OPTIMIZED BALANCED SCORECARD INTEGRATED MODEL FOR EVALUATION OF ORGANIZATIONS PERFORMANCE

by

Hagag Maher Abd El-Hameed Abou El-Hasan
B.Sc. Industrial Engineering

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE
in
MECHANICAL DESIGN AND PRODUCTION

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GIZA, EGYPT
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Title of Thesis: Optimized Balanced Scorecard Integrated Model for Evaluation of Organizations Performance
Key Words: Strategic Planning, Performance Measurement, Balanced Scorecard, Genetic Algorithm, Analytic Hierarchy Process
Summary:
This study covers the measurement of organizations performance using Balanced Scorecards (BSC). BSC model is integrated with Analytic Hierarchy Process (AHP) technique which used to estimate BSC weights. One of the main problems in AHP is inconsistency of the judgment and accuracy. So, this work proposes a new prioritization model. The proposed prioritization model combines AHP and Genetic Algorithm (GA) called AHPGA model. Verification of AHPGA model is performed in numerous cases. BSC model applied to an industrial company and the results show that BSC model is a successful tool to measure organizations performance. And developed BSC is a good tool for monitoring strategic plan. Results of AHPGA model are compared with other prioritization methods. Comparisons show that AHPGA model yields better and accurate results than the others models used.
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<td>DLSM</td>
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<td>European Foundation Of Quality Management</td>
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<td>EPS</td>
<td>Earnings Per Share</td>
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LIST OF SYMBOLS

\( c_1 \) Weight of criterion 1
\( c_2 \) Weight of criterion 2
\( c_3 \) Weight of criterion 3
\( P_A \) Priority of alternative A
\( P_B \) Priority of alternative B
\( ac_1 \) Priority of alternative A with respected to criterion 1
\( bc_1 \) Priority of alternative B with respected to criterion 1
\( ac_2 \) Priority of alternative A with respected to criterion 2
\( bc_2 \) Priority of alternative B with respected to criterion 2
\( ac_3 \) Priority of alternative A with respected to criterion 3
\( bc_3 \) Priority of alternative B with respected to criterion 3
\( n \) Matrix Size (number of compared objectives)
\( a_{ij} \) Comparing objective i with objective j
\( a_{ij}^{-1} \) Reciprocals of \( a_{ij} \)
\( [a_{ij}]_{n \times n} \) Pair-wise comparison matrix
\( O_i \) Objective i
\( O_j \) Objective j
\( a_{11} \) Judgment ratio of objective 1 with respected to objective 1
\( a_{1n} \) Judgment ratio of objective 1 with respected to objective n
\( a_{n1} \) Judgment ratio of objective n with respected to objective 1
\( a_{nn} \) Judgment ratio of objective n with respected to objective n
\( \lambda_{\text{max}} \) Maximum Eigen-value
\( \text{CR} \) Consistency ratio
\( \text{RI} \) Random index
\( Y_i \) Corresponding outcome
\( w_i \) Weight of \( i^{\text{th}} \) element
\( w_j \) Weight of \( j^{\text{th}} \) element
\( w_{ij} \)  
Weight ratio of element \( i \) respect to \( j \)

\( \{w_{ij}\}_{n\times n} \)  
Matrix of weight ratios

\( w_{ik} \)  
Weight ratio of element \( i \) respect to \( k \)

\( w_{kj} \)  
Weight ratio of element \( k \) respect to \( j \)

\( W \)  
Weighting vector (priority vector)

\( w_1, w_2, \ldots, w_n \)  
Weight of elements 1,2,…,\( n \)

\( w \)  
Eigenvector of \( W \)

\( a_{ik} \)  
Comparing objective \( i \) with objective \( k \)

\( a_{jk} \)  
Comparing objective \( j \) with objective \( k \)

\( I \)  
Identity matrix \( n \times n \)

\( \delta_{ij}^+, \delta_{ij}^- \)  
Deviations variables

\( ch_i \)  
\( i^{th} \) chromosome

\( K \)  
Population size

\( \nu(ch_i) \)  
Roulette wheel sector

\( F(ch_i) \)  
Value of the fitness function of chromosome \( ch_i \)

\( p_s(ch_i) \)  
Probability of selecting chromosome \( ch_i \)

\( a, b \)  
Beginning and the end of the circle fragment

\( p_m \)  
Probability of mutation

\( p_c \)  
Probability of crossover

\( x_i \)  
The \( i \)-th gene

\( Y_i \)  
New value of the gene

\( U_i(0, 1) \)  
Random variable

\( Z_i \)  
Random variable

\( CV \)  
Consistency vector

\( TD \)  
Total deviation

\( F(x) \)  
Fitness function
ACKNOWLEDGMENTS

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ABSTRACT

Performance measurement is an important function for monitoring organizations strategic plan. Balanced scorecard (BSC) system developed by Kaplan and Norton is a performance measurement tool using financial and nonfinancial measures to provide an organization with ways to develop and evaluate strategic objectives and goals. BSC captures both leading and lagging performance measures, thereby providing a more balanced view of organizations performance. It has been revealed in the review of relevant literature that despite the satisfying levels achieved by balanced scorecard application, the method has some deficiencies in terms of implementation on a quantitative basis and that there remain some problems to be resolved. BSC weights are an important issue, because these weights reflect the importance of indicators to each other.

First objective of this study covers the measurement and evaluation of organizations performance using BSC. In this study BSC model is integrated with analytic hierarchy process (AHP) technique. The integrated model used to determine the organizations performance based on its vision and strategies. AHP used to estimate BSC indicators weights. One of the main problems in the AHP procedure is inconsistency of judgments and accuracy. Second objective of this study is to propose a new model for prioritization of BSC weights. This is achieved through a proposed prioritization model which combines AHP and Genetic Algorithm (GA) called AHPGA model. The new prioritization model is modeled and analyzed using MATLAB. Verification of the proposed AHPGA model is performed in numerous cases.

The proposed BSC model applied to an industrial company as a real case study. The results show that BSC model is a successful and acceptable tool to measure and improve organizations performance. Performance indicators with different structures included in BSC can be consolidated with the help of AHP. Results
of proposed AHPGA prioritization model are compared with other BSC prioritization methods reported in the literature. Comparisons show that the proposed AHPGA prioritization model yields better and accurate results than the others models used. The proposed AHPGA model gives realistic and more accurate results (within tested limits in this search) in case of consistent ($0.003 < \text{Consistency Ratio (CR)} < 0.1$) and inconsistent matrices ($0.229 > \text{CR} > 0.1$). Thesis results show also that the developed BSC model is a good tool for monitoring organizations strategic plan. Finally, modification in GA parameter setting may be needed for the proposed prioritization AHPGA model in case of high consistent (CR $< 0.003$) and high inconsistent (CR $> 0.229$) matrices.
CHAPTER 1

INTRODUCTION

1.1 Background

Organizational performance has always exerted considerable influence on the actions of companies. Every organization has its performance measurement system to evaluate its progress. Many organizations have mission and visions statements, which are translated into business strategies. Limited numbers of organizations are able to fully implement their strategies. A number of innovative management and strategic control techniques have been developed over the past two decades aimed at evaluating – from a strategic management perspective – the results of the activities carried out by a business.

The Balanced Scorecard (BSC) is an approach to strategic management and performance evaluation depending on organization mission and strategies. BSC developed by Drs. Robert Kaplan and David Norton (Harvard Business School) in 1992. BSC is an effective tool that can help managers to translate visions and strategies into integrated set of performance objectives and measures. BSC captures both leading and lagging performance measures, thereby providing a more balanced view of organizations performance. Previous systems for performance measurement that incorporated nonfinancial measurements used ad hoc collections of performance measures. More like checklists of measures for managers to keep track of and improve a comprehensive system of linked measurements. BSC emphasizes the linkage of measurement to strategy and the cause and effect linkages that describe the hypotheses of the strategy [1].

Kaplan and Norton present four perspectives that need to be balanced in performance measurement system: financial, customer, internal business process and learning and growth. In BSC not only financial lagging indicators but also leading indicators such as customer, internal business process and