Study of adaptive business intelligence techniques for optimization of organizational decision making
(In select automobile manufacturing companies in Maharashtra)

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Abstract: Lack of technological awareness, adaptability and self-system administration are the important factors affecting on IT enabled decision making today. All types of technology ready practices which fall under adaptive business intelligence techniques are already emerging in various areas of business. The study is basically aimed to draw conclusion that adaptive business intelligence techniques are not adopted on large scale due to impact of internal and external factors. ABI techniques can help business managers of all levels to take better decisions. Automobile manufacturing companies being a pillar of global economy should give special attention to adoption of adaptive business intelligence techniques.

Keywords: Adaptability; Adaptive Business Intelligence techniques; Optimization; System Administration; Decision making;

I. INTRODUCTION

Today Most of the business organizations are using internet technology, network and wireless technology for improving business performance measured in terms of cost, efficiency, competitiveness and profitability. They are using enterprise solutions such as ERP (Enterprise Resource Planning), SCM (Supply Chain Management), and CRM (Customer Relationship Management) which are supported by technologies such as data warehouse, decision support systems and knowledge management systems. E-business enterprise is more process driven, technology enabled hence intelligent, adaptive solutions are required for faster decision making.

In the near future “digital” and “business” will be nearly synonymous for the automobile industry as automotive companies need a multifaceted technology in order to attain sustainable growth in an environment that is more complex, dynamic and competitive. Complexities in making effective and timely decisions in highly competitive markets have driven automobile industries to adopt data–information-knowledge-intelligence driven decision making processes using multifaceted adaptive business intelligence techniques.

During the past few decades, organizations have strived to improve their decision making capability by collecting and storing more data. The need to convert this raw data into usable knowledge has resulted in the emergence of Business intelligence industry. Although the major goal of business intelligence is to help managers make optimum, faster and smarter decisions, organizations now realize that there is a vast gap between having right knowledge and making the right decision. For this reason the future of the business intelligence industry lies in systems that can predict, optimize and adapt, i.e. Adaptive Business Intelligence.

Adaptive Business Intelligence can be defined as “the discipline of using prediction and optimization
techniques to build self-learning decision making’ systems”. The power and strength of Adaptive Business Intelligence Systems reside in their ability to answer the two fundamental questions behind all information system decisions: What is the best decision right now? And what is likely to happen in future? The goal of Adaptive systems is solving real-world business problems that have complex constraints, possibly conflicting objectives, an enormous number of possible solutions and which are set in a time-changing environment. Adaptive Business Intelligence System incorporates prediction and optimization modules to obtain near optimal decisions and an adaptability module for improving future recommendations. Such systems can help business managers make decisions that increase efficiency, productivity, and competitiveness.

**KEY DEFINITIONS**

**Business Intelligence**: Computerized information Systems for gathering, storing, analyzing and providing access to data in the form of various reports.

**Adaptive Business Intelligence**: Computerized Information System which gives support to predict the situation and helps in choosing best alternative.

**Prediction**: The basic function of prediction is to produce an output based on some input. To make the prediction module functional it is necessary to train the various underlying models using historical data. Organization must have decision trees ready to solve problems in different situations.

**Optimization**: A system or module capable of recommending the best answer. As every industry strives for excellence optimization techniques help managers to find better solutions through decision making.

**Adaptability**: A system or module that would improve over time by learning from its own prediction errors is truly adaptive. Because today’s accurate prediction might be inaccurate tomorrow, the prediction system must be capable of learning from and adapting to changes in the environment.

**Dashboard**: A dashboard is an easy to read, often single page, real-time user interface, showing a graphical presentation of the current status (snapshot) and historical trends of an organization’s key performance indicators to enable instantaneous and informed decisions to be made at a glance

**ORGANIZATIONAL DECISION -MAKING**

An Organization is an arrangement of individuals having different goals. Since the organization system has a dynamic role to play to meet the changing needs of a business, the decision making gives common support for playing the dynamic role. Thus Decision making plays very important role in improving culture of the organizational management

The organizations perform in an environment of uncertainty such as market uncertainty, the price fluctuations, the changes in the government policy, moves of the competitors, the technology changes are some of the factors which make the business environment uncertain. Organizational management will therefore be towards minimizing the risk in decision making with available information support.

Thus Decision making is very important factor of every organizational management. Decision making also plays important role in all the functions of the management.
INDIA'S CAR MANUFACTURING INDUSTRY HUB

The majority of India's car manufacturing industry hub is based around three clusters of south, west and north. The southern cluster near Chennai is the biggest with 35% of the revenue share, followed by the west comprising of Maharashtra at 33% and the north cluster comprising mainly of Haryana with 32%.

The Chakan corridor near Pune, Maharashtra is the western cluster with companies like General Motors, Volkswagen, Skoda, Mahindra & Mahindra, Tata Motors, Mercedes Benz, Land Rover, Fiat and Force Motors having assembly plants in the area. Aurangabad with Audi, Skoda and Volkswagen also forms part of the western cluster.

There are 30 manufacturing plants of passenger vehicles in 9 states of India, out of which 11 plants are located in Maharashtra itself. Researcher has chosen 10 automobile passengers car companies in Maharashtra state to carry out this study.

II. LITERATURE REVIEW

Michalewicz Zbigniew, Martin Schmidt, Matthew Michalewicz, Constantin Chiriac, (2007) discussed the concept of adaptive business intelligence and explain different roles that prediction and optimization play as they occur in business, in producing near optimal decisions. While taking operational & strategic decisions, knowledge of this book is very useful to business managers at all the levels.

Literature review clearly indicates that based on inter organizational relationship perspectives, organizational theory and IS planning literatures, there is a need to examine the interrelationships of the organizational factors, technological factors and environmental factors on the ABI and further the influence of ABI techniques on the business performance and hence decision making.

ASSOCIATION OF INDIAN AUTOMOBILE MANUFACTURERS

a. The Society of Indian Automobile Manufacturers (SIAM) is the apex industry body representing 38 leading vehicle and vehicular engine manufacturers in India. SIAM is an important channel of communication for the Automobile Industry with the Government, National and International organizations. The Society works closely with all the concerned stakeholders and actively participates in formulation of rules, regulations and policies related to the automobile industry.

b. The Automotive Research Association of India (ARAI)

ARAI Pune offers automotive research and development center in India, vehicle type certification, automotive testing and calibration, vehicle design labs.

c. Maratha Chamber Of Commerce Industries & Agriculture, (MCCIA) has been playing a significant role in accelerating the industrial and economic development of Pune region for more than seven decades now. It is one of the most active chambers of Commerce in India and has been instrumental in promoting number of institutions in Pune. MCCIA has continuously driven to make Pune a global business destination and has been catalyst for economic development of the region.

IMPACT OF DIGITAL INDIA INITIATIVE ON AUTOMOBILE SECTOR

Digital India is an initiative of Government of India to integrate the government departments and people of India. It aims at ensuring the government services are made available to citizens electronically by reducing paperwork. The Make in India campaign will make India a global hub for the manufacturing of goods to increase localization of CAR models with the challenge of low cost
manufacturing. Mercedes Benz has brought into the “Make in India“ program in luxury car segments, it has decided to manufacture more of its components in India, thus increasing the localization of its new model C220 CDI to 60%. BMW also has signed deal with approximately 20 companies who supply its components.

Renault, the French automobile major has also improved localization of its KWID model to 98%. The US behemoth, Ford has also committed to invest for R&D, in its Chennai facility. Also a number of foreign manufacturers have successfully overcome India’s infrastructure bottlenecks in the past. Hyundai’s small car manufacturing base is in India.

The challenge behind adoption of technology readiness practices is the readiness status in an Indian context. In most of the cases companies have to start from very basic initiatives of introductory computer training and then climb the ladder of transactional automation and further seamless planning of all the resources. The kind of resistance received at every phase will create hindrances of technology readiness success. Researcher has studied these facts to understand adaptive technology projects undertaken by different countries and the relative position of Indian Auto Industry.

III. NEED FOR THE STUDY

The optimization of automobile industries especially production lines is a very challenging manufacturing problem, which involves elements of demand forecasting, scheduling of labor and sequencing of production orders. Although the production process at many manufacturing companies might be conceptually straightforward, it contains many details that make scheduling quite complex. Adaptive Business Intelligence Systems combine prediction and optimization techniques to assist decision makers in complex, rapidly changing environments.

Most business managers have a limited technology background and they should understand strength and weaknesses of prediction and optimization methods, their principles and applicability, by gaining additional knowledge they will be in a better position to control the situation by taking appropriate decision.

Organizational decision making is the most critical job in front of all the managers. Today most business managers realize that a gap exist between having the right knowledge and making the right decision. Because this gap affects management’s ability to answer business questions related to operational performance, financial performance & non-financial performance. Business managers need more than graphs, charts and numerical reports. They need systems that can predict the future and recommend the best course of action. For this reason, the future of business intelligence industry lies in systems that can predict, optimize and adapt and can take decisions.

The problem to be tackled in this research has a multi-dimensional perspective. The research has to identify the external influences on the ABI and study the influence of ABI on the optimization of organizational decision making thus leading to the business performance of the organization.

The main objective of research is to study ABI techniques and do they create impact on decision making and business performance. The research was then more pin pointed towards finding out the relationship between ABI and decision making.

IV. OBJECTIVES OF THE STUDY

The objective of this research is to find out various information systems, tools and techniques adopted in the company, and to find the factors affecting these techniques and to study the relationship between gaining knowledge of ABI, Decision making and business performance. Following objectives are framed.
1. To identify adaptive business intelligence techniques adopted in select automobile manufacturing companies.
2. To study the factors influencing on adaptive business intelligence techniques.
3. To find the relationship between adoption of adaptive business intelligence and the business performance.
4. To draw the implications to the managers for enhancing the use of adaptive business intelligence techniques for better decision making.

V. RESEARCH METHODOLOGY
The Research methodology will be analytical for testing the hypothesis and exploratory in providing a new framework for optimization of decision making in critical situations.

Sampling Design:
Population: As per the statistics obtained from internet there are 11 passenger vehicle plants in Maharashtra state. And 6 plants out of 11 are located in and around Pune.

Sampling frame: It is a Subset of defined target population from which we can realistically select a sample for our research. The researcher has selected western cluster comprising of ten Automobile companies (Passenger Cars) in Maharashtra state.

Sampling units: The Chakan, Pimpri-Chinchwad corridor near Pune, Maharashtra is the western cluster with companies like Tata Motors, Volkswagen, General Motors, Skoda, Mahindra & Mahindra, Mercedes Benz, Fiat and Force Motors, Premier Limited which are sufficiently established for more than 10 years and having assembly plants in the area are considered. Total of 10 passenger vehicles companies are selected for the study.

Sampling Element (individual respondent): Managerial executives of functional Departments who are sufficiently using adaptive techniques for decision support.

Population: The no of managerial executives involved in decision making process in ten selected passenger car automobile companies accounts for a figure of around 511 depending upon size of company, no of car models and many other factors. Hence based on company information, population size is 511.

Sampling Procedure: Initially Stratified Random sampling (Discussions, interviews, email & based on strata). Later convenience sampling method was used to collect the samples.

Sample Size
By Cochran’s sample size formula for categorical data - minimum sample size obtained by formula is 284 with 95% level of confidence. Since this sample size exceeds 5% of the population size (511*0.05= 25.55); Cochran’s (1977) correction formula should be used to calculate the final sample size. By Cochran’s (1977) correction formula the final sample size minimum sample size obtained is 183.

The sample collected for study is 212. Hence sample size for the main study is 212.

Pilot study
During initial stage the researcher carried out pilot study by interviewing retired senior executives of automobile company to find out feasibility of the study. Then researcher has designed a questionnaire over a random sample of 32 respondents. Questionnaire was designed & revised during pilot phase of the study. Restructured questionnaire with 5 point likert scale having 49 parameters was used for main survey.
**LIST OF SELECTED AUTOMOBILE COMPANIES**

<table>
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<tr>
<th>Table No 1</th>
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<td>3</td>
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<td>4</td>
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</table>

**Business Performance**

<table>
<thead>
<tr>
<th><strong>Variable Term</strong></th>
<th><strong>Variable Name used for analysis</strong></th>
<th><strong>Type</strong></th>
</tr>
</thead>
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<tr>
<td>Adaptive Business Intelligence</td>
<td>ABI</td>
<td>Independent</td>
</tr>
<tr>
<td>Financial Performance</td>
<td>FPP</td>
<td>Dependent</td>
</tr>
<tr>
<td>Non-financial Performance</td>
<td>NFP</td>
<td>Dependent</td>
</tr>
<tr>
<td>Operational Performance</td>
<td>ORP</td>
<td>Dependent</td>
</tr>
</tbody>
</table>

**Variables under the dimensions of the study**

_Demographic variables_ are such as age, education, designation, experience, sex are independent variables. Sometimes there could be a relationship of dependence between two demographic variables themselves. Table 2 given below shows variables under the dimension of the study apart from demographic variables.

<table>
<thead>
<tr>
<th><strong>Table no 2 Variables under the dimension of the study</strong></th>
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<tbody>
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<td><strong>Sr. no</strong></td>
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<td>3</td>
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</tbody>
</table>

**1. HYPOTHETICAL RESEARCH MODEL**

Considering the area of research in organizational management and the focal theme “Adaptive business intelligence techniques”, the researcher has given following basic hypothetical research model (figure 1).

Based on model, researcher proposes following statements for hypothesis,

- a. Organizational factors affect ABI adoption in select automobile manufacturing companies.
- b. Technological factors affect ABI adoption in select automobile manufacturing companies.
- c. Environmental factors affect ABI adoption in select automobile manufacturing companies.
- d. Adoption of Adaptive business intelligence techniques affects on business performance in select automobile companies.
VI. RESEARCH HYPOTHESIS

Following research hypotheses are framed based on the hypothetical research model. The study is conducted to test the following hypothesis.

1. $H_{10}$: There is no significant influence of organizational factors on adoption of adaptive business intelligence techniques.

   $H_{1a}$: There is a significant influence of organizational factors on adoption of adaptive business intelligence techniques.

2. $H_{20}$: There is no significant influence of technological factors on adoption of adaptive business intelligence techniques.

   $H_{2a}$: There is a significant influence of technological factors on adoption of adaptive business intelligence techniques.

3. $H_{30}$: There is no significant influence of environmental factors on adoption of adaptive business intelligence techniques.

   $H_{3a}$: There is a significant influence of environmental factors on adoption of adaptive business intelligence techniques.

Figure 1 Basic Hypothetical Research Model

ABI - Adaptive Business Intelligence
4. $H_{40}$: There is no significant influence of adoption of adaptive business Intelligence techniques on business performance.

$H_{4a}$: There is a significant influence of adoption of adaptive business Intelligence techniques on business performance.

VII. DATA ANALYSIS & MAJOR FINDINGS

DESCRIPTIVE STATISTICS
The Gender wise data shows that percentage of male is (98%) which is more than that of female (2%). This could be due to automobile passenger car manufacturing companies, more hardship, more responsibilities and long working hours

1. The age-wise distribution of the respondents shows that highest no of respondents are in the age group of 35-45, below that in the age-group of 45-55.

2. Educational qualification data shows that majority of the respondents are graduates (80%) , 8% have completed PG, 10% are diploma holders and 2% have acquired professional qualification.

3. Experience wise profile of the respondents shows that distribution of respondents based on experience is in proportionate of the age of respondents. The least (2%) can be mapped with the age group of less than 27 years. And respondents having experience above 20 years are in the age group of 45 to 55 years. The respondents having experience of 5-10 years are 89% belong to the age group of 28-40 years.

4. The data shows that distribution of respondents based on designation is in proportionate of the experience of respondents. The least (3%) can be mapped with the designation of vice presidents who were interviewed.

5. The data shows that a broad range of applications of business intelligence technologies are deployed in (60%) automobile companies. Figure shows Basic Office Automation Systems are most widely used in 44% automobile companies whereas data warehousing in 24% , followed by Supply Chain Management 13%, Online Analytical Processing 11% with significant drop off to Business Activity Monitoring. Other Analytics applications such as HR, FINANCE, CRM analytics applications are observed 2%

STATISTICAL TOOLS USED
- Correlation Coefficient - The Karl Pearson’s correlation coefficient
- Multiple Regression Analysis
- One way ANOVA for averages of independent & more than two samples

TESTING OF HYPOTHESIS
Hypothesis 1: There is a significant influence of Organizational factors on adoption of adaptive business intelligence techniques that is there is positive correlation between Organizational factors & Adaptive business intelligence techniques.

To test the hypotheses,
The null hypothesis, H0:
There is no positive correlation between Organizational factors & adaptive business intelligence techniques.

Vs.
The alternative hypothesis, Ha:
There is positive correlation between Organizational factors & adaptive business intelligence techniques.

### Table no 3 Calculation Table: Pearson’s correlation coefficient & Significance

<table>
<thead>
<tr>
<th>Automobile Companies</th>
<th>Correlation Coefficient</th>
<th>P value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined Data of select automobile companies</td>
<td>0.480</td>
<td>0.000</td>
<td>Significant</td>
</tr>
<tr>
<td>General Motors India Private Limited</td>
<td>0.641</td>
<td>0.002</td>
<td>Significant</td>
</tr>
<tr>
<td>Tata Motors Limited</td>
<td>0.541</td>
<td>0.001</td>
<td>Significant</td>
</tr>
<tr>
<td>Fiat India Automobiles Limited</td>
<td>0.127</td>
<td>0.583</td>
<td>Non-Significant</td>
</tr>
<tr>
<td>Mahindra &amp; Mahindra Ltd -Nasik</td>
<td>0.565</td>
<td>0.008</td>
<td>Significant</td>
</tr>
<tr>
<td>Premier Limited</td>
<td>-0.084</td>
<td>0.748</td>
<td>Non-Significant</td>
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<tr>
<td>Mercedes-Benz India Pvt Ltd</td>
<td>0.638</td>
<td>0.002</td>
<td>Significant</td>
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<tr>
<td>Force Motors Ltd.</td>
<td>0.086</td>
<td>0.751</td>
<td>Non-Significant</td>
</tr>
<tr>
<td>Skoda Auto India Private Limited</td>
<td>0.753</td>
<td>0.001</td>
<td>Significant</td>
</tr>
<tr>
<td>Volkswagen India Private Limited</td>
<td>0.087</td>
<td>0.665</td>
<td>Non-Significant</td>
</tr>
<tr>
<td>Mahindra &amp; Mahindra Ltd -Mumbai</td>
<td>0.502</td>
<td>0.020</td>
<td>Significant</td>
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</tbody>
</table>

As p value < level of significance = 0.05, there is strong evidence to reject the null hypothesis

**Conclusion (Hypothesis 1):**

The general findings and statistical analysis from the above Pearson’s correlation coefficient Statistics output table 3 shows that:

- There is positive correlation between Organizational factors & adaptive business intelligence techniques if Combined Data for all companies & companies as General Motors India Private Limited, Tata Motors, Mercedes-Benz India & Skoda Auto India Private Limited Mahindra & Mahindra-Nasik & Mahindra & Mahindra-Mumbai are considered.
- There is no positive correlation between Organizational factors & adaptive business intelligence techniques if companies as Fiat India Automobiles Limited, Premier Limited, Force Motors Ltd., and Volkswagen India Private Limited are considered. The result might be significant for the increased sample size.

**Hypothesis 2:** There is a significant influence of Technological factors on adoption of adaptive business intelligence techniques that is there is positive correlation between Technological factors & adaptive business intelligence techniques.

To test the hypotheses,

**The null hypothesis, H0:**
There is no positive correlation between Technological factors & adaptive business intelligence techniques.

Vs.

**The alternative hypothesis, Ha:**
There is positive correlation between Technological factors & adaptive business intelligence techniques.

The test statistic is Pearson’s correlation coefficient.
### Table no 4 Calculation Table : Pearson’s correlation coefficient & Significance

<table>
<thead>
<tr>
<th>Automobile Companies</th>
<th>Correlation Coefficient</th>
<th>P value</th>
<th>Significance</th>
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</thead>
<tbody>
<tr>
<td>Combined Data of select automobile companies</td>
<td>0.665</td>
<td>0.000</td>
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<tr>
<td>General Motors India Private Limited</td>
<td>0.866</td>
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<td>Tata Motors Limited</td>
<td>0.727</td>
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<td>Fiat India Automobiles Limited</td>
<td>-0.229</td>
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<td>0.488</td>
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<td>Mercedes-Benz India Pvt Ltd</td>
<td>0.862</td>
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<tr>
<td>Force Motors Ltd.</td>
<td>0.362</td>
<td>0.168</td>
<td>Non-Significant</td>
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<tr>
<td>Skoda Auto India Private Limited</td>
<td>0.862</td>
<td>0.000</td>
<td>Significant</td>
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<td>Volkswagen India Private Limited</td>
<td>0.472</td>
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<td>Mahindra &amp; Mahindra Ltd - Mumbai</td>
<td>0.058</td>
<td>0.804</td>
<td>Non-Significant</td>
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</table>

(Source: SPSS data analysis)

As p value < level of significance = 0.05, there is strong evidence to reject the null hypothesis.

**Conclusion (Hypothesis 2):**

The general findings and statistical analysis from the above Pearson’s correlation coefficient Statistics output table 4 shows that:

There is positive correlation between Technological factors & adaptive business intelligence techniques if Combined Data for all companies & companies as General Motors India Private Limited, Tata Motors, Mahindra & Mahindra-Nasik, Mercedes-Benz India, Skoda Auto India Private Limited & Volkswagen India Private Limited are considered.

There is no positive correlation between Technological factors & adaptive business intelligence techniques if companies as Fiat India Automobiles Limited, Premier Limited, Force Motors ltd. & Mahindra & Mahindra-Mumbai are considered. The result might be significant for the increased sample size.

**Hypothesis 3:** There is a significant influence of Environmental factors on adoption of adaptive business intelligence techniques that is there is positive correlation between Technological factors & adaptive business intelligence techniques.

To test the hypotheses,

**The null hypothesis, H0:**

There is no positive correlation between Environmental factors & adaptive business intelligence techniques.

Vs.

**The alternative hypothesis, Ha:**

There is positive correlation between Environmental factors & adaptive business intelligence techniques.

The test statistic is Pearson’s correlation coefficient.

### Table no 5 Calculation Table : Pearson’s correlation coefficient & Significance

<table>
<thead>
<tr>
<th>Automobile Companies</th>
<th>Correlation Coefficient</th>
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<td>Combined Data of select automobile companies</td>
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<td>0.000</td>
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<td>General Motors India Private Limited</td>
<td>0.474</td>
<td>0.030</td>
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<tr>
<td>Tata Motors Limited</td>
<td>0.459</td>
<td>0.008</td>
<td>Significant</td>
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</tbody>
</table>
As p value < level of significance = 0.05, there is strong evidence to reject the null hypothesis.

Conclusion (Hypothesis 3):
The general findings and statistical analysis from the above Pearson’s correlation coefficient Statistics output table 5 shows that:

There is positive correlation between Environmental factors & adaptive business intelligence techniques if Combined Data for all companies & companies as General Motors India Private Limited, Tata Motors, Mercedes-Benz India, Skoda Auto India Private Limited, Volkswagen India Private Limited and Mahindra & Mahindra-Mumbai are considered.

There is no positive correlation between Technological factors & Adaptive business intelligence techniques if companies as Fiat India Automobiles Limited, Premier Limited, Force Motors ltd., and Mahindra & Mahindra-Nasik are considered. The result might be significant for the increased sample size

Hypothesis 4: There is a significant influence of adoption of adaptive business intelligence on business performance denoted by Financial Performance, Non-financial Performance, and Operational Performance that is there is positive correlation between Financial Performance, Non-financial Performance, Operational Performance & adaptive business intelligence techniques.

Part a) Financial Performance
To test the hypotheses,
The null hypothesis, $H_0$: There is no positive correlation between Financial Performance & adaptive business intelligence techniques.

Vs.
The alternative hypothesis, $H_a$: There is positive correlation between Financial Performance & adaptive business intelligence techniques.

The test statistic is Pearson’s correlation coefficient

<table>
<thead>
<tr>
<th>Automobile Companies</th>
<th>Correlation Coefficient</th>
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<td>General Motors India Private Limited</td>
<td>0.859</td>
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<td>Tata Motors Limited</td>
<td>0.76</td>
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</table>
Fiat India Automobiles Limited 0.813 0.000 Significant
Mahindra & Mahindra Ltd -Nasik 0.831 0.000 Significant
Premier Limited 0.728 0.001 Significant
Mercedes-Benz India Pvt Ltd 0.835 0.000 Significant
Force Motors Ltd. 0.859 0.000 Significant
Skoda Auto India Private Limited 0.796 0.000 Significant
Volkswagen India Private Limited 0.77 0.000 Significant
Mahindra & Mahindra Ltd -Mumbai 0.699 0.000 Significant

If p value < level of significance = 0.05, there is strong evidence to reject the null hypothesis

Conclusion (Hypothesis 4-a):
There is positive correlation between Financial Performance & adaptive business intelligence techniques if Combined Data for all companies & all companies under consideration

Part b] Non-financial Performance
To test the hypotheses,

The null hypothesis, $H_0$:
There is no positive correlation between Non-financial Performance & adaptive business intelligence techniques.

Vs.

The alternative hypothesis, $H_a$:
There is positive correlation between Non-financial Performance & adaptive business intelligence techniques.

The test statistic is Pearson’s correlation coefficient.

Table no 7 Calculation Table: Pearson’s correlation coefficient & Significance

<table>
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<th>Automobile Companies</th>
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<td>0.276</td>
<td>0.226</td>
<td>Non-significant</td>
</tr>
<tr>
<td>Premier Limited</td>
<td>-0.268</td>
<td>0.298</td>
<td>Non-significant</td>
</tr>
<tr>
<td>Mercedes-Benz India Pvt. Ltd</td>
<td>0.765</td>
<td>0.000</td>
<td>Significant</td>
</tr>
<tr>
<td>Force Motors Ltd.</td>
<td>0.253</td>
<td>0.345</td>
<td>Non-significant</td>
</tr>
<tr>
<td>Skoda Auto India Private Limited</td>
<td>0.842</td>
<td>0.000</td>
<td>Significant</td>
</tr>
<tr>
<td>Volkswagen India Private Limited</td>
<td>-0.188</td>
<td>0.349</td>
<td>Non-significant</td>
</tr>
<tr>
<td>Mahindra &amp; Mahindra Ltd -Mumbai</td>
<td>0.226</td>
<td>0.325</td>
<td>Non-significant</td>
</tr>
</tbody>
</table>

(Source: SPSS data analysis)

If p value < level of significance = 0.05, there is strong evidence to reject the null hypothesis.

Conclusion (Hypothesis 4-b):
There is positive correlation between Non-financial Performance & adaptive business intelligence techniques if Combined Data for all companies & companies as General Motors India Private Limited, Tata Motors, Mercedes-Benz India Pvt. Ltd. & Skoda Auto India Private Limited are considered.

There is no positive correlation between Non-financial Performance & adaptive business intelligence techniques if companies as Fiat India Automobiles Limited, Mahindra & Mahindra-Nasik, Premier
Ldt., Force Motors Ltd., Volkswagen India Private Limited & Mahindra & Mahindra-Mumbai are considered. The result might be significant for the increased sample size.

**Part c]: Operational Performance**

To test the hypotheses,

**The null hypothesis, \( H_0 \):**
There is no positive correlation between Operational Performance & adaptive business intelligence techniques.

**Vs.**

**The alternative hypothesis, \( H_a \):**
There is positive correlation between Operational Performance & adaptive business intelligence techniques.

**The test statistic is Pearson’s correlation coefficient.**

Table no 8 Calculation Table: Pearson’s correlation coefficient & Significance

<table>
<thead>
<tr>
<th>Automobile Companies</th>
<th>Correlation Coefficient</th>
<th>P value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined Data of select automobile companies</td>
<td>0.41</td>
<td>0</td>
<td>Significant</td>
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<tr>
<td>General Motors India Private Limited</td>
<td>0.589</td>
<td>0.005</td>
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<tr>
<td>Tata Motors Limited</td>
<td>0.533</td>
<td>0.002</td>
<td>Significant</td>
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<tr>
<td>Fiat India Automobiles Limited</td>
<td>-0.202</td>
<td>0.38</td>
<td>Non-significant</td>
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<tr>
<td>Mahindra &amp; Mahindra Ltd -Nasik</td>
<td>0.003</td>
<td>0.988</td>
<td>Non-significant</td>
</tr>
<tr>
<td>Premier Limited</td>
<td>-0.284</td>
<td>0.269</td>
<td>Non-significant</td>
</tr>
<tr>
<td>Mercedes-Benz India Pvt Ltd</td>
<td>0.593</td>
<td>0.005</td>
<td>Significant</td>
</tr>
<tr>
<td>Force Motors Ltd.</td>
<td>0.335</td>
<td>0.205</td>
<td>Non-significant</td>
</tr>
<tr>
<td>Skoda Auto India Private Limited</td>
<td>0.607</td>
<td>0.017</td>
<td>Significant</td>
</tr>
<tr>
<td>Volkswagen India Private Limited</td>
<td>-0.26</td>
<td>0.189</td>
<td>Non-significant</td>
</tr>
<tr>
<td>Mahindra &amp; Mahindra Ltd -Mumbai</td>
<td>0.019</td>
<td>0.934</td>
<td>Non-significant</td>
</tr>
</tbody>
</table>

(Source: SPSS data analysis)

If \( p \) value < level of significance = 0.05, there is strong evidence to reject the null hypothesis.

**Conclusion (Hypothesis 4-c):**

There is positive correlation between Operational Performance & adaptive business intelligence techniques if Combined Data for all companies & companies as General Motors India Private Limited, Tata Motors, Mercedes-Benz India & Skoda Auto India Private Limited are considered.

There is no positive correlation between Operational Performance & adaptive business intelligence techniques if companies as Fiat India Automobiles Limited, Mahindra & Mahindra-Nasik, Premier Limited, Force Motors, Volkswagen India Private Limited & Mahindra & Mahindra-Mumbai are considered. The result might be significant for the increased sample size.
2. SCOPE AND LIMITATION OF THE STUDY

Although the results of hypothesis testing find positive results regarding enabling factors impacting on adoption of ABI techniques there are few limitations that need to be addressed.

1. The factors affecting on ABI identified in this study are based on reviewing literature which may not include all the factors that have impact on ABI techniques and optimization of decision making. Therefore future research can use this study as foundation to identify other factors that are enablers for adoption of ABI and decision making.

2. Due to time constraint, resources and data limitations the study was restricted to the passenger car automobile companies in Maharashtra state only. It would be interesting to conduct further studies examining ABI adoption and its impact on decision making in other industry sectors to see if any difference exists. This would help expand our understanding about decision making process and its relation with adoption of ABI techniques.

3. The study is not based on different types of passenger car models. Further study can be considered for all types of vehicles.

4. Most of the managers were unaware of many theoretical terms related to information systems. In order to obtain valid & reliable data, researcher has given power point presentation. Arranging such session was a challenging job.

5. The personal interviews and the personal data collection were limited to Pune city only. The data were collected by sending soft copies of the questionnaire by e-mail, Google form, hard copies through personal contacts and one on one discussion with eminent personalities from the automobile industry.

6. Selection of independent and dependent variables was done after reviewing of literature. More variables can be included to make it more comprehensive list.

7. The scope of study is limited to the Lower and middle level of managerial executives as it is very difficult to obtain the appointment of top level management executives through official HR process.

8. This study used a quantitative approach using survey based questionnaire to identify the factors that affecting on ABI adoption. Thus, further research can consider qualitative research methodology such as case studies and interviews with top level executives is encouraged to offer many clear explanations about knowledge of ABI and optimization of decision making.

3. SUGGESTIONS

Since Adaptive business intelligence technologies has significant influence on financial performance with respect to net profits and revenue growth as well as operational performance with respect to cost reduction measures, waste reduction measures, improving quality, flexibility and delivery performance it is recommended that all managers senior executives in automobile companies must gain the knowledge of such technologies for better operational and strategic decision making.

Automobile companies must plan a methodology to adopt ABI technologies as ABI for automobile manufacturing industry leverages all the sources of data available throughout the manufacturing process to deliver a holistic view. Smart decisions must be based on data that accurately reflects the true state of the entire manufacturing process.

Following suggestions are put forth based on findings of the study.

- **Updating data**: More emphasis should be given on regularly updating data and information using Adaptive Business Intelligence techniques as new and competitive data arrives at regular intervals.

- **Decision database**: Since technological factors has significant influence on adoption of adaptive business intelligence & hence business performance, it is suggested that top level management should create & maintain a decision database in order to retain the history of complex situation arrived, period of arrival, role of adaptive business intelligence techniques.
during the period, no of alternatives available, decisions taken, outcome of decision in terms of business performance etc. Management should analyze frequency of occurrence of any new problem using adaptive techniques and decision database.

- **Formal methodology**: There should be formal methodology in terms of application usage, functionality, maintenance for evaluating the effectiveness of adaptive business applications.
- **Standardization**: Standardization of report formats with the help of IT department, frequency of report generation, proper communication, frequent training and review should be taken by the top & middle level managers.

As the present scope of the study is limited to Maharashtra state, it can be further expanded to all over India. This study can be applicable to overall manufacturing sector. Also future study can be done for following applications in India.

- Marketing Campaigns
- Investment Strategies
- Emergency response services such as ambulance and police cars.
- Credit Card fraud
- Academic Sector

This study will also help business managers to solve many real world business problems ranging from demand forecasting, scheduling, fraud detection, investment strategies as these problems have similar characteristics and application of ABI can provide significant benefits to the organization.

### VIII. CONCLUSION

The study is basically aimed to draw conclusion that,

1. Existing IT enabled information systems are not sufficient to meet the needs of outcome based decision making.
2. Adaptive Business Intelligence techniques are not adopted on large scale. More awareness should be created about such techniques.
3. An Adaptive Business Intelligence techniques can help business managers of all levels to take better decisions that increase efficiency, productivity and competitiveness.

In order to support ‘Digital India initiative’ launched on July 2015 by Prime Minister Narendra Modi, automobile manufacturing companies being a pillar of global economy, growth, stability and sustainability should give special attention to adaptive business intelligent techniques and its benefits for prediction of future demands, handling of critical situations and optimization of organizational decision making.

Adoption of technology ready practices like adaptive business intelligence techniques by automobile manufacturing companies along with knowledge management practices will improve organizational Learning, organization’s culture, organizational motivation, organizational effectiveness & organizational behavior which will further improve upon organizational decision making and hence will result into better business performance.

If managerial executives learn to predict the future with the help of technology ready practices like adaptive business intelligence techniques then they can avoid information overload, work pressure and will be able to take outcome oriented decisions in planning, organizing, coordinating, communicating, budgeting and keeping the evidences.

### SELECT BIBLIOGRAPHY


**Links to selected websites:**
1. www.bitpipe.com
2. www.SolveITSoftware.com
3. www.mccia.com
4. www.AdaptiveBusinessIntelligence.com
5. www.ieee.org
6. www.acs.org
7. www.automobileindia.com
9. www.siam.in
List of selected abbreviations:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABI</td>
<td>Adaptive Business Intelligence</td>
</tr>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>BI</td>
<td>Business Intelligence</td>
</tr>
<tr>
<td>CRM</td>
<td>Customer Relationship Management</td>
</tr>
<tr>
<td>DW</td>
<td>Data warehouse</td>
</tr>
<tr>
<td>DSS</td>
<td>Decision Support System</td>
</tr>
<tr>
<td>ERP</td>
<td>Enterprise Resource Planning</td>
</tr>
<tr>
<td>MIS</td>
<td>Management Information System</td>
</tr>
<tr>
<td>SCM</td>
<td>Supply Chain Management</td>
</tr>
<tr>
<td>SIAM</td>
<td>Society of Indian Manufacturers</td>
</tr>
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</table>