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DMTC-EBSC: A Novel Decision Making Technique in Cloud Environment Based on Extended BSC

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ABSTRACT-**Advantages of cloud computing have attracted a large number of companies and encouraged the IT industry for adoption. However, for migration from traditional media to a new environment, there are requirements to adopt a well-defined strategic management model. The strategic management framework that we have proposed for cloud environment includes a strategic management model, a decision making technique, and a computation and evaluation process of the technique. This method has a comprehensive analysis for capabilities and the entities involved in a cloud environment. We present a decision making technique in cloud environment based on extended BSC (DMTC-EBSC) as a blend of modified BSC model, and SWOT tools for both cloud providers and consumers in a holistic approach for cloud computing environment. Also, the method distributes decision making process over strengths, weaknesses, opportunities, and threats to give a full view of environmental aspects of cloud ecosystems. To validate the proposed technique, we consider a case study in which we have applied the DMTC-EBSC to a cloud environment for a small and medium-sized enterprise (SME). Evaluation results indicate superiority of the DMTC-EBSC over the original BSC-SWOT technique which is an extended BSC in terms of standard KPIs.**

Keywords-Cloud Services, SWOT Tools, Original BSC, Extended BSC, Cloud Environments, Key Performance Indicators, DMTC-EBSC.

I. INTRODUCTION

Cloud computing as a new and modern technology has become a focus of attention and a platform for future services. Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. Cloud Computing is the result of evolution and adoption of

existing technologies and paradigms. The goal of cloud computing is to allow users to take advantage from all of these technologies without the need for deep knowledge about or expertise with them. The cloud aims to cut costs, and help the users focus on their core business instead of being impeded by IT obstacles[1, 2]. Cloud offers many strong points: infrastructure flexibility, faster deployment of applications and data, cost control, adaptation of cloud resources to real needs, improved productivity, etc. In general, cloud model is composed of five essential characteristics: On-demand self-service, Broad network access, Resource pooling, Rapid elasticity, Measured service, three service models: Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS) and four deployment models: Private cloud, Community cloud, Public cloud and Hybrid cloud[3-5]. Also, Cloud computing offers a reduced IT overhead for the consumers, great flexibility, reduced total cost of ownership (TCO), on-demand services, and improved productivity[6]. Economic benefits, simplification and convenience of the way various services are delivered seems to be the key drivers to speed up the adoption of cloud computing[7]. Moreover, cloud adoption provides cost reduction, increases efficiency, and ultimately creates a competitive business model in any market [8]. In the NIST cloud computing reference architecture, a hierarchical tree-like structure of four-level is presented to describe the key concepts about cloud computing. Level 1 is role of cloud actors, which is consisted of five major participating actors: cloud consumer, cloud provider, cloud broker, cloud auditor and cloud carrier. Level 2 is activity of the cloud actors which includes service deployment, service orchestration, cloud service management, security and privacy. Level 3 is component, which refer to the specific processes, actions, or tasks that must be performed to meet the objective of a specific activity. Level 4 is sub-component, which presents a modular part of a component. However, this hierarchical structure does not help developers and consumers to choose their appropriate product or service according to their needs and based on real capabilities of different cloud computing tools and services[9]. Migration from traditional IT models to such a dynamic and complex service delivery model requires a delicate strategic management process to evaluate the pros and cons of cloud environments. Strategic management involves the formation and implementation of the major goals and initiatives taken by a company's top management, based on consideration of resources and an assessment of the internal and external environments in which the organization competes[10, 11]. This model includes a feedback loop to monitor execution and inform the next round of planning. The difficulty of fully comprehending and responding to the complex issues faced by an organization has led to a proliferation of strategic management models. Each of the various models attempts to organize a number of issues and make them more readily understandable. One of the most important steps necessary for a successful strategic management process is analysis method. Comprehensive analysis is essential because subsequent steps in the strategic management process directly depend on its output results. One of the basic tools widely-used is SWOT analysis, which examines both internal elements of the organization are strengths, weaknesses, external element opportunities and threats. SWOT analysis is just one method of categorization and has its own weaknesses[12]. Small and medium enterprise (SME) makes up about 97% of all firms. Potential and managerial implications of using cloud computing by SMEs are very significant. Cloud computing allows SMEs to trail every user and usage of cloud computing services in an organization. Cloud computing allows SMEs the ability to switch to a different service provider easily and without significant costs. Also, it allows SME employees access to services from any platform or device using simple tools such as a browser[13, 14]. The balanced scorecard (BSC) has emerged as a decision support tool at the strategic management level. Many business leaders now evaluate corporate performance by supplementing financial accounting data with goal-related measures from the following perspectives: consumer, internal business process, learning and growth[15]. However, in this paper we introduce a new technique for cloud computing environment analysis which incorporates cloud with a modified form of BSC (EBSC). It gives a more comprehensive vision to both cloud providers and cloud consumers to step carefully through cloud computing adoption with a case study for SMEs. Our proposed decision making method can make more robust decision on cloud adoption by application of a holistic view to the strategic management process. Also it distributes decision making process to give a full view of cloud ecosystems. Proposed method is evaluated against a baseline method via key performance indicators. The rest of the paper has organized as follows: In section 2 related works and other researches are reviewed. Background and basic concepts of original BSC-SWOT which are prerequisites of this paper are introduced in section 3. Afterward, strategic management with the proposed decision making technique for cloud computing systems is introduced in section 4. In section 5, our proposed technique DMTC-EBSC (Decision Making Technique in Cloud Based on Extended BSC) for environment analysis of a cloud system is explained. This section introduces EBSC method and describes perspectives proposed for a cloud system analysis using BSC as its basics. Section 6 introduces proposed computation and evaluation process of DMTC-EBSC Technique. Section 7 includes our performance evaluation results of the proposed technique with a case study. Finally, concluding remarks are presented in section 8.

II. Related Works

A number of research works in literature have investigated the adoption of BSC to evaluate Cloud computing services in SMEs. A BSC implementation in SMEs is presented in[16]. This paper has highlighted the existence of important potential and

real benefits to SMEs for applying the BSC as a strategic management tool. But, that does not provide a strategic management tool to SMEs by applying the BSC. Also it does not help developers and consumers to decision making process in adoption of Cloud Computing services. Evolution of generating the BSC design is presented in [17]. This paper only describes its evolution, recognizing three distinct generations of BSC design. Cobbold et al. [18] describes characteristics of BSCs appropriate for each purpose, and suggests a framework. But, it does not provide a comprehensive framework that applies all features of cloud computing. Rosemann et al. [19] evaluate the application of the BSC for IT evaluation and represents a novel application area for this strategic management concept. However, it does not provide a strategic management comprehensive for cloud computing. Mahara et al. [20] propose a framework called PEST (Political, Economic, Social and Technological) to analyze the factors that should be addressed by SME to select Enterprise resource planning (ERP) in cloud environment. This framework categorizes a factor in the PEST framework as political, economic, social or technological. However, this framework does not provide a comprehensive model that applies all features of cloud computing. Shimba et al. [21] proposes only a roadmap for cloud computing adoption and states that a successful adoption requires an understanding of different dynamics and expertise in diverse domains. The Cloud Score Card (CSC) in [22] aims to extend and apply the balanced score card principles to cloud computing. Various methodologies can be used to enable cloud service providers to excel and differentiate themselves, by succeeding in each quadrant of the Cloud Score Card. A BSC for strategic management by SWOT and strategic map is presented in [23]. However, that does not distribute decision making process over strengths, weaknesses, opportunities, and threats to give a full view of environmental aspects of cloud ecosystems. This manual evaluates the BSC and how to design the SWOT and strategic map by many case-studies. Exploring the use of cloud computing in SMEs is presented in [13]. It offers a SWOT analysis conducted to evaluate feasibility of cloud computing applications for SMEs.

A serious weakness with the current studies, however, is that they emphasis only on one part of analysis model and ignore to provide a comprehensive strategic management analysis model. Moreover, they fail to address different entities such as providers and consumers involved in cloud. Besides, their model is not well suited for cloud environments.

III. ORIGINAL BSC-SWOT

The balanced scorecard is a strategic planning and management system that is used extensively in business and industry, government, and nonprofit organizations worldwide to align business activities to the vision and strategy of the organization, improve internal and external communications, and monitor organization performance against strategic goals. It was originated as a performance measurement framework that added strategic non-financial performance measures to traditional financial metrics to give managers and executives a more 'balanced' view of organizational performance. The original model of Kaplan & Norton's Balanced Scorecard for the strategic management process is shown in figure 1. It provides a framework that not only provides performance measurements, but helps planners identify what should be done and measured. Financial measures are inadequate, however, for guiding and evaluating the journey that information age companies must make to create future value through investment in consumers, suppliers, employees, processes, technology, and innovation[24]. In the figure, we will answer the questions: In Financial perspective, to succeed financially, how should we appear to our shareholders? In Consumer perspective: to achieve our vision, how should we appear to our customers? In Learning perspective: to achieve our vision, how will we sustain our ability to change and improve? In Internal Business Process perspective: to satisfy our shareholders & customer, what business processes must we do?

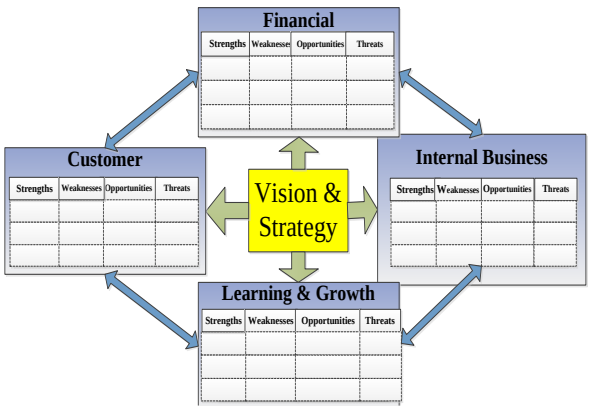

Fig. 1. The Original Model of SWOT-BSC

SWOT analysis investigates the following aspects of an environment: Strengths are characteristics of the business, or project team that give it an advantage over others. Weaknesses (or Limitations) are characteristics that place the team at a disadvantage relative to others. Opportunities are external chances to improve performance (e.g. make greater profits) in the environment. Threats are external elements in the environment that could cause trouble for the business or project [3][4]. The strategic management framework that we utilize for cloud environments includes the following three parts:

- A strategic management model for cloud environments.
- An analysis technique: DMTC-EBSC
- Computation and evaluation process of DMTC-EBSC technique.

In the following section, we describe with more details.

IV. Strategic Management with Proposed Decision Making Technique for Cloud Environment

Strategy is a game plan management using to stack out a market position, conduct its operation, attract and please consumers, compete successfully, and achieve organizational objectives. Strategic management consists of the analysis, decisions, and actions that an organization undertakes in order to create and sustain competitive advantages[25]. To establish and maintain a distinctive strategic management, Porter[26] stipulates that a company needs to a Strategic Management Model that have six fundamental principles: right goal, actions to implementation, value proposition, trade-offs, fit the organization, and continuity. We utilize a novel strategic management model which is based on the Harrison and John's foundations include five phases[27, 28]. Harrison and John's model is improved for cloud computing and prepared a strategic analysis in phase 2 with DMTC-EBSC. The model improves Harrison and John's model by substituting the model adopted in the second phase with our proposed DMTC-EBSC technique. More precisely, this model takes advantage of DMTC-EBSC technique for recognition and analysis phase which notably improves the performance of the strategic management system for cloud environment regarding Key Performance Indicator (KPI) metric. The strategic management is a step-to-step model and it is shown in Figure 2.

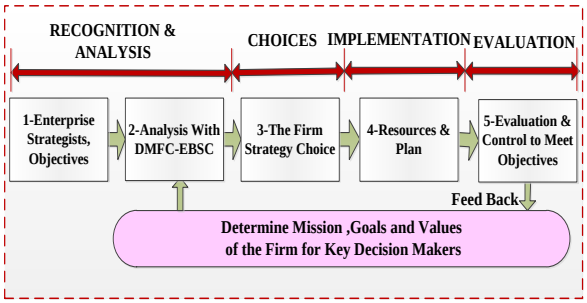

Fig. 2. Strategic Management with Proposed Decision Making Technique for Cloud Environment

According to figure 2, the strategic management processes include the following sections:

A. *Enterprise Strategies Objectives*

One of the basic principles of strategy management is enterprise strategy and objectives and mission. It must start with the right goal. Only by the grounding strategy in sustained profitability will real economic value be generated. Objectives describe where the strategy is heading and it is a set of major achievements that will accomplish the vision such as financial returns and consumer services[29].

B. *Analysis with DMTC-EBSC*

For an appropriate strategy, we must analysis the current internal and external environment. Here, we proposed DMTC-EBSC technique, which is a new analysis technique for the strategy development.

C. *The Firm Strategy Choice*

After recognition and analysis, at first we must find generic strategies alternative, then we select the firm strategy.

D. *Resources & Plan*

Major process of strategic management is implementation, which involves decisions regarding how the organization's resources will be aligned and mobilized towards the objectives. Implementation results in how the organization's resources are structured, leadership arrangements, communication, incentives, and monitoring mechanisms in order to track progress towards objectives among the others[30].

E. *Evaluation & Control to Meet Objectives*

This phase is strategy control and includes evaluation and control to meet objectives and feedback for better adjustment. Feedback is to determine mission, goals and values of the firm for key decision markers.

Once the strategy is determined, various goals and measures may be established to chart a course for the organization, measure performance and control implementation of the strategy. Here, our strategic management tool is DMTC-EBSC that it measures various criteria to achieve a 'balanced' perspective that coming in the next section.

V. Proposed Analysis Technique: DMTC-EBSC

To make more accurate results of the strategy map, we propose a cloud extended balance scorecard card technique as depicted in figure 3. In original BSC model, the concept is based on four main parameters of Strengths, Weaknesses, Opportunities, and Threats; but, those parameters are not enough for an overall analysis. We extend the model in three different aspects which are key initiative for cloud computing (CC) system. DMTC-EBSC technique proposes a new method to evaluate the migration process from traditional platforms to cloud computing platforms regarding three domains including (1) data center, (2) cloud platform, and (3) cloud services such as SaaS, PaaS and IaaS. Datacenters are infrastructure and core system for implementing a cloud facility. On top of the datacenters, cloud software and its modules create cloud platform where different application tools provide variety of services. We can analyze these three layers with proposed EBSC method from six different factors including cultural & social, security, business process, security management, legal & law and leaning, as it is depicted in figure 4.

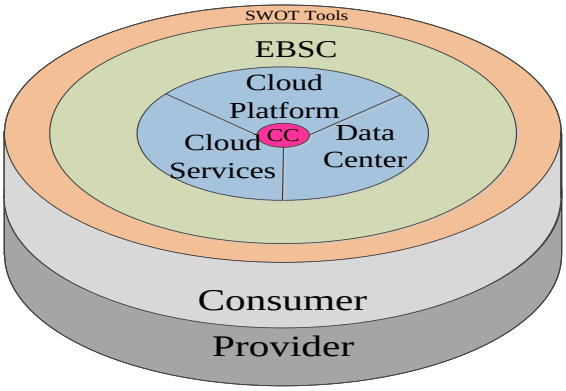

Fig. 3. Proposed DMTC-EBSC technique

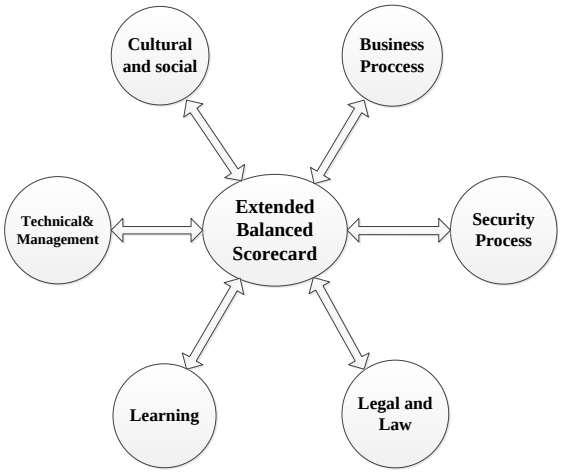

Fig. 4. Proposed EBSC method for Cloud Computing

We have emphasized on these parameters with more details in the next section. We apply SWOT tools for all the stated parameters and extend the analysis criteria. It is very important to consider that all those parameters are not similar from different perspectives. We separate our viewpoint from provider and consumer perspectives. One of the major strengths of the proposed technique is that it can be easily extended to include other cloud entities such as cloud auditor, cloud carrier, and cloud creator. It is important to note that results of analysis are different from each angle and combinations of both results provide a comprehensive answer. In this section we present our extended BSC model modified and adapted for cloud computing environments which considers all important aspects and perspectives of cloud ecosystems.

A. Cultural and Social

This perspective refers to the procedure of interaction establishment between different entities involved in cloud. The more easily the entities of a community can communicate with each other, the more social is the infrastructure of that community. Cloud computing provides a dynamic and rigorous infrastructure for all entities in cloud to interact automatically among them.

B. Business Process

This perspective refers to internal and external business processes. Taking this perspective into consideration, allows the managers to investigate their monetary aspects of their business, and to know whether their products and services conform to the defined goals and requirements. Financial data are considered to be handled as a part of this process which is a vital requirement for a prosperous business. Timely and accurate funding data will always be a priority, and managers will do whatever necessary to provide it. In fact, often there is more than enough handling and processing of financial data. With the implementation of a corporate database, it is hoped that more of the processing can be centralized and automated.

C. Security Process

This perspective describes the structured consideration of security in different aspects such as software, hardware, resource management, data management, service delivery, etc. A secure infrastructure is vital for all entities to have safe interactions with each other. In order to have a secure infrastructure, managers and engineers should be cautious of security in different design process levels such as conceptual models, communication processes, data transfers and saving algorithms, data encryption algorithms, access types and so on.

D. Legal and Law

This perspective involves legislations and laws defined in each environment to establish rational and strong interactions between the entities of that environment. Legislations may be originated from laws that are specific for each country or from normal rules defined in each community.

E. Learning

This perspective includes employee training and corporate attitudes related to both individual and corporate self-improvement. In a knowledge-worker organization, people – the only repository of knowledge – are the main resource. In the current climate of rapid technological change, it is becoming necessary for knowledge workers to be in a continuous learning mode. Metrics can be put into place to guide managers in focusing training funds where they can help the most.

F. Technical & Management

This perspective contains technical as well as management aspects necessary to investigate an environment. Technical issues refers to the hardware or software design and exploitation issues such as network bandwidth in the infrastructure level or the model used for interconnection of data centers which directly influence delay, jitter, or throughput of the system. Management issues include the management models, architectures, or algorithms used to both monitor the operations and handle the requests delivered to the system.

VI. Computation and Evaluation Process of DMTC-EBSC Technique

Here, we thoroughly present the DMTC-EBSC technique given in figure 3. This method can be presented by six SWOT tables from the two viewpoints of providers and consumers, and the three aspects of data centers, cloud platforms and cloud services. Each table consists of SWOT analysis for the six features given in figure 4. The entire tables (Table 1 to Table 6) are presented in below. For example, Table 1 shows the SWOT analysis for the data center aspect of cloud providers. The tables indicate that the strengths and opportunities of using cloud computing services for SMEs far exceed the weaknesses and threats.

Table 1. SWOT Analysis for Datacenter Aspect of Cloud Provider

Feature	Strengths	Weaknesses	Opportunities	Threats
Cultural and Social	1.Interoperability with other Data Centers	1.Standardization 2.Rapid Changes in Technology	1.Offerring Services Using Other Provider Resources	1. Cultural Invasion
Business Process	1.Reduction of Costs in IT Infrastructure 2.Lower costs of Maintenance 3.Optimal Use of the Hardware and Resources	1.The High Cost of Bandwidth 2. High Cost for Securing Communications Network	1.Beinga New Topic 2.Economic Downturn 3.Providing Telecommunications Facilities as a Service	1.Industrial and Economic Sanctions 2.Additional Costs to Purchase of Hardware and Software
Security Process	1.Unified Monitoring for Security 2.Capable for Balancing Distribution of Workloads	1. Complexity of Security Tools 2.Greater Complexity in Test and Diagnosis	1. Up to Date the Security Tools in Cloud Environment	1.Complexity in Protecting the User's Data 2.Ignoring the Security Precautions
Legal and Law	1.Improve the Quality of Services and Achieving SLA	1.Lack of Proper Law Enforcement	Not defined	1.Lack of Legal Laws Related to Cloud Computing
Learning	1.Large Number of Experts in IT 2.Accelerate Development IT Capability	1.Low Expertise in the Field of Cloud Computing	1. Use of Relatively Inexpensive Workforce	1.Moving the Expertise from One Provider to Others
Technical & Management	1.Managing the System from One Central Point 2. Continuity of Service Delivery 3.Possibily for Assigning the Virtual Resources	1. Need for Qualified Personnel in the Areas of Virtualization and Cloud Computing	1.Ability to Provide Diversified Service Delivery	1.Weak Communication Infrastructure

Table 2. SWOT Analysis for Cloud Platform Aspect of Cloud Provider

Feature	Strengths	Weaknesses	Opportunities	Threats
Cultural and Social Perspective	1. Widely Available	1- Encourage for Considering the Right.	1.Expantion of Unified Culture and Policy	1.Abusing the Facility and Tools
Business Process	1.Cost Reduction 2.Fast Software Upgrade 3.Lower Maintenance Costs 4.Lower Costs for IT Infrastructure 6.The Possibility of Hosting More Sites	1.The High Cost of Bandwidth for Users 2.Weakness in Communications Network 3.Purchasing Special Hardware and Software Cloud	1.The New Issue of Cloud Computing 3.Offering Software and Resources as a Service	1. Industrial and Economic Sanctions
Security Process	1. Saving Private Data	1. Complexity	1.Unified Security Tools and Software	1.Data Security
Legal and Law	1.Saving the Public Data	1.Lack of Necessary Law and Regulation	1.Expantion of Regulation and Law Enforcement	1.Lack of Legal Laws Related to Cloud Computing 2.Legal Issues in Applying Cloud Computing
Learning	1.Efficient and Talented Workforce	1.Low Experimental Background in the Field of Cloud Computing	1.Inovative Research	1.Payment and Cost
Technical & Management	1.Fast Software Upgrade 2.Reducing the Operation Time 3.Accelerate Development IT Capability	1.Require a Permanent Connection to the Internet 2.Cloud Computing with Low-speed	1.New Research and Challenges	1.New Kind of Software's

Table 3 . SWOT Analysis for Cloud Services Aspect of Cloud Provider

Feature	Strengths	Weaknesses	Opportunities	Threats
Cultural and Social Perspective	1. Widely Available 2. Communications Legacy Systems Supported 3.Cultural, Attitudinal, Behavioral Organizationally Acceptable	Not defined	1.Increase Collaboration, 2.Interoperability with Business Partners,	Not defined
Business Process	1. Pay Per Usage, 2. Less Expensive to Upgrade 3. Aspects of Marketing-reach has Not Barriers to Entry	Not defined	1.Global Market Access, 2. New markets with Eliminate Barriers to Entry 3.New Business Model 4.Local,Regional, and Global Business Relationship	1.Industrial and Economic Sanctions
Security Process	1.Scalability 2.Back up and Disaster Recovery	1.Real and Perceived Lack of Information and Systems Security 2.Information Systems, Architecture, and Infrastructure are not Physically Located On Site	1.Global Service with Competitors' Vulnerabilities	1.Real and Perceived Lack of Information and Systems Security

Legal and Law	1.Widely Accepted in Accreditations, Qualifications, Certifications 2.High Degree of Agility, Philosophy and Values	1.Lack of Laws	Not defined	1.Service Level Agreements for Cloud Computing Services
Learning	1.Extensive Storage 2.High Return on Investment, 3.Improve Services	Not defined	1.Increase Innovation, 2.Natural Evolution with Networking and the Internet	Not defined
Technical & Management	1.Competition Leveler 2. Mainly Managed Externally 3.Reducing the Operation Time Services	1.Real and Perceived Lack of Information and Systems Control 2.Lack of On-site IT/IS Support	Not defined	1.Off-site Data Centers and Resources 2.Real and Perceived Lack of Information and Systems

Table 4. SWOT Analysis for Datacenter Aspect of Cloud Consumer

Feature	Strengths	Weaknesses	Opportunities	Threats
Cultural and Social Perspective	1.The Possibility of Further Collaboration in the Cloud	Not defined	1.Presence in Global Markets	1.Unknown Cloud Computing
Business Process	1.Reduce the Cost of Hardware 2.Reduce the Cost of Software and Licenses	1.The High Cost of Bandwidth for Users 2.Restrict Users to Specific Organizations	1.It is a New Topic 2.Few Competitors in the Market	1.The Global Economic Downturn
Security Process	1.More data Security 2. Reduction in the Duration of the Service Down	1.Data Security 2.The Location of the Consumer Data in Cloud	Not defined	1.Security and Privacy Users 2.Information Security
Legal and Law	Not defined	1.Not Clear the Cloud Rules	Not defined	1.Increase in Trade Restrictions 2.Legal Requirements
Learning	Not defined	Not defined	Not defined	Not defined
Technical & Management	1.Independence Computing on a Particular Platform 2.No need to Build Infrastructure	1.Require a Permanent Connection to the Internet	1. Capability for Expansion of Virtual Resources	1.The Emergence of a Strong Alternative Technology

Table 5. SWOT Analysis for Cloud Platform Aspect of Cloud Consumer

Feature	Strengths	Weakness	Opportunities	Threats
Cultural and Social Perspective	1.The Possibility of Further Collaboration in the Cloud	1.High Cost of Services	1. Accessing to the Global Services	1.Unknown Cloud Computing Between Consumers
Business Process	1.Reduce Hardware and Software Costs 2.Lower and Easier Maintenance Costs 3.Lower Costs for IT Infrastructure 4.Fast Software Upgrade	1.The high Cost of Bandwidth for Users 2.Weakness in Communications Network 3.Limitations of Applications	1.A New Topic 3.High Number of Competitors	1.Industrial and Economic Sanctions 2.Vulnerability to Economic Downturn
Security Process	1.More Data Reliability	1. Data Security 2.Risk to the Reliability of the Cloud	1. Automatic Upgrade of Security Software	1.Abuses Hacker from Power of the Cloud 2Access Transparent
Legal and Law	1. High Degree of Agility, Philosophy and values	1.Legal Issues in Applying Cloud Computing	Not defined	1.Not Being Clear the Cloud Rule 2.Increase in Trade Restrictions
Learning	1.New Chances for Using the Updated and New Services	Not defined	1.Opportunity for New Services	1.Global Economy
Technical & Management	1.Universal Access to Documents 2.Access and Better Management 3.Computing Independent of the User's Hardware	1.Sharing the Virtual Resources	1.Access to the Latest Version Editor for Documents 2.Online Store User Data 3.Receive More Computing Power	1.The Emergence of a Strong Alternative Technology

Table 6. SWOT Analysis for Cloud Services Aspect of Cloud Consumer

Feature	Strengths	Weaknesses	Opportunities	Threats
Cultural and Social Perspective	1.Communications Legacy Systems Supported	1.Abusing the Contents	1.Increase Collaboration, Interoperability with Business Partners	1.Cultural Invasion
Business Process	1.Lower Maintenance Costs 2. Reduce the Cost of Hardware and Software	1. Limitations of Cloud Services 2.Restrict Users to Limited Provider	1. Global Market Access	1.Industrial and Economic Sanctions
Security Process	1.Back up and Disaster Recovery	1. Real and Perceived Lack of Information and Systems Security	1.Global Service with Competitors' vulnerabilities	1. Lack of Information and Security
Legal and Law	1.Widely Accepted in Accreditations, Qualifications, Certifications	1.Legal Issues in Preserving Privacy in Cloud Computing	1.New Regulations	1.Legal Issues in Applying Cloud Computing
Learning	1.New Research Opportunity	1.Lack of Expertise	1.Increase Innovation	1.Global Economy
Technical & Management	1.Access and Better Management as Global	1.Lack of On-site IT/IS Support	1.Universal Access to Services	1. Off-site Data Centers and Resources

VII. PERFORMANCE EVALUATION

In this section, a case study for evaluation of the proposed technique is presented. We have obtained our results and compared them with the tables and results in [6].

A. Case Study

In order to validate our results and compare with other published literatures, we consider the similar case study conducted in [13]. This case study assumes a cloud service provider for a SME application in a reference company. In this type of scenario, the main objectives of the SMEs are as follows:

- Enhance the service quality in national level.
- Improve the flexibility in service delivery.
- Cost reduction.
- Increasing the area of service facility.

These objectives are applied to our proposed technique through tables in section VI, and also, the framework proposed in [13].

B. Evaluation Metrics

In order to evaluate our method, we have considered the key performance indicator (KPI) metric proposed in[31]. Developing KPIs is one of the most important tasks in BSC. KPI is not only useful in evaluating the performance, but also it serves as a basis for companies to redesign. We tried to derive the strategies, strategic objectives and KPIs for the balanced scorecard in the case study as mentioned in the tables in before section. In addition we have considered an absolute importance (AI) parameter with the following values in different four cases.

$$AI = \begin{cases} 3 & \textit{for very important} \\ 2 & \textit{for important} \\ 1 & \textit{for unimportant} \\ 0 & \textit{for very unimportant} \end{cases} \quad (1)$$

According to Eq. 1, degree of AI for an issue is 3 if it is very importance and is zero if it is very importance. In [32, 33] provided a formula for the importance of design requirements. We have considered the technical importance of design requirement as presented in Eq. 2, 3. Here, we have extended the formula to our problem in different dimensions.

$$KPI_j = \sum_{i=1}^{n} \left(\mathrm{R_{i,j}} \times (\mathrm{S}_i * 2 + \mathrm{W}_i + \mathrm{O}_i + \mathrm{T}_i) \right) \quad (2)$$

$$KPIs = \sum_j d_j \times KPI_j \quad (3)$$

Where $\mathrm{KPI_j}$ is absolute, technical importance of a view or aspect point j where j = 1, 2…m. Where KPIs is summation performance of design requirement j where j = 1, 2…m. $\mathrm{R_{i,j}}$ is quantified relationship index between consumer requirement i, and design requirement, j where i = 1,2,…,n, and j = 1,2,…,m. $\mathrm{S_i}$, $\mathrm{W_i}$, $\mathrm{O_i}$ and $\mathrm{T_i}$ parameters stand for Strengths, Weakness, Opportunities and Threats for feature i. $\mathrm{d_j}$ define degree of AI for requirement j where j=1,2,…,m[31].

In our evaluation, the prototype is a cloud service provider for a SME with the objectives described in the case study. We analyze the proposed DMTC-EBSC technique in all the aspects with respect to tables 1 to 6. Details of all calculation and assignments are provided in Appendix-A (Table 8, Table 9, Table 10 and Table 11). We evaluate the effect of each aspect in the proposed method and show how effective is in final decision making process. This is done with using the scoring tables and obtained the importance of each factor in the final processes. According to the objectives of the case study, $\mathrm{d_i}$ is assigned as shown in Table 7.

Table 7: Degree of Absolute Importance

Aspects \ Views	provider	Consumer
Datacenter	$\mathrm{d_1}$:very important(3)	$\mathrm{d_4}$: unimportant(1)
Cloud Platform	$\mathrm{d_2}$:important(2)	$\mathrm{d_5}$:veryimportant(3)
Cloud Services	$\mathrm{d_3}$: important(2)	$\mathrm{d_6}$:very important(3)

The relationship index ($\mathrm{R_{i,j}}$) between consumer requirements and design requirements are presented in 1 to 5 scales where W (Weak relationship=1), F (Fair relationship=2), S (Strong relationship=3), V (Very strong relationship=5). Appendix-A show details of calculation for all tables (1-6), original BSC in [6] and calculations of KPIs. The complete result of calculation for table 1-6 is given in Appendix-A. We explain the equations in continue.

$$KPI_1 = \sum_{i=1}^{6} \left(\mathrm{R_{i,1}} \times (\mathrm{S}_i * 2 + \mathrm{W}_i + \mathrm{O}_i + \mathrm{T}_i) \right) = 51$$

$$KPI_2 = 59, KPI_3 = 97, KPI_4 = 9, KPI_5 = 30,$$

$$KPI_6 = 12 \; and \; KPIs = 600$$

In addition, the maximum value of KPIs is calculated based on Eq.4.

$$Max\ KPIs = \sum_j (\mathrm{d_j} \times max\ KPI_j) \quad (4)$$

Where $\max \mathrm{KPI_j} = \sum_{i=1}^{n} \left(\mathrm{R_{i,j}} \times (\mathrm{S_i} * 2) \right)$

Where $\max \mathrm{KPI_j}$ is maximum absolute, technical importance of a view or aspect point j where j = 1, 2…m. Where Max KPIs is summation of maximum performance for design requirement j where j = 1, 2…m. Therefore maximum KPIs for proposed technique based values in Table 8 in Appendix-A is:

$$\mathrm{Max\ KPIs} = 817$$

On the other hand, we have calculated the KPIs based on information mentioned in tables of [13]. We have applied the original BSC-SWOT based on information in sec.3.1 to the SWOT tables in [6]. Since there is only one view default aspect of cloud computing for provider, we can calculate only one

KPIs value. The define degree of AI has very important (3) value. Results for KPIs in original BSC based on tables and results in reference [13] are in Appendix-A. The calculation method is given in continue.

$$KPI_{Original} = 99, KPIs = d_1 \times KPI_{Original} = 297$$

C. Evaluation Results

We have calculated KPIs for each point of view in figure 5-6. Figure 5 show evaluation results from provider view point and its data center, cloud platform and service aspects. As it is show in figure 5, Total KPIs of provider is summation KPIs of data center, KPIs of cloud and KPIs of service for provider view point. Figure 6 show evaluation results from consumer view point and its data center, platform and service aspects. As it is show in figure 6, total KPIs of consumer is summation KPIs of data center, KPIs of cloud and KPIs of service for consumer view point.

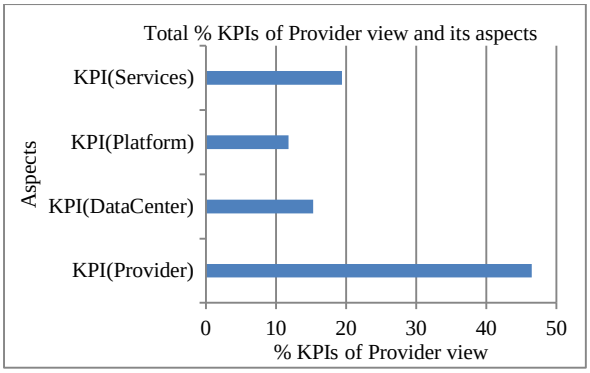

Fig. 5. Evaluation Results from Provider view point

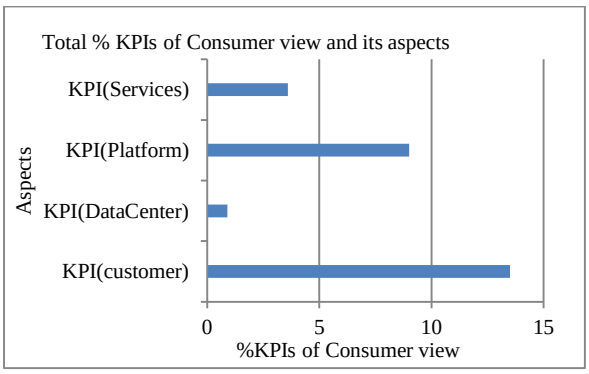

Fig. 6. Evaluation Results from consumer view point

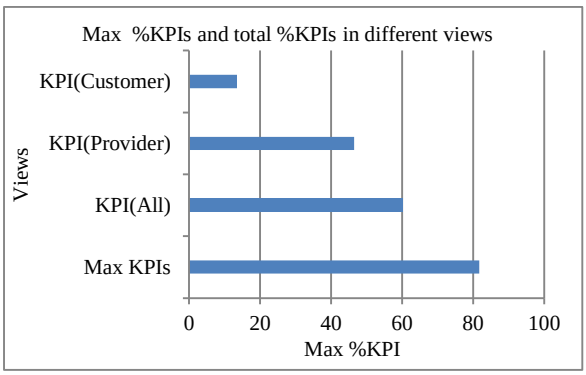

Fig. 7. Combination of different views

Figure 7 is combination of total views and final evaluation results from different views in comparison with maximum of KPIs. As it is shown in figure 7, KPIs of all views is summation KPIs of provider and KPIs of consumer and KPI (All) is close to max KPIs. In figure 8, we compare our evaluation results with tables and results in reference [13]. We evaluate KPIs of proposed technique in the paper with KPIs of standard SWOT analysis in the adoption of Cloud Computing services for small and medium-sized enterprises.

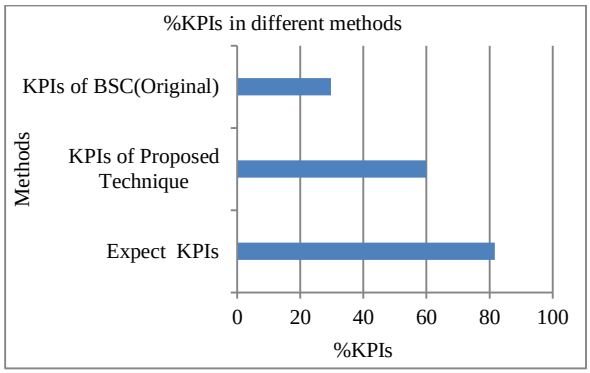

Fig. 8. Comparison of expected results, proposed technique and original BSC-SWOT

In the figure, expect KPIs is the maximum KPI resulted from applying equation 4 whereas the other two KPIs reported are the results of applying the proposed technique and the BSC original model [13]. The results show that the proposed technique has significantly better KPIs than that of the original BSC. This is due to the fact that in the proposed technique we have considered several extra aspects such as consumers, business, and culture, which are not included in the original BSC model.

VIII. Conclusion

We have investigated the current standard strategic management model as a base management system to give broad vision of using cloud computing ecosystems in IT industry. We devised a new technique called DMTC-EBSC for environment analysis, which is one of the most important steps in the strategic management models. The key idea in the proposed technique is considering all the important parameters related to a cloud ecosystem and proposing a proper decision making process over strengths, weaknesses, opportunities, and threats in a cloud environment. We categorized structure of the proposed technique in three isolated levels include data center, cloud provider and services which facilitated the task of decision making in the cloud computing strategic management process. In the final section of the paper, we evaluate the proposed method with a case study for SMEs and compare with the original BSC-SWOT model using standard KPIs metric in different aspects. Results of evaluation show the superiority of the proposed technique over the original BSC in cloud environments for the small and medium-sized enterprises.

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APPENDIX- A

Table 8. Calculations for All Tables 1 to 6.

R_1	$R_{i,1}$	S	W	O	T	R_{ij}	M_1
CS	f	1	-2	1	-1	0	4
BP	v	3	-2	3	-2	25	30
SP	f	2	-2	1	-2	2	8
LL	w	1	-1	0	-1	0	2
LG	s	2	-1	1	-1	9	12
TM	s	3	-1	1	-1	15	18

R_2	$R_{i,2}$	S	W	O	T	R_{ij}	M_2
CS	f	1	-1	1	-1	2	4
BP	v	5	-3	2	-1	40	50
SP	f	1	-1	1	-1	2	4
LL	w	1	-1	1	-2	0	2
LG	s	1	-1	1	- 1	3	12
TM	s	3	-2	1	-1	12	18

R_3	$R_{i,3}$	S	W	O	T	R_{ij}	M_3
CS	f	3	0	2	0	16	8
BP	v	3	0	4	-1	45	30
SP	f	2	-2	1	-1	4	8
LL	w	2	-1	0	-1	2	4
LG	s	3	0	2	0	24	18
TM	s	3	-2	0	-2	6	18

R_4	$R_{i,4}$	S	W	O	T	R_{ij}	M_4
CS	s	1	0	1	-1	6	3
BP	w	2	-2	2	-1	3	4
SP	s	2	-2	0	-2	0	8
LL	f	0	-1	0	-2	-6	0
LG	w	0	0	0	0	0	0
TM	f	2	-1	1	-1	6	4

R_5	$R_{i,5}$	S	W	O	T	R_{ij}	M_5
CS	s	1	-1	1	-1	3	6
BP	w	4	-3	2	-2	5	8
SP	s	2	-2	2	-2	6	12
LL	f	2	-2	0	-2	0	8
LG	w	1	0	1	-1	2	2
TM	f	3	-1	3	-1	14	12

R_6	$R_{i,6}$	S	W	O	T	R_{ij}	M_4
CS	s	1	-1	1	-1	3	6
BP	w	2	-2	1	-1	1	4
SP	s	1	-1	1	-1	3	6
LL	f	1	-1	1	-1	2	4
LG	w	1	-1	1	-1	1	2
TM	f	1	-1	1	-1	2	4

Table 9. Calculations for Original BSC in [13].

R_O	R	S	W	O	T	R_{ij}
FP	v	3	0	4	-1	45
CP	s	3	0	2	0	24
IP	s	2	-2	1	-1	6
LG	s	3	0	2	0	24

Table 10. Abbreviation Table

R: Relationship	**S:** Strengths	**W:** Weakness	**O:** Opportunities	**T:** Threats	**M:** Maximum R
CS: Cultural and Social	**BP:** Business Process	**SP:** Security Process	**LL:** Legal and Law	**LG:** Learning	**TM:** Technical & Management
R1: Datacenter Aspect of Cloud Provider	**R2:** Cloud Platform Aspect of Cloud Provider	**R3:** Services Aspect of Cloud Provider	**R4:** Datacenter Aspect of Cloud Consumer	**R5:** Datacenter Aspect of Cloud Consumer	**R6:** Datacenter Aspect of Cloud Consumer
R_O: Original R	**FP:** Financial Perspective (Business)	**CP:** Consumer Perspective (Cultural and Social)	**IP:** Internal Process (Security)	**LG:** Learning	

Table 11. Calculations of KPIs

$KPI_1 = \sum_{i=1}^{6}\left(\mathrm{R}_{i,1} \times (\mathrm{S}_i * 2 + \mathrm{W}_i + \mathrm{O}_i + \mathrm{T}_i)\right) \quad \max KPI_1 = \sum_{i=1}^{n}\left(\mathrm{R}_{i,1} \times (\mathrm{S}_i * 2)\right),\ Max\ KPIs = \sum_{j=1}^{6}(d_j \times \max KPI_j)$
KPI_1=2*(1*2-2+1-1+0)+5*(3*2-2+3-2)+2*(2*2-2+1-2)+1*(1*2-1+0-1)+3*(2*2-1+1-1)+3*(3*2-1+1-1)=51
KPI_2=2*(1*2-1+1-1)+5*(5*2-3+2-1)+2*(2*1-1+1-1)+1*(2*1-1+1-2)+3*(2*1-1+1-1)+3*(3*2-2+1-1)=59
KPI_3=2*(3*2-0+2-1)+5*(3*2-0+4-1)+2*(2*2-2+1-1)+1*(2*2-1+0-1)+3*(3*2-0+2-0)+3*(3*2-2+0-2)=97
KPI_4=3*(1*2-0+1-1)+1*(2*2-2+2-1)+3*(2*2-2+0-2)+2*(0*2-1+0-2)+1*(0*2-0+0-0)+2*(2*2-1+1-1)=9
KPI_5=3*(1*2-1+1-1)+1*(4*2-3+2-2)+3*(2*2-2+2-2)+2*(2*2-2+0-2)+1*(1*2-0+1-1)+2*(3*2-1+3-1)=30
KPI_6=3*(1*2-1+1-1)+1*(2*2-2+1-1)+3*(1*2-1+1-1)+2*(1*2-1+1-1)+1*(1*2-1+1-1)+2*(1*2-1+1-1)=12
Max KPIs=74*(3)+90*(2)+86*(2)+21*(1)+48*(3)+26*(3)=817
KPIs=51*(3)+59*(2)+97*(2)+9*(1)+30*(3)+12*(3)=600
Provider: KPIs=51*(3)+59*(2)+97*(2)=465
Consumer: KPIs=9*(1)+30*(3)+12*(3)=135
Data Center: KPIs=51*(3)+ 9*(1)=162
Cloud Platform: KPIs=59*(2)+30*(3)=208
Cloud Services: KPIs=97*(2)+12*(3)=230
KPIs of BSC (Original)=99*(3)=297

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