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# The study of Business Intelligence and Productivity and Prioritizing the Factors of Business Intelligence by AHP Approach

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### ABSTRACT

The main goal of this research is to study the relationship between Business Intelligence and productivity in the companies, manufacturer of pressure vessels, located in Amol – Mazandaran. The other goal of this research is to prioritize the factors of Business Intelligence using AHP approach. The population of the research consists of top, middle, and operating managers, that out of a group of 90 people, 76 of them have been selected, based on the Morgan Sample Capacity Estimating Table, as the sample of the study. For collecting data, two questionnaires of Business Intelligence and productivity have been used. At first, to analyze the research data, the efficiency of each unit has been measured by the help of DEA technique. Then by the help of descriptive and inferential statistics, the hypothesis of the research have been studied and finally the factors of Business Intelligence have been prioritized by the AHP approach. According to the results of DEA technique, units that have more resources will act in a weaker level in terms of efficiency. The result of testing the hypothesis showed that there was a positive and meaningful relationship between Individual ( $P=0.006$ ), system quality ( $P=0.009$ ), individual learning ( $P=0.043$ ), competitive performance ( $P=0.01$ ), and productivity. There is also a positive and meaningful relationship between Business Intelligence and productivity ( $P=0.02$ ). Among the factors of Business Intelligence, the competitive performance is the most important factor in enhancing productivity, and the Mental Model Maintenance is the least one.

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### Introduction

Considering the development of modern technologies and their outstanding speed in advancement, the organizations are seeking for some tricks to compete with their rivals and ensure their survival in this agitated and confused field. Nowadays, the environment in which organizations are performing is going to be more and more complex (Huber 2003). This complexity, on one hand, makes some opportunities, but on the other hand, it may cause some problems. Companies should accept that the philosophy of their life has changed and now they should look for competition and its tools (Golestani 2008). Organizations, for supporting the decisions and improving their business operations, have to collect, understand, and manage the data. In addition, today the lifetime of the commercial cycle of business has been shortened. So, a fast, informed, and good decision making has been become a competitive requirement (Asfydany, noori 2010). The Business Intelligence is a tool which can provide the situation for an informed decision making and competing in the market. Business Intelligence is a term which was introduced by Gartner and its researchist, Howard Dresner, in 1989 (Mohaghar et al. 2008, Ghazanfari, Jafari, Taghavi Fard, Rouhani 2008, Haghghat Monfared 2010). Business Intelligence is an umbrella term which includes a set of concepts, methods, and processes that with utilizing the facts and the systems which are based on those facts cause to improve the process of decision making (Mohaghar et al. 2008, Ghazanfari, Jafari, Rouhani 2011). In fact, it could be said that Business Intelligence is a wide dimension of softwares and analytical solutions for collecting, integrating, analyzing, and

accessing the procedure that allows the users of businesses to make better decisions (Serbanescu 2010, Gangadharan & Swami 2004, Wang & Wang 2008, Michalewicz, Schmidt, Chiriac 2006, Woodside 2010). Indeed, Business Intelligence is a tool that improves the process of decision making in organization by combining the operating and analytical devices (Serbanescu 2010, Kapoor 2010, Golfarelli, Rizi, Cella 2004, Hannula & Pirttimaki 2003, Negash & Gray 2003). One can say that the Business Intelligence is a tactic that is more used for sensitive, strategic, and problematic areas (Mohaghar et al 2008, James.H & Thomas 2001). Nevertheless, it supports the process of decision making at all levels of management (Mahmudi 2008). Business Intelligence, by collecting data and making it available, improves the competitive Performance and advantage (Jones 2005, Seah, Huei Hsieh, Weng 2010, Mohaghar et al 2008, Wang & Wang 2008, Michalewicz, Schmidt, Chiriac 2006, Hannula & Pirttimaki 2003, Ghazanfari, Jafari, Rouhani 2011). Efficiency improvement or productivity is known as one of the most important approaches for economical, social, and cultural development among various nations, and success in accelerating the process of improving the productivity is one of the main conditions for accessing an appropriate position in the global competition field. During many years, researchers have mentioned that the productivity of organizations is extremely influenced by some factors (Armstrong 2006, Clawson & Newburg 2005, Hankin 2004, Williams & Williams 2003, Griffin 2002). Knowing the effective factors on productivity is a prerequisite for improving the efficiency of organizations

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(Gryna , Chua , DeFeo 2007 , Coggburn & Schneider 2003 , Longenecker & Leffakis 2002).

Josef Woodside (2010) made an investigation by studying the Business Intelligence and learning as stimuli of competitive Performance and quality. Seven factors have been considered in this research, which are as follow: individual learning; data quality; system quality; service quality; organizational learning; organization quality; and competitive efficiency. The research shows that Business Intelligence systems are capable of increasing the relationship between learning and competitive efficiency.

Oykuisik (2010) made an investigation on the practical evaluation of the role of Business Intelligence ability and system environment. He expresses the Business Intelligence ability in eight items that include data grouping, data types, interaction with other systems, users' accessibility, data reliability, risk level, flexibility, and the direct understanding of complexity of the analysis. This study has been administered in the United States and on the managers who use the Business Intelligence. According to this study, high quality and reliable data are two factors available for Business Intelligence.

Ghazanfari, Jafari, and Rouhani (2010) studied a tool for evaluating the Business Intelligence in businesses and they express that if there is a technique for evaluating the level of intelligence in business system, then we can have improvement in the process of decision making. The authors believe that the data presented in this study can cause better decision in designing, selecting, evaluating, and buying business systems for making decision about working environment systems. Bhushan Kapoor (2010), in an investigation, has utilized the Business Intelligence in human resources management. He mentions that the Business Intelligence plays an important role for gaining competitive advantage among rivals, especially at the time of fluctuations in the market. The organization utilizes the Business Intelligence to increase cleverness and sagacity in informational systems and for faster and more reliable decision makings.

Lin, Ti Sai, et al. (2008) evaluated the performance of Business Intelligence systems by using the ANP technique. In this study there are nine indices and twelve sub indices. The main indices are: the system response time, security systems, accuracy and validity of the output data, implementing the experiences of the advisor, understanding degree of the business executor, the supporting degree of high level management usage, adaptations with requirements, supporting the organizational productivity, and supporting the organization decision making. This research has studied the top managers. The evaluation results show that the critical factors in utilizing the Business Intelligence, according to their priority, are: A) Accuracy and validity of the output data B) Adaptation with requirements C) Supporting the organizational productivity D) the system response time, that this prioritizing has been achieved by using the ANP technique. In fact, the systems' more emphasis is on the accuracy and validity of the data; excessive persistence at the time of system responding may cause some undesirable consequences.

Saremi and Shahriari (2003), for complete ranking of the determiner units, used DEA and AHP models simultaneously to neutralize each other's problems. DEA (Data Envelopment Analysis) is a scientific approach that calculates the efficiency. But the units are divided into two groups of efficient and deficient and there is not a complete ranking of units. In this study, they tried to demonstrate a complete ranking of determiner units by combining the AHP and DEA models. Zila

(2002) believes that either of the methods has its own limits. One of the problems of DEA model is that when there are few units and the number of input and output data is high, a large number of units will be completely efficient, that by utilizing the AHP method, the diagnostic power, with the weights presented, will increase.

Adel Azar (2000) has done a comparative study between DEA and Analytical Hierarchy Process, and has studied the soft and hard techniques in the decision-making process. DEA has been selected from among hard decision-making techniques, and the Analytical Hierarchy Process has been selected from among soft decision-making techniques, and the power of these two techniques has been compared. The results of the study show that although both techniques will give similar results, the power of AHP is more than that of DEA. The following results have been concluded from the study:

1. Although the DEA technique is based on historical and objective data and its analysis is done according to hard technique in management science, its base is completely similar to that of AHP technique, which is done due to soft techniques.
2. Although the AHP technique is based on the subjective judgments of the determiner, because of the sameness of the basis of both AHP and DEA, their results are also similar.
3. The AHP technique, in addition to similar results with DEA technique, provides the determiner with more information. For example, in addition to comparing the determiner units with each other, it is possible in AHP technique to compare the efficient units with each other and specify their efficiency order.
4. The aforementioned study shows the better efficiency of AHP technique in comparison with DEA.

Adel Azar recommends in this study to investigate more in other decision-making environments, and he believes that the comparison of DEA techniques with AHP techniques, due to fuzzy logic, can provide the scientific society with remarkable and useful results.

### Methodology

This research, regarding grouping based on the goal, can be considered as an applied research. In terms of data collection, this is a descriptive survey which utilizes correlation study and is done as a field research. The population of this study is consisted of the managers, a number of 90, of the companies manufacturer of pressure vessels, located in Amol – Mazandaran. According to the population and the Morgan Table, the sample of the study includes 76 people. This study, done on 6 units, evaluates the productivity of each unit by utilizing the DEA technique in a period of 6 successive years, from 2006 to 2011. For evaluating the productivity, four indices as input and two indices as output are used. The inputs are: the number of manpower; person-hour training; material; and capital, and the output includes number of production and benefit, that DEA Master software has been used here. For assessing the relationship between Business Intelligence and productivity two questionnaires have been used that include:

1. Business Intelligence questionnaire with 51 questions and 7 value scales (1= totally disagreed to 7= totally agreed), which evaluates 10 indices: 1) Individual 2) System Quality 3) Information Quality 4) Individual Learning 5) Mental Model Building 6) Mental Model Maintenance 7) Organizational Learning 8) Competitive Performance 9) Service Quality 10) Organization Quality.

2. Productivity questionnaire with 30 questions and 5 value scales (1= very little to 5= very much)

To describe the findings the inferential statistics method has been used, and to study the relationship between the variables

the correlation coefficient, with the significance level of  $P \leq 0.05$ , has been utilized. Finally, for ranking the indices of Business Intelligence the AHP approach has been used, getting help from Expert Choice software.

**Research Hypothesis**

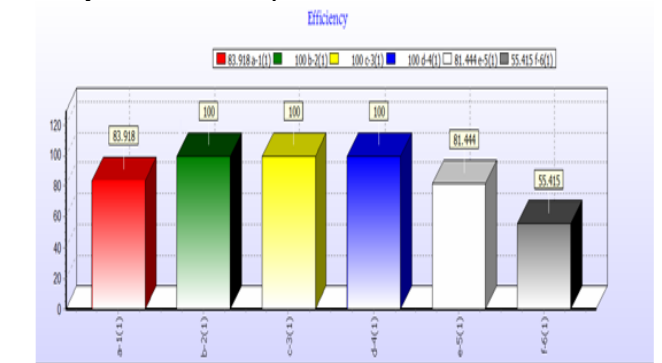
1) There is a meaningful relationship between Business Intelligence and productivity. 2) There is a meaningful relationship between individual and productivity. 3) There is a meaningful relationship between system quality and productivity. 4) There is a meaningful relationship between information quality and productivity. 5) There is a meaningful relationship between individual learning and productivity. 6) There is a meaningful relationship between Mental Model Building and productivity. 7) There is a meaningful relationship between the Mental Model Maintenance and productivity. 8) There is a meaningful relationship between organizational learning and productivity. 9) There is a meaningful relationship between competitive performance and productivity. 10) There is a meaningful relationship between service quality and productivity. 11) There is a meaningful relationship between organization quality and productivity.

**Research Findings**

Among a sample of 76 people, there are 53 men, 69.7% of total, and 23 women, 30.3% of total, which 14.4% of them are top managers, 30.3% are middle managers, and 55.3% are operating managers. 29 of these people, 38.2% of total, work in production unit which is the highest percentage of total. 61.9% of people have been working in the organization for less than five years, and 57.9% of them are between 25 to 34 years old.

**Data Envelopment Analysis Findings**

After collecting the studied units' data and finding the efficiency of each year, the total efficiency has been evaluated and the results can be seen in Picture 1 1 : total efficiency of the units. Moreover, the data of the each year's efficiency and the total efficiency of the units are presented in Table 1.



**Table 1 : efficiency of the units**

Unit	2006	2007	2008	2009	2010	2011	Total Efficiency
A	100	98.778	100	100	100	91.717	83.918
B	100	100	100	80.667	85.067	70.957	100
C	100	97.828	100	85.004	100	100	100
D	100	100	86.549	93.108	88.876	100	100
E	100	100	100	100	97.899	100	81.4444
F	100	100	100	100	100	99.116	55.415

But the noteworthy point here is that the units A, E, and F have higher resources than other units, but their efficiencies were weaker.

Unit A has had an approximately good efficiency during a period of six years, but in comparison to other units it is in a lower rank.

Unit B has had a desirable efficiency in the first three years, 2006, 2007, and 2008, but its efficiency declined in the next three years and in 2010 it has presented its weakest efficiency.

Nevertheless, in comparison with other units, it has the total efficiency of 100% that is a warning for this unit, and it is likely that the total efficiency decreases in the next years. So, as a result, this unit has to extremely control its activities.

Unit C has had a good efficiency, except in 2009, and by the calculations that it did, it made up its weaknesses in the next years. In comparison to other units, it has 100% efficiency and, as a result, it should maintain its position.

Unit D has had a good efficiency in 2006 and 2007, but its efficiency has decreased for about 13.5% in 2008, that some of this decrease has been made up in 2009, but in 2010 there was a 4.3% decrease than 2009, and this point shows a kind of fluctuation during three years. But in 2011 the reduction of efficiency has been compensated and the efficiency is now 100%. Regarding to the fluctuations mentioned above, however, this unit should try more in order for maintaining the existing stability. Nevertheless, in comparison to other units, the efficiency of this unit was better and its total efficiency is 100%, Unit E has had an acceptable and identical efficiency in successive years, but its efficiency compared to other units is not appropriate and the total efficiency of this unit is 81.4%, which shows its undesirable condition compared with other units. For accessing the desirable condition and competitive advantage, this unit needs to try more and increase its efficiency by using the resources which it has.

Unit F, like unit E, has had an acceptable and identical condition but it has been recognized as the weakest unit among all units, and this point shows the wrong usage of resources.

With the analyses that are done, it can be concluded that these units are not capable of using their resources in a desirable manner.

**Inferential Statistics Findings**

From eleven hypothesis that have been evaluated in this study, five hypothesis have been accepted, and six of them have been rejected, which their results can be seen in Table 2.

In this study, we are going to evaluate the relationship between two variables, one of them as our independent variable, and the other one as our dependent variable. The Null hypothesis (H0) is based on the inexistence of a meaningful relationship between the two variables, and the Directional hypothesis (H1) is based upon the existence of a meaningful relationship between the two variables. In this study, the Pearson Correlation Coefficient has been used which shows the amount of correlation between the two variables and the kind of relationship between them. In addition to Correlation Coefficient, there is another factor used as a significance level. If  $P \leq 0.05$ , then the Null hypothesis will be rejected and the Directional hypothesis will be accepted, which shows a meaningful relationship between the two independent and dependent variables.

As we see, the level of significance of five indices, individual; system quality; individual learning; competitive Performance; and Business Intelligence has been less than 0.05, it can be concluded that there is a meaningful relationship between individual; system quality; individual learning; competitive Performance; and Business Intelligence, and the more amount of these indices, the more productivity we have. Finally, there is a meaningful relationship between Business Intelligence and productivity, that is, if the amount of Business Intelligence increases, productivity will increase as well. Depending on this Table, the significance level of information quality, mental model building, mental model maintenance, organization learning, service quality, and system quality is more than 0.05, and it can be concluded that there is not any

meaningful relationship between information quality, mental model building, mental model maintenance, organization learning, service quality, system quality, and productivity. Directional hypothesis is rejected and the Null hypothesis is accepted.

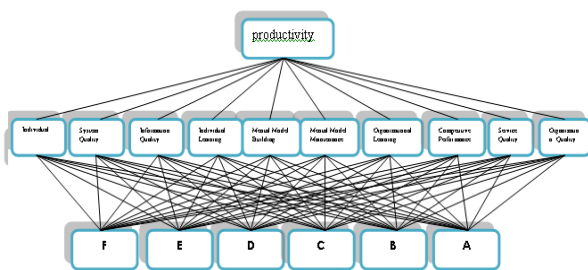
**Table 2 : results of the hypothesis testing**

Independent variable (x)	Dependent variable (y)	Pearson Correlation Coefficient	significance level	reject or accept H <sub>1</sub>
Individual	productivity	0.313	0.006<0.05	accept
System Quality	productivity	0.3	0.009<0.05	accept
Information Quality	productivity	0.146	0.209>0.05	reject
Individual Learning	productivity	0.234	0.043<0.05	accept
Mental Model Building	productivity	0.201	0.081>0.05	reject
Mental Model Maintenance	productivity	0.185	0.113>0.05	reject
Organizational Learning	Productivity	0.210	0.069>0.05	reject
Competitive Performance	Productivity	0.292	0.01<0.05	accept
Service Quality	Productivity	0.111	0.345>0.05	reject
Organization Quality	Productivity	0.218	0.058>0.05	reject
Business Intelligence	Productivity	0.269	0.020<0.05	accept

**Prioritizing of Business Intelligence factors by AHP approach**

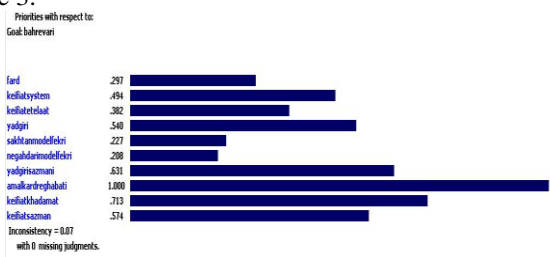
The Analytical Hierarchy Process is one of the most comprehensive systems designed for decision making with multiple criteria, which was developed for the first time by Thomas el Saati in 1980. This process makes it possible for managers to examine different scenarios (ghodsipoor 2006). AHP approach is based upon paired or two by two comparisons of alternatives and decision making criteria. The basis of the execution of the AHP technique is as follows: 1) making a hierarchy tree 2) paired comparisons 3) normalization and prioritizing 4) consistency rate (salehi 2001).

The hierarchy tree, which is used in this study, is shown in Picture 2.



**Picture 2 : hierarchy tree**

Expert Choice software has been used in this study to solve the AHP model. The result of this software can be seen in Picture 3.



**Picture 3 : Prioritizing the Factors of Business Intelligence by AHP Approach**

As we see, the priorities have been included in Table 3.

**Table 3: Prioritizing the Factors of Business Intelligence Conclusion**

Priorities	Factors of Business Intelligence	Weight
1	Competitive Performance	0.197
2	Service Quality	0.141
3	Organizational Learning	0.125
4	Organization Quality	0.113
5	Individual Learning	0.107
6	System Quality	0.098
7	Information Quality	0.075
8	Individual	0.059
9	Mental Model Building	0.045
10	Mental Model Maintenance	0.041

The results of DEA technique show that the studied units do not have the capability to use their resources in a desirable manner. This is because the units which are provided with more resources have had weaker efficiency in terms of productivity. Organizations should therefore select a system that causes optimized usage of resources.

The results of testing hypothesis show that, among 10 Business Intelligence factors, there are 4 factors which have a meaningful relationship with productivity.

1. Individual and productivity have a meaningful relationship between each other with the significance level of 0.006. According to studies, if an individual has more abilities in the organization, the productivity will increase as well. Seah, Hsieh and Weng It has been shown in 2010 that top managers, by increasing their leadership power, can increase the productivity of Business Intelligence in organization. Moreover, Oknen et al.(2002) shows in his studies that management knowledge, efficiency evaluation, and Business Intelligence are related with one another and this relationship will increase the productivity in the organization, and the more competent managers, the more productivity we have.

2. System quality and productivity have a meaningful relationship with the significance level of 0.009. According to the results, if the ease of system interactions is more, the system will have a higher analysis power, and if the reliability and data consistency is more and the system architecture is more systematic and the accessibility to the requests is easier, then productivity will increase. This finding is accordant with Eckerson study in 2003. He showed that Business Intelligence will increase data reliability up to 59% and improve the approaches and programs up to 56%.

3. There is a meaningful relationship between individual learning and productivity with the significance level of 0.043. So it can be said that if the continuous improvement in an individual is more and the change of understanding and behavior is faster in him, the productivity will increase as well.

4. There is a meaningful relationship between competitive Performance and productivity with the significance level of 0.01, and this means that if the organization tries more to satisfy the beneficiaries and it has more capability to maintain the desirable and pleasant condition, the productivity will increase as well. Ghazanfari, Jafari, Rouhani in 2011 shows that Business Intelligence improves the decision making process in organization and through this the organization achieves competitive advantage. Asfydany and Noori (2010) In a book, named as Business Intelligence, it is said that attempt to achieve a competitive advantage is one of the practical goals of Business Intelligence. Organizations achieve this goal by using Business Intelligence through improving the brand and customer loyalty. . Bhushan kapoor (2010) believe that Business Intelligence plays

a very important role in maintaining the competitive advantage in the industry.

Moreover, studies have shown that, in manufacturer of pressure vessels, there has been a positive relationship between information quality, Mental Model Building, Mental Model Maintenance, organizational learning, service quality, system quality, and productivity, but with no significance level. It can be concluded therefore that the aforementioned factors do not have any influence on organization productivity.

The total result of this study shows the existence of a positive and meaningful relationship between Business Intelligence and productivity with the significance level of 0.02. This finding is exactly similar to the result of the Lin, Ti Sai, et al. study that was done in 2009. They have shown that the Business Intelligence raised the system efficiency in organization for 24%.

In this research the AHP approach has been used for prioritizing the factors of Business Intelligence, and for giving weight to the factors the opinions of 10 experts and top managers have been used, and also the results of DEA approach and organization information have been utilized to give weight to the alternatives. The results show that the competitive Performance is one of the most important factors of Business Intelligence which increases the productivity in the organization. Therefore, the main factor of increasing the productivity is related to the competitive Performance of markets, that this result is identical to the result of Salehi (2010). Moreover, Mental Model Maintenance has been considered as the least important factor of Business Intelligence in increasing the productivity.

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