decision making by using Appropriate information			*							
9	A strong evaluation plan with measurement of outcomes at major milestones.								*		
10	Aware of the degree of uncertainty, and risk									*	
11	Integrates with Desktop and Operational Applications					*					
12	Foster Rapid Development					*					
13	Analytical Capabilities	*	*	*							
14	Acceptance of a phased and iterative development approach.	*					*		*		
15	Appropriate team skills	*					*	*			
16	sufficient resources (funding, information, human beings, ...)			*	*		*	*	*		
17	Acceptance of a set of standardized BI tools, policies, and procedures to support the BI Initiative.							*	*		
18	Effective data management	*		*			*	*	*	*	
19	Well-defined information and systems requirements						*	*		*	
20	Content quality (relevance, soundness)			*		*		*	*		
21	A strong communication plan which is phased and targeted to specific groups of users.					*			*		
22	Conforms to The Way Users Work					*		*			
23	Engaged business sponsors	*	*						*		
24	Restrictions or rules imposed on the BI application which define boundaries or conformance standards for the application							*		*	
25	A sustainable BI environment with the ability to adapt to future requirements.						*				

MATERIALS AND METHODS

In this paper the authors had a random sampling for the survey on BI factors, for this purpose a questionnaire was designed in three main parts: first section of the questionnaire consisted of some questions about the characteristics of the interviewees, The second section was for reviewing main concept of business Intelligence and finally the third section of the questionnaire

consisted of critical dimensions of business Intelligence [listed in Table 2 which were asked as the important factors to evaluate the BI effect on organizational success.

The statistical society in this paper is the IT-based Company's members that are about 250 people, by using the related formula (sample number of restricted society) that is shown in relation 1-the number of statistical sample is calculated that is 102 people, for more confidence, 170 validated samples were choused.

$$n = \frac{N \times Z_{\alpha}^2 \times \sigma^2}{\epsilon^2 (N-1) + \frac{Z_{\alpha}^2 \times \sigma^2}{2}}$$

Relation 1- sample number of restricted society

$$n = \frac{250 \times 3.84 \times 0.44}{0.01 \times 249 + (3.84 \times 0.44)} = 102$$

At least 102 questionnaires was completed, in these questionnaires, the importance of 25 factor of BI are Questioned through the Likert Spectrum that is shown in Table 3.

Validity and Reliability Analysis: Validity analysis tries to define the measuring tool's ability to measure the intended characteristics, in this paper for validity analysis the authors had some consulting sessions with BI professors and then, after designing the questionnaire (as a measuring tool) they checked it several times with more than ten experts of BI department in the case study Company.

With reliability analysis, you can get an overall index of the repeatability or internal consistency of the measurement scale as a whole and you can identify problem items that should be excluded from the scale. The Cronbach's α is a model of internal consistency, based on the average inter-item correlation. By using SPSS software The Cronbach's α [28] calculated from the 25 variables of this research that was 0.676 (67 percent), which showed high reliability for designed measurement scale.

Demographic Profiles of Interviewees: In this section, the generic and demographic characteristics of interviewees are analyzed; the demographic profile of employees who participate in the survey has been summarized in Table 4. As it shows:

Most of the members (56.5 percent) had Master of Science (MS) or higher educations. About the job title point of view, 60.6 percent of the participants were expert, 32.9 percent were supervisors and the others were managers in different levels. Table 4. Also shows the seniority of the participants. As it can be seen, 10.5 percent had over 20 years seniority, 18.7 percent had 12-20 years, 39.1 percent had 4-12 years and the others had less than four years seniority.

Table 3: Likert Spectrum

Very Low	Low	Middle	High	Very High
1	2	3	4	5

Table 4: Demographic characteristics of the interviewees

Characteristics	Grouping	Number	Percent (%)
Education	Diploma	2	1.2
	Bachelor of Science (BS)	67	39.4
	Master of Science (MS)	96	56.5
	PHD	5	2.9
	Total	170	100
Job title	Expert	103	60.6
	supervisor	56	32.9
	Top management	8	4.7
	Director	3	1.8
	Total	170	100
Seniority	0-4 years	54	31.6
	4-12 years	66	39.2
	12-20 years	32	18.7
	Over 20 years	18	10.5
	Total	170	100
Age	25-30 years	63	37.1
	30-35 years	45	26.5
	35-40 years	39	22.4
	Over 40 years	23	14.1
	Total	170	100
Gender	Male	99	0.58
	Female	71	0.42
	Total	170	100

DISCUSSION

In this paper, 25 factors of business Intelligence are reviewed [1], for having more proper management on these factors in the case study company, it's essential to reduce the factors to some main components. For this purpose, the Factor Analysis method is used to reduce the factors and then group them in some components.

With factor analysis, the researcher can first identify the separate factors of the structure and then determine the extent to which each variable is explained by each factor. Once these factors and the explanation of each variable are determined, the two primary uses for factor analysis-summarization and data reduction-can be achieved. In summarizing the data, factor analysis derives underlying factors that, when interpreted and understood, describe the data in a much smaller number of concepts than the original individual variables. Data reduction can be achieved by calculating scores for each underlying factors and substituting them for the original variables [29].

In order to determine whether the partial correlation of the variables is small, the authors used the Kaiser-Meyer-Olkin measure of sampling adequacy and

Bartlett's χ^2 test of sphericity [30] before starting the factor analysis. The result was a KMO of 0.771 and less than 0.05 for Bartlett test, which showed good correlation as depicted in Table 5.

Factor analysis is a technique particularly suitable for analyzing the patterns of complex, multidimensional relationships encountered by researchers. It defines and explains in broad, conceptual terms the fundamental aspects of factor analytic techniques. Factor analysis can be utilized to examine the underlying patterns or relationships for a large number of variables and to determine whether the information can be condensed or summarized in a smaller set of factors or components. To further clarify the methodological concepts, basic guidelines for presenting and interpreting the results of these techniques are also included. Factor analysis provides direct insight into the interrelationships among variables or respondents and empirical support for addressing conceptual issues relating to the underlying structure of the data. It also plays an important complementary role with other multivariate techniques through both data summarization and data reduction [29].

An important tool in interpreting factors is factor rotation.

The term rotation means exactly what it implies. Specifically, the reference axes of the factors are turned about the origin until some other position has been reached. The un-rotated factor solutions extract factors in the order of their importance. The first factor tends to be a general factor with almost every variable loading significantly and it accounts for the largest amount of variance. The second and subsequent factors are then based on the residual amount of variance. Each accounts for successively smaller portions of variance. The ultimate effect of rotating the factor matrix is to redistribute the variance from earlier factors to later ones to achieve a simpler, theoretically more meaningful factor pattern. The simplest case of rotation is an orthogonal rotation, in which the axes are maintained at 90° [29].

Table 5: KMO indicator and Bartlett test

KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.771
Bartlett's Test of Sphericity Approx. Chi-Square	2.872E3
df	351
Sig.	.000

In this research, the factor analysis method is "principle component analysis" which was developed by Hotelling [31].

Table 7. Shows the rotated matrix of the variables, each variable should have significant factor loading (greater than 0.5) only on one component.

The condition for selecting factors was based on the principle proposed by Kaiser [32]: Eigen value larger than one and an absolute value of factor loading greater than 0.5. The 25 factors were grouped into five components. The results can be seen in Table 6. Five components had an Eigen value greater than one and the interpretation variable was 62.155 percent. The factors were rotated according to Varimax.

The authors attempted to name the factors briefly without losing contents of components. In this way, the names and content of the five components are as below:

"Information Technology", "Executive and Supporting variables", "Environmental Analysis", "Human resource" and "Strategy" are the names of first, second, third, fourth and fifth components of business Intelligence. These components with the related variables are shown in Table 8.

Finally, Correlation analysis between organizational features and the BI components was performed; the organizational features discussed here include interviewee's age, gender, seniority, job titles and educational degree.

The correlation analysis showed that Job title had an extremely positive correlation with these BI components: "Strategy", "Executive and supporting variables" and "Environmental analysis". This may be resulted from the understanding level of personnel about management area

Table 6: Factor analysis results

Rotation Sums of Squared Loadings

Component	Initial eigen values	Total	% of Variance	Cumulative %
1	4.937	4.613	17.085	17.085
2	3.877	3.819	14.143	31.228
3	3.231	3.485	12.908	44.136
4	2.433	2.461	9.114	53.250
5	2.304	2.404	8.905	62.155

Table 7: Rotated component matrix

No	Factors	Information Technology	Executive and Supporting variables	Environmental Analysis	Human resource	Strategy and Management
1	strategy	.065	.013	-.041	-.047	.956
2	KM	.021	-.084	.666	-.022	-.042
3	agent	.022	.043	.586	-.035	-.024
4	service_area	-.106	.697	.130	-.218	-.032
5	IT_BI	-.079	.742	-.077	.087	-.031
6	management	.008	.037	-.005	-.077	.824
7	planning	.041	.691	-.072	.023	.168
8	information_usage	.061	-.030	.035	.063	.846
9	evaluation	-.098	.830	.043	-.074	.013
10	risk	.760	-.142	-.015	.016	-.009
11	software_intigration	.733	-.067	-.098	.020	.038
12	platform	.726	.010	-.015	-.121	.045
13	analysis_software	.723	-.007	.008	.093	.037
14	developement	.655	-.024	-.011	-.127	.008
15	users_skill	.054	-.070	-.030	.901	-.009
16	resources	-.081	.831	-.168	.005	-.076
17	tools	-.032	.913	-.054	-.042	-.026
18	date_management	.724	-.024	.086	-.004	-.079
19	requirement_definition	.737	-.058	-.071	.057	.129
20	information_quality	.944	-.069	-.014	.018	.007
21	users_relation	-.066	-.073	.003	.858	.034
22	users_satisfaction	-.040	.001	.024	.888	-.088
23	sponserers	-.086	-.017	.579	-.013	.064
24	rules	-.013	.085	.713	.042	.070
25	future_enviroment	-.010	.012	.925	.021	.000

Table 8: the main components with related factors

NO.	Main Components	Factors (variables)
1	Information Technology	Aware of the degree of uncertainty, Integrates with Desktop and Foster Rapid Development Analytical Capabilities Acceptance of a phased and iterative development approach. Effective data management Well-defined information and systems requirements Content quality (relevance, soundness)
2	Executive and Supporting variables	choosing the areas of services Functioning IT/ business partnership Providing adequate governance for the BI program management A strong evaluation plan with measurement of outcomes at major milestones. sufficient resources (funding, information, human beings, ...) Acceptance of a set of standardized BI tools, policies and procedures to support the BI Initiative.
3	Environmental Analysis	Restrictions or rules imposed on the BI application which define boundaries or conformance standards for the application A sustainable BI environment with the ability to adapt to future
4	Human resource	Appropriate team skills A strong communication plan which is phased and targeted to specific groups of users. Conforms to The Way Users Work
5	Strategy and Management	Clear link with business objectives, vision and strategies Widespread management support Decision making by using

and different features of organization; it means that people with higher ranks in the organization believe that these topics are crucial for successful BI adoption. This may be resulted from their understanding about the situation and their familiarity about the importance of these subjects.

Seniority and age have the positive correlation with "Environmental analysis"; it would be interpreted in the way that people with more experience will be more familiar with the environmental changes, so they have more sense about the importance of environment.

Educational degree of interviewees was positively correlated with "Information Technology". Since, they already had a thorough knowledge of BI related science and their cognition increases with higher educations.

Also there is a positive correlation between gender and the component of "human resource"; it may be because of the sensitivity of females that make them to pay more attention than males to the communicational and motivational factors of human beings.

CONCLUSION

In this paper from a comprehensive literature review, 25 critical dimensions of business Intelligence¹ were distinguished. Therefore, the interviewees selected more important dimensions from these 25 variables by assigning the ranks to them.

The study then used factor analysis to extract critical factors of business Intelligence¹ in the case study Company through 25 variables. The result of factor analysis was extracting five main component of business Intelligence¹ that are: "Information Technology", "Executive and Supporting variables", "Environmental Analysis", "Human resource" and "Strategy". Then by using correlation analysis, the relationship between demographic profiles of interviewees and extracted components of BI was analyzed, that concluded to some appropriate and logical results for the related company.

The authors believe that after this research, the BI managers of the case study Company can decide in a better way for establishing the business intelligence systems. For further research the authors suggest other organizations to recognize their own business Intelligence¹'s factors for designing a suitable pattern of BI evaluation.

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