*African Journal of Engineering Research*
**Vol. 7(1), pp. 17-32, March 2019**
**DOI: 10.30918/AJER.71.19.015**
**ISSN: 2354-2144**
***Full Length Research Paper***

# SMC-SPMV: A new strategic management model for cloud computing based on SWOT/PESTEL multi view

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Accepted 28 February, 2019

**ABSTRACT**

Cloud computing is of growing interest to companies throughout the world, but there are many barriers associated with its adoption which should be eliminated. Moreover, the widespread usage of cloud computing services 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. A SWOT analysis which consists of strengths, weaknesses, opportunities and threats has also carried out in which cloud computing adoption for Enterprises is evaluated. We present a strategic management model for cloud computing based on SWOT and PESTEL techniques (SMC-SWOT/PL). Evaluation results indicate superiority of the SMC-SWOT/PL over the original SWOT-BSC technique which is an extended SWOT in terms of standard KPIs.

**Keywords:** Cloud services, PESTEL, key performance indicators, SWOT analysis.

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## INTRODUCTION

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. 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 (Hamdaqa and Tahvildari, 2012; Buyya et al., 2009). In Cloud computing, new IT services come into view from the collaborative convergence of business and technology perspectives; moreover, enabling users to gain accessibility of explicit knowledge, services could effectively make a contribution to information and knowledge sharing (Ghaffari et al., 2014). Cloud Computing aims to reduce the amount of complexity, minimizes costs, and enhances organizational agility (Ghaffari et al., 2014). Cloud computing decrease the obstacles to conduct information process intensive activities; Indeed, people do not need to maintain their own technology infrastructure as they transfer the burden of system management and data protection to the cloud computer service provider (Ghaffari et al., 2014). 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 (Liu et al., 2011). 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 (Babcock, 2010; Rom and Rohde, 2006). This model includes a feedback loop to monitor execution and inform the next round of planning. 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 (Sabbaghi and Vaidyanathan, 2004). 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 (Martinsons et al., 1999). PEST framework analyzes the external business environment to understand the 'big picture' in which the organization operates thus enabling them to take advantage of the opportunities and minimize the threats faced by the organization's business activities (Babcock, 2010). However, in this paper we introduce a new technique for cloud computing environment analysis which incorporates cloud with a modified form of PEST (SWOT/PL). That is a combination of SWOT and PESTEL. the PESTEL (Political, Economic, Social, Technological, Environmental and Legal) analysis allow the organizations to understand the big picture of adopting cloud computing in the business environment and to realize the advantages, opportunities and to minimize the threats of this technology. 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.

## RELATED WORKS

A number of research works in literature have investigated the adoption of PEST and balanced scorecard (BSC) to evaluate Cloud computing services in SMEs. A BSC implementation in SMEs is presented in Lawrie et al. (2006). But, it does not help developers and consumers to decision making process in adoption of cloud computing services. Issa et al. (2010) paper provides a brief literature review of cloud computing, followed by an analysis of the cloud-computing environment using the PESTEL framework. Toward cloud computing in Ghaffari et al. (2014) is a SWOT analysis on its adoption in SMES. This paper aims to investigate Cloud Computing and discusses the drivers and inhibitors of its adoption. Rosemann (2001) evaluates 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 (2013) 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. Also, a PEST framework for analyzing cloud computing adoption by Mauritian SMEs is presented in Antoo et al. (2010). These frameworks categorize 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 (2010) 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 Kemp (2015) 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 Fujii (2014). 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 PESTEL and how to design the SWOT and strategic map by many case-studies. Exploring the use of cloud computing in SMEs is presented in Hadidi (2010). 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, consumers and regulator involved in cloud.

Besides, their model is not well suited for cloud environments. In this research we consider our analysis from more angles including, regulator, provider and consumers to cover all players in cloud ecosystem.

## ORIGINAL SWOT AND PEST

SWOT analysis is an efficient tool used to identify environmental conditions and intra organizational capabilities involved in every project and have been used extensively in various decision making processes. In this analysis, firstly the goal of project and secondly its internal and external determinant factors are identified. This method can make a contribution in investigating and evaluating issues from all main aspects in which every issue is analyzed comprehensively based on the mentioned factors (Sabbaghi and Vaidyanathan, 2004). PEST analysis (political, economic, socio-cultural and technological) describes a framework of macro-environmental factors used in the environmental scanning component of strategic management. It is part of an external analysis when conducting a strategic analysis or doing market research, and gives an overview of the different macro-environmental factors to be taken into consideration. Figure 1 shows the Original SWOT analysis vs. PEST. This method is a better approach would be to perform an extensive PEST analysis and use that finding in the opportunities and threats section in the SWOT analysis. It is a strategic tool for understanding market growth or decline, business position, potential and direction for operations. 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: SMM-SWOT/PL
- Computation and evaluation process of SMM-SWOT/PL technique.

## STRATEGIC MANAGEMENT WITH PROPOSED TECHNIQUE FOR CLOUD ENVIRONMENT

Strategy is a game plan management used 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 (Truong, 2010). To establish and maintain a distinctive strategic management, Porter (2001) stipulates that a company needs 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 that include five phases (Harrison and John, 2013; Kundra, 2011). Harrison and John's model is improved for cloud computing and prepared by a strategic analysis in phase 2 with SMM-SWOT. The model improves Harrison and John's model by substituting the model adopted in the second phase with our proposed SMM-SWOT/PL technique. More precisely, this model takes advantage of SMM-SWOT/PL 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.

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


**Figure 1.** The original SWOT analysis vs PEST.

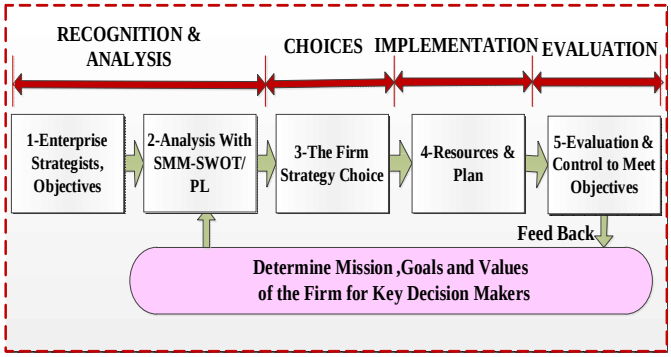


**Figure 2.** Strategic management with proposed decision making technique for cloud environment.

### 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 (Chew et al., 2009).

### Analysis with SMM-SWOT/PL

For an appropriate strategy, we must analyse the current internal and external environment. Here, we proposed SMM-SWOT/PL technique, which is a new analysis technique for the strategy development.

### The firm strategy choice

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

### Resources and 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 (Rittinghouse and Ransome, 2009).

### Evaluation and 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.

## PROPOSED ANALYSIS TECHNIQUE: SMM-SWOT/PL

To make more accurate results of the strategy map, we propose a SWOT/PL technique as depicted in Figure 3. In original SWOT 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. SMM-SWOT/PL 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. Despite the traditional approach that just has two major groups of stakeholders encompassing service providers and consumers, in Cloud Computing stakeholders are

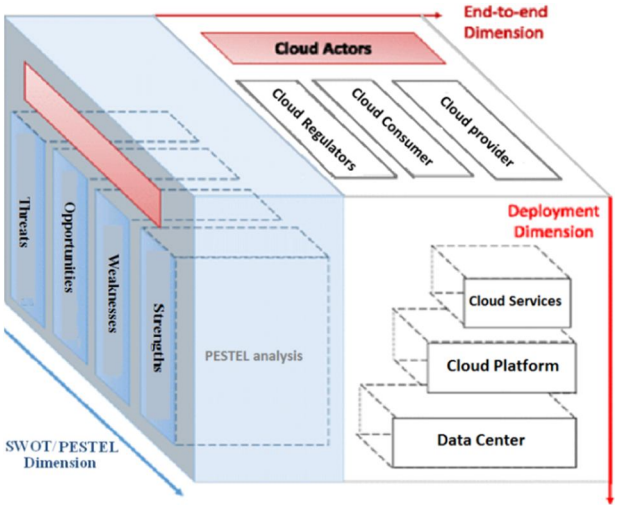


**Figure 3.** Proposed SMM-SWOT/PL technique.

more detailed. These stakeholders are:

- Providers: Vendors perform the maintenance and upgrade of the system and are responsible for protecting consumer's data. Enablers are organizations that are responsible for selling services, facilitating the delivery, adoption and utilization of cloud computing
- Consumers: Subscribers who purchase and make use of system.
- Regulators: International entities that permeate across the other stakeholders

We can analyze these three domains with proposed SWOT method from six different factors including political, economic, social, technological, environmental and legal, as it is depicted in Figure 4.

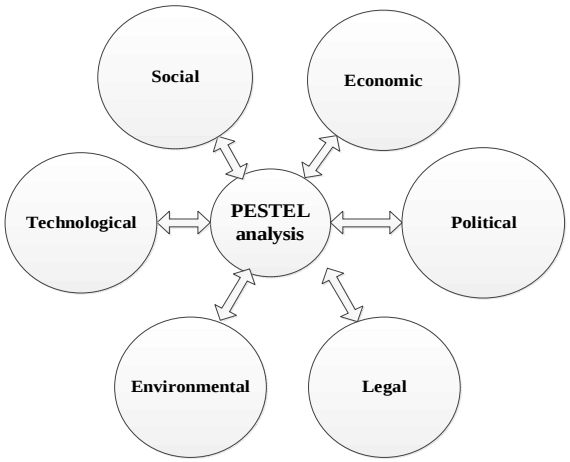


**Figure 4.** Proposed EBSC method for cloud computing.

We have emphasized on these parameters with more

details in the next section. It is very important to consider that all those parameters are not similar from different perspectives. We separate our viewpoint from provider, consumer and regulator 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 PEST model modified and adapted for cloud computing environments which considers all important aspects and perspectives of cloud ecosystems.

*A. Political*
Political factors are basically how the government intervenes in the economy.
*B. Economical*
Economic factors include economic growth, interest rates, exchange rates, inflation rate. These factors greatly affect how businesses operate and make decisions.
*C. Social*
Social factors include the cultural aspects and health consciousness, population growth rate, age distribution, career attitudes and emphasis on safety.
*D. Technological*
Technological factors include technological aspects like R&D activity, automation, technology incentives and the rate of technological change.
*E. Environmental*
Environmental factors include ecological and environmental aspects such as weather, climate, and climate change, which may especially affect industries such as tourism, farming, and insurance.
*F. Legal*
Legal factors include discrimination law, consumer law, antitrust law, employment law, and health and safety law. These factors can affect how a company operates, its costs, and the demand for its products.

## EVALUATION PROCESS OF SMM-SWOT/PL TECHNIQUE

Here, we thoroughly present the SMM-SWOT/PL technique given in Figure 3. This method can be presented by nine SWOT tables from the three viewpoints of providers, consumers and regulators, 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 9) are presented. For example, Table 1 shows the SWOT analysis for the data center aspect of cloud providers.

## PERFORMANCE EVALUATION

In this section, a case study for evaluation of the proposed technique is presented. The case study is assuming a national cloud service provider enterprise. Objective is enhancing the position of company to provide services at the national level. In order to validate our results we compare results of proposed technique with original BSC-SWOT conducted in Hadidi (2010).

### Evaluation metrics

In order to evaluate our method, we have considered the key performance indicator (KPI) metric proposed in Katsaros et al. (2011). Developing KPIs is one of the most important tasks in SWOT analysis. 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/HOWs for SWOT/PL in the case study as mentioned in the tables in previous section. In addition we have considered a degree of importance parameter (D) with the following values in different four cases.

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

According to Equation 1, degree of D for an issue is 3 if it is very importance and is zero if it is very unimportance. In Li et al. (2008) and Chen and Chen (2014) provided a formula for the importance of design requirements. We have considered the technical importance of design requirement as presented in Equations 2 and 3. Here, we have extended the formula to our problem in different dimensions.

$$KPI_j = \sum_{i=1}^{n} \left( R_{i,j} \times (S_i * 2 + W_i + O_i + T_i) \right) \quad (2)$$

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

Where $KPI_j$ 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. $R_{i,j}$ is quantified relationship index between consumer requirement i, and design requirement, j where i = 1, 2,…, n, and j = 1, 2,…,m. The relationship indices between customer requirements and design requirements are represented on a 1-2-3-5 scales. Those items may be different in each relationship. $S_i$, $W_i$, $O_i$ and $T_i$ parameters stand for Strengths, Weakness, Opportunities and Threats for feature i. $d_j$ define degree of D for requirement j where j = 1, 2, …, m (Katsaros et al. (2011).

In our evaluation, the prototype is a cloud service provider for a SME with the objectives described in the

**Table 1.** SWOT analysis for datacenter aspect of cloud provider.

| Feature | Strengths | Weaknesses | Opportunities | Threats |
|---|---|---|---|---|
| Political | 1. Encourage in using the services<br>2. Protect the scale of services | 1. Lack of physical control of data<br>2. Unified the different data centers<br>3. Providing the SW/HW equipment's | 1. Supporting the continuities of services | 1. Variation in stabilities<br>2. Ignoring the arguments |
| Economical | 1. Reduction of costs in IT Infrastructure<br>2. Lower costs of maintenance<br>3. Optimal use of the hardware and resources | 1. The high cost of bandwidth<br>2. High cost for securing communications network | 1. Being a new service<br>2. Economic downturn<br>3. Providing telecommun-ications facilities as a service | 1. Industrial and Economic Sanctions<br>2. Additional costs to purchase of hardware and software |
| Social | 1. Interoperability with other data centers | 1. Standardization<br>2. Rapid changes in technology | 1. Using support of other provider resources | 1. Cultural invasion |
| Technical | 1. Managing the system from one central point<br>2. Continuity of service delivery<br>3. Possibility for assigning the virtual resources | 1. Need for qualified personnel in the areas of virtualization and cloud computing<br>2. Data transfer bottlenecks | 1. Ability to provide diversified service delivery<br>2. Offering worldwide services | 1. Weak Communication Infrastructure |
| Environmental | 1. Protecting the environment | 1. Negative effect of environments | 1. Saving the energy | 1. Vast resources |
| Legal | 1. Improve the quality of services to achieve the SLA | 1. Lack of Proper Law Enforcement<br>2. Lack of commitment to the high quality of service and availability guarantees<br>3. Inability of providers to guarantee the location of the company's information | 1. Defined the qualified data center services | 1. Lack of legal laws related to cloud computing |

case study. We analyze the proposed SMM-SWOT/PL technique in all the aspects with respect to Tables 1 to 9. Details of all calculation and assignments are explained in APPENDIX-A. We evaluate the effect of each aspect in the proposed method and show how effective it 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, $d_i$ is assigned as shown in Table 10.

The relationship index ($R_{i,j}$) 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). We calculate KPIs for all tables (1 to 9) and original table in Hadidi (2010) and explain the calculation results in continue.

$$KPI_1 = \sum_{i=1}^{6} \left( R_{i,1} \times (S_i * 2 + W_i + O_i + T_i) \right) = 44$$

$$KPI_2 = 70, KPI_3 = 62, KPI_4 = 16, KPI_5 = 24,$$
$$KPI_6 = 47, KPI_7 = 19, KPI_8 = 18, KPI_9 = 18, KPIs = 676$$

In addition, the maximum value of KPIs is

**Table 2.** SWOT analysis for cloud platform aspect of cloud provider.

| Feature | Strengths | Weaknesses | Opportunities | Threats |
|---|---|---|---|---|
| Political | 1. Variation in accepted platform | 1. Complexity in operations | 1. Offering unified service and support | 1. Uncertainty in cloud agreements |
| Economical | 1. Cost reduction<br>2. Fast software upgrade<br>3. Lower maintenance costs<br>4. Lower costs for IT infrastructure<br>6. The possibility of hosting more sites | 1. The high cost of bandwidth for users<br>2. Weakness in communications network<br>3. Purchasing special hardware and software cloud | 1. The new issue of cloud computing<br>2. Offering software and resources as a service | 1. Industrial and economic sanctions |
| Social | 1. Widely available | 1. Encourage for considering the right | 1. Explanation of unified culture and policy | 1. Abusing the facility and tools |
| Technical | 1. Fast software upgrade<br>2. Reducing the operation time<br>3. Accelerate development IT capability | 1. Require a permanent connection to the internet<br>2. Cloud computing with low-speed | 1. New research and challenges | 1. New kind of softwares |
| Environmental | 1. Sharing costly resources | 1. Costly environment for availability | 1. Innovative services | 1. Payment and cost |
| Legal | 1. Saving the public data | 1. Lack of necessary law and regulation | 1. Explanation of regulation and law enforcement | 1. Lack of legal laws related to cloud computing<br>2. Legal issues in applying cloud computing |

**Table 3.** SWOT analysis for cloud services aspect of cloud provider.

| Feature | Strengths | Weaknesses | Opportunities | Threats |
|---|---|---|---|---|
| Political | 1. Support services<br>2. Facilitate the requirements | 1. Dependency | 1. Spread of supported services | 1. Policy variation |
| Economical | 1. Pay per usage<br>2. Less expensive to upgrade<br>3. Aspects of marketing-reach has not barriers to entry | 1. Competition price<br>2. Innovation in services<br>3. Coverage area | 1. Global market access<br>2. New markets with eliminate barriers to entry<br>3. New business model<br>4. Local, regional, and global business relationship | 1. Industrial and economic sanctions |

**Table 3.** Continues.

| | | | | |
|---|---|---|---|---|
| Social | 1. Offering widely services<br>2. Communications legacy systems supported<br>3. Cultural, attitudinal, behavioral organizationally acceptable | 1. Competition between providers<br>2. Enforce up to date<br>3. Standard variations | 1. Increase collaboration,<br>2. Interoperability with business partners | 1. Limitation in number of users<br>2. Up to date in service and facilities |
| Technical | 1. Mainly managed externally<br>2. Reducing the operation time services | 1. Real and perceived lack of information and systems control<br>2. Lack of on-site IT/IS support | 1. Services expansion | 1. Off-site data centers and resources<br>2. Real and perceived lack of information and systems |
| Environmental | 1. Cost reduction<br>2. Unified services | 1. Services connectivity | 1. Cost reduction | 1. Disasters |
| Legal | 1. Widely accepted in accreditations, qualifications, certifications<br>2. High degree of agility, philosophy and values | 1. Lack of Laws | 1. Users confidence | 1. Service level agreements for cloud computing services |

**Table 4.** SWOT analysis for datacenter aspect of cloud consumer.

| Feature | Strengths | Weaknesses | Opportunities | Threats |
|---|---|---|---|---|
| Political | 1. Encourage using data center services | 1. The location of the consumer data in cloud | 1. Low cost services | 1. Security and privacy users<br>2. Information security |
| Economical | 1. Reduce the cost of hardware<br>2. Reduce the cost of software and licenses | 1. The high cost of bandwidth for users<br>2. Restrict users to specific organizations | 1. It is a new topic<br>2. Few competitors in the market | 1. The global economic downturn |
| Social | 1. The possibility of further collaboration in the cloud | Not defined | 1. Presence in global markets | 1. Unknown cloud computing |
| Technical | 1. Independence computing on a particular platform<br>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 |
| Environmental | 1. Protecting the environment | 1. Service quality | 1. Service creation | 1. Disaster |
| Legal | 1. Define law and regulation | 1. Not clear the DC rules | 1. Service attraction | 1. Increase in trade restrictions<br>2. Legal requirements |

**Table 5.** SWOT analysis for cloud platform aspect of cloud consumer.

| Feature | Strengths | Weakness | Opportunities | Threats |
|---|---|---|---|---|
| Political | 1. Unified platform | 1. Variety of platform spec. | 1. Development of services | 1. Compatibilities with other platforms |
| Economical | 1. Reduce hardware and software costs<br>2. Lower and easier maintenance costs<br>3. Lower costs for IT infrastructure<br>4. Fast software upgrade | 1. The high cost of bandwidth for users<br>2. Weakness in communications network<br>3. Limitations of applications | 1. A new topic<br>2. High number of competitors | 1. Industrial and economic sanctions<br>2. Vulnerability to economic downturn |
| Social | 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 |
| Technical | 1. Universal access to documents<br>2. Computing independent of the user's hardware | 1. Sharing the virtual resources | 1. Access to the latest version editor for documents<br>2. Online store user data<br>3. Receive more computing power | 1. The emergence of a strong alternative technology |
| Environmental | 1. Easy service development | Not defined | 1. Opportunity for new services | 1. Dependency |
| Legal | 1. High degree of agility, philosophy and values | 1. Legal issues in applying cloud computing | Not defined | 1. Not being clear the cloud rule<br>2. Increase in trade restrictions |

**Table 6.** SWOT analysis for cloud services aspect of cloud consumer.

| Feature | Strengths | Weaknesses | Opportunities | Threats |
|---|---|---|---|---|
| Political | 1. Energy saving<br>2. Maintenance cost reduction | 1. Increased dependency | 1. Adaptive to future needs<br>2. Standardized process<br>3. Quick solution for problems | 1. Security concern<br>2. Compatibility reduction<br>3. Possibility of backlash from entrenched incumbents |
| Economical | 1. Lower maintenance costs<br>2. Reduce the cost of hardware and software | 1. Limitations of cloud services<br>2. Restrict users to limited provider | 1. Global market access<br>2. Good chance for SMEs in upfront investments<br>3. Marketplace enhancement in functionality, innovation and price | 1. Industrial and economic sanctions<br>2. Hidden cost (backup, recovery…) |
| Social | 1. Communications legacy systems supported<br>2. Friendly utilization | 1. Abusing the contents | 1. Increase collaboration, interoperability with business partners | 1. Cultural invasion |

**Table 6.** Continues.

| | | | | |
|---|---|---|---|---|
| Technical | 1. Faster provisioning of systems and application<br>2. Secured infrastructure<br>3. Resilient in disaster recovery<br>4. Better control of the resources | 1. Lack of on-site IT/IS support<br>2. Development of applications<br>3. Difficulty of integration with local software | 1. Universal access to services<br>2. Invent scalable store<br>3. Offering modern solutions according the last technology | 1. Off-site data centers and resources<br>2. Data security |
| Environmental | 1. Flexible and innovative<br>2. Compliant facilities<br>3. Convenient level of accessibility<br>4. Independence of time and location<br>5. Environmental protection | 1. Post training require<br>2. High-speed internet connection requirement | 1. Pay for use licenses<br>2. High-tech work environment | 1. Difficulty from migration from one to another platform |
| Legal | 1. Widely accepted in accreditations, qualifications, certifications | 1. Legal issues in preserving privacy | 1. New regulations<br>2. Improve confidence | 1. Legal issues in applying cloud computing<br>2. Lack of specific standard regulation (local, national and international) |

**Table 7.** SWOT analysis for datacenter aspect of cloud regulators.

| Feature | Strengths | Weaknesses | Opportunities | Threats |
|---|---|---|---|---|
| Political | 1. Law and regulation in DC | 1. Ignore the rule and regulation | 1. Service development | 1. Privacy and security |
| Economical | 1. The need for large corporations to create a corporate private cloud | 1. The possibility of losing part of traditional control over data stored in external data centers | 1. Economic recession | 1. Existence of better cloud infrastructure outside of country<br>2. Economic sanctions |
| Social | 1. Monitoring the cloud interaction | 1. Ignore regulations | 1. Expanding culture and common policies | 1. Economic sanctions |
| Technical | 1. Government policies in the development of the national information network | 1. Less control | 1. Apply general security policies to consumers | 1. Ignoring quality spec. |
| Environmental | 1. Saving the environment | 1. Lack of regulation | 1. Service expansion | 1. Low enforcement |
| Legal | 1. Control over more information in native data centers | 1. Insufficient rules to support the provision of services | 1. Encourage the localization of data centers | 1. Poor identity and access management |

**Table 8.** SWOT analysis for cloud platform aspect of cloud regulators.

| Feature | Strengths | Weakness | Opportunities | Threats |
|---|---|---|---|---|
| Political | 1. Unified platform | 2. Connectivity and unification | 1. Value added services | 1. Lack of regulations |
| Economical | 1. Development and supply of banking and financial services<br>2. New business models for cloud-enhanced products | 1. Less control over business starters and handlers<br>2. Limitations of Applications | 1. A new topic<br>2. Increased competitiveness through local platforms | 1. Vulnerability to economic downturn |
| Social | 1. Suitable platform for more cooperation | 1. Variation of platform | 1. Expanding culture and common policies | 1. Unknown cloud computing between consumers |
| Technical | 1. Standardization and unified services | 1. Sharing the Virtual Resources | 1. Services expansion | 1. The emergence of a strong alternative technology |
| Environmental | 1. Saving cost and environment | 1. Weakness in regulations | 1. Services expansion | 1. Disaster |
| Legal | 1. Saving of data ownership, privacy | 1. Insufficient rules to support the provision of services | 1. Services expansion | 1. Legal issues in implementation of cloud computing<br>2.Increase in Trade Restrictions |

**Table 9.** SWOT analysis for cloud services aspect of cloud regulators.

| Feature | Strengths | Weaknesses | Opportunities | Threats |
|---|---|---|---|---|
| Political | 1. On demand structure | 1. Political issues due to global | 1. Anywhere/anytime accessibility | 1. System monitoring and logs 2. Reliability |
| Economical | 1. Abundance of SME's<br>2. Development and supply of banking and financial services<br>3. Cost advantage predicted on cloud efficiencies | 1. Lack of awareness<br>2. Economic value | 1. Support for SME's through return on investment<br>2. Cost reduction structure | 1. Industrial and economic sanctions |
| Social | 1. Participation in standardization and cloud-based groups | 1. Legal use of the contents | 1. Macro managing implementation of the higher policies | 1. Cultural invasion |
| Technical | 1. Specific cloudy ways to seize marginal markets | 1. Connectivity and open access<br>2. Challenges of cloud security | 1. Quick accessibility<br>2. Innovation incentive structure | 1. Security and privacy |
| Environmental | 1. Saving cost and environment | 1. Cloud standards<br>2. Boundaries | 1. Collaboration among users | 1. Resource location<br>2. Interoperability |
| Legal | 1. Saving of data ownership, privacy | 1. Insufficient rules to support the provision of services<br>2. Multi tenancy issue | 1. New regulations | 1. The lack of legal framework for the cloud environment |

**Table 10.** Degree of absolute importance.

| Views / Aspects | Provider | Consumer | Regulators |
|---|---|---|---|
| Datacenter | $d_1$: very important (3) | $d_4$: unimportant (1) | $d_7$: unimportant (1) |
| Cloud platform | $d_2$: important (2) | $d_5$: very important (3) | $d_8$: important (2) |
| Cloud services | $d_3$: important (2) | $d_6$: very important(3) | $d_9$: very important (3) |

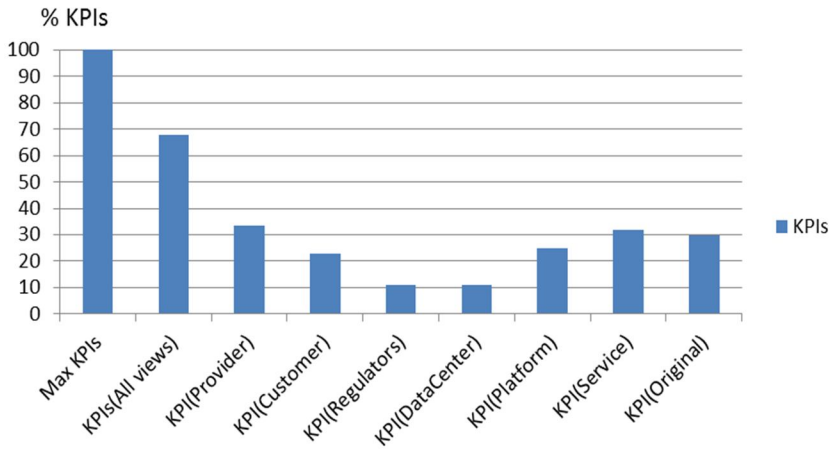


**Figure 5.** Evaluation Results from KPIs with new method.

calculated based on Equation 4.

$$Max\ KPIs = \sum_{j} (d_j \times max\ KPI_j) \quad (4)$$

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

Where $\max KPI_j$ 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 the maximum KPIs in proposed technique based values in the Tables, is:

Max KPIs = 1230

On the other hand, we have calculated the KPIs based on information mentioned in tables of Hadidi (2010). We have applied the original SWOT-BSC based on information in Sec.III for SWOT tables. Since there is only one view default aspect of cloud computing for provider, we can calculate only one KPIs value. The define degree of D has very important (3) value. We calculated results for KPIs in original PEST based on tables and results in reference (Hadidi, 2010). The calculation method is given as follows:

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

***Evaluation results***

We have calculated KPIs for different point of view in Figure 5. This figure shows the evaluation results from different view point and service aspects in Table 10. As shown 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 5 shows evaluation results from KPIs with SMM-SWOT/PL method. It includes maximum expected KPI and sum of the result of all KPIs in the case study. Also KPIs from viewpoints of provider, consumer, regulators, data center, platform, service and the total KPI of original resource in Hadidi (2010) are depicted in this figure.

Figure 6 is the combination of total views and final evaluation results from different views in comparison with maximum of KPIs. As it is shown in the figure, KPIs of all views is summation KPIs of provider and KPIs of consumer and KPI (All) is close to max KPIs. In Figure 6, we compare our evaluation results with tables and results 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.

In the figure, expected 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 SWOT-BSC original model (Hadidi, 2010). The results show that the proposed technique has

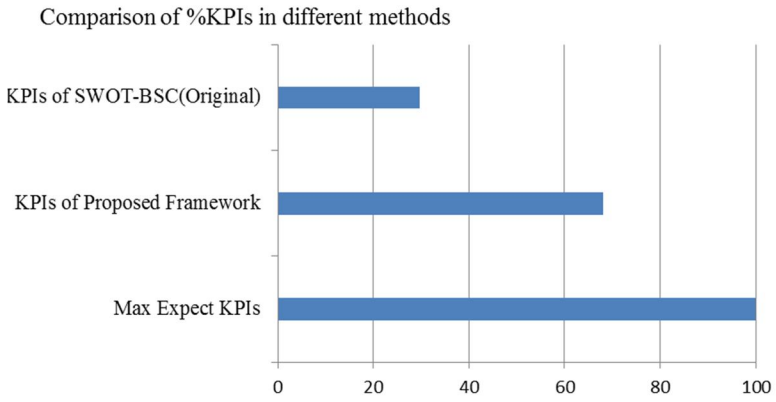


**Figure 6.** Comparison of expected results, proposed technique and original BSC-SWOT.

significantly better KPIs than that of the original SWOT-BSC. This is due to the fact that in the proposed SMM-SWOT/PL technique, we have considered several extra aspects such as regulator, consumer, legal and environmental, which are not included in the original model.

## CONCLUSION

We have investigated the current standard strategic management as a base. We devised a new technique called SMM-SWOT/PL 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 and compare with the original SWOT-BSC model using standard KPIs metric in different aspects. Results of evaluation show the superiority of the SMM-SWOT/PL proposed technique over the original technique in cloud environments.

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**Citation:** Ahmadi MR, Maleki D, Ahmadi A (2019). SMC-SPMV: A new strategic management mdel for cloud computing based on SWOT/Pestel multi view. Afr J Eng Res, 7(1): 17-32.

## APPENDIX A

The relationship indices between customer requirements and design requirements are represented on a 1-2-3-5 scale. W = 1 (Weak relationship), F = 2 (Fair relationship), S = 3 (Strong relationship), V = 5 (Very strong relationship).

**Table 11.** Abbreviation Table.

| | | |
|---|---|---|
| PL: Political | EC: Economical | SO: Social |
| TE: Technical | EN: Environmental | LE: Legal |
| R: Relationship | S: Strengths | W: Weakness |
| O: Opportunities | T: Threats | M: Maximum R |
| 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: Cloud Platform Aspect of Cloud Consumer | R6: Services Aspect of Cloud Consumer |
| R7: Datacenter Aspect of Regulators | R8: Cloud Platform Aspect of Regulators | R9: Services Aspect of Regulators |
| RO: Original R | | |

**Table 12.** Calculations for All Tables 1 to 9.

| $R_1$ | $R_{i,1}$ | S | W | O | T | $R_{ij}$ | $M_1$ |
|---|---|---|---|---|---|---|---|
| PL | v | 2 | -3 | 1 | -2 | 0 | 20 |
| EC | v | 3 | -2 | 3 | -2 | 25 | 30 |
| SO | f | 1 | -2 | 1 | -1 | 0 | 4 |
| TE | s | 3 | -2 | 2 | -1 | 15 | 18 |
| EN | s | 1 | -3 | 1 | -1 | -3 | 6 |
| LE | s | 1 | -3 | 1 | -1 | -3 | 6 |

| $R_2$ | $R_{i,2}$ | S | W | O | T | $R_{ij}$ | $M_2$ |
|---|---|---|---|---|---|---|---|
| PL | v | 1 | -1 | 1 | -1 | 5 | 10 |
| EC | v | 5 | -3 | 2 | -1 | 40 | 50 |
| SO | f | 1 | -1 | 1 | -1 | 2 | 4 |
| TE | s | 3 | -2 | 1 | -1 | 12 | 18 |
| EN | f | 1 | -1 | 1 | -1 | 2 | 4 |
| LE | s | 3 | -2 | 1 | -2 | 9 | 18 |

| $R_3$ | $R_{i,3}$ | S | W | O | T | $R_{ij}$ | $M_3$ |
|---|---|---|---|---|---|---|---|
| PL | v | 2 | -1 | 1 | -1 | 15 | 20 |
| EC | v | 3 | -3 | 4 | -1 | 30 | 30 |
| SO | f | 3 | -3 | 2 | -2 | 6 | 12 |
| TE | s | | -2 | 1 | -2 | 3 | 12 |
| EN | f | 1 | -1 | 1 | -1 | 2 | 4 |
| LE | s | 3 | -2 | 1 | -2 | 9 | 18 |

| $R_4$ | $R_{i,4}$ | S | W | O | T | $R_{ij}$ | $M_4$ |
|---|---|---|---|---|---|---|---|
| PL | f | 1 | -1 | 1 | -2 | 0 | 4 |
| EC | w | 2 | -2 | 2 | -1 | 3 | 4 |
| SO | s | 1 | 0 | 1 | -1 | 6 | 6 |
| TE | f | 2 | -1 | 1 | -2 | 4 | 8 |
| EN | f | 1 | -1 | 1 | -1 | 2 | 4 |
| LE | w | 1 | -1 | 1 | -1 | 1 | 2 |

| $R_5$ | $R_{i,5}$ | S | W | O | T | $R_{ij}$ | $M_5$ |
|---|---|---|---|---|---|---|---|
| PL | s | 1 | -1 | 1 | -1 | 3 | 6 |
| EC | w | 4 | -3 | 2 | -2 | 5 | 8 |
| SO | s | 1 | -1 | 1 | -1 | 3 | 6 |
| TE | f | 2 | -1 | 3 | -1 | 10 | 8 |
| EN | f | 1 | 0 | 1 | -1 | 4 | 4 |
| LE | w | 1 | -1 | 0 | -2 | -1 | 2 |

| $R_6$ | $R_{i,6}$ | S | W | O | T | $R_{ij}$ | $M_6$ |
|---|---|---|---|---|---|---|---|
| PL | f | 2 | -1 | 3 | -3 | 6 | 8 |
| EC | w | 2 | -2 | 3 | -2 | 3 | 4 |
| SO | s | 2 | -1 | 1 | -1 | 9 | 12 |
| TE | f | 1 | -1 | 1 | -1 | 2 | 4 |
| EN | s | 5 | -2 | 2 | -1 | 27 | 30 |
| LE | w | 1 | -1 | 1 | -2 | 0 | 2 |

| $R_7$ | $R_{i,7}$ | S | W | O | T | $R_{ij}$ | $M_7$ |
|---|---|---|---|---|---|---|---|
| PL | s | 1 | -1 | 1 | -1 | 3 | 6 |
| EC | f | 1 | -1 | 1 | -2 | 0 | 4 |
| SO | s | 1 | -1 | 1 | -1 | 3 | 6 |
| TE | v | 1 | -1 | 1 | -1 | 5 | 10 |
| EN | s | 1 | -1 | 1 | -1 | 3 | 6 |
| LE | v | 1 | -1 | 1 | -1 | 5 | 10 |

| $R_8$ | $R_{i,8}$ | S | W | O | T | $R_{ij}$ | $M_8$ |
|---|---|---|---|---|---|---|---|
| PL | s | 1 | -1 | 1 | -1 | 3 | 6 |
| EC | f | 2 | -2 | 2 | -1 | 6 | 8 |
| SO | s | 1 | -1 | 1 | -1 | 3 | 6 |
| TE | s | 1 | -1 | 1 | -1 | 3 | 6 |
| EN | s | 1 | -1 | 1 | -1 | 3 | 6 |
| LE | v | 1 | -1 | 1 | -2 | 0 | 10 |

| $R_9$ | $R_{i,9}$ | S | W | O | T | $R_{ij}$ | $M_9$ |
|---|---|---|---|---|---|---|---|
| PL | s | 1 | -1 | 1 | -1 | 3 | 6 |
| EC | f | 3 | -2 | 2 | -1 | 10 | 12 |
| SO | s | 1 | -1 | 1 | -1 | 3 | 6 |
| TE | v | 1 | -2 | 2 | -1 | 5 | 10 |
| EN | s | 1 | -2 | 1 | -2 | -3 | 6 |
| LE | v | 1 | -2 | 1 | -1 | 0 | 10 |

**Table 12.** Calculations for Original BSC in Antoo et al. (2010).

| $R_O$ | 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** |

$KPI_1 = \sum_{i=1}^{6}\left(R_{i,1} \times (S_i * 2 + W_i + O_i + T_i)\right)$ $\max KPI_1 = \sum_{i=1}^{n}\left(R_{i,1} \times (S_i * 2)\right)$, $Max\ KPIs = \sum_{j=1}^{6}(d_j \times \max KPI_j)$

$Kpi_1$ = 5*(2*2-3+1-2) + 5*(3*2-2+3-2) + 2*(1*2-2+1-1) + 3*(3*2-2+2-1) + 3*(1*2-3+1-1) + 3*(1*2-3+1-1) = 44
$Kpi_2$ = 5*(1*2-1+1-1) + 5*(5*2-3+2-1) + 2*(1*2-1+1-1) + 3*(3*2-2+1-1) + 2*(1*2-1+1-1) + 3*(3*2-2+1-2) = 70
$Kpi_3$ = 5*(2*2-1+1-1) + 5*(3*2-3+4-1) + 2*(3*2-3+2-2) + 3*(2*2-2+1-2) + 2*(1*2-1+1-1) + 3*(2*2-1+1-2) = 62
$Kpi_4$ = 2*(1*2-1+1-2) + 1*(2*2-2+2-1) + 3*(1*2+0+1-1) + 2*(2*2-1+1-2) + 2*(1*2-1+1-1) + 1*(1*2-1+1-1) = 16
$Kpi_5$ = 3*(1*2-1+1-1) + 1*(4*2-3+2-2) + 3*(1*2-1+1-1) + 2*(2*2-1+3-1) + 2*(1*2+0+1-1) + 1*(1*2-1+0-2) = 24
$Kpi_6$ = 2*(2*2-1+3-3) + 1*(2*2-2+3-2) + 3*(2*2-1+1-1) + 2*(1*2-1+1-1) + 3*(5*2-2+2-1) + 1*(1*2-1+1-2) = 47
$Kpi_7$ = 3*(1*2-1+1-1) + 2*(1*2-1+1-2) + 3*(1*2-1+1-1) + 5*(1*2-1+1-1) + 3*(1*2-1+1-1) + 5*(1*2-1+1-1) = 19
$Kpi_8$ = 3*(1*2-1+1-1) + 2*(2*2-2+2-1) + 3*(1*2-1+1-1) + 3*(1*2-1+1-1) + 3*(1*2-1+1-1) + 5*(1*2-1+1-2) = 18
$Kpi_9$ = 3*(1*2-2+2-1) + 2*(3*2-2+2-1) + 3*(1*2-1+1-1) + 5*(1*2-2+2-1) + 3*(1*2-2+1-2) + 5*(1*2-2+1-1) = 18

Total of M's: M1 = 84, M2 = 104, M3 = 90, M4 = 28, M5 = 34, M6 = 60, M7 = 42, M8 = 42, M9 = 50
Max KPIs = 256 + 208 + 180 + 28 + 102 + 180 + 42 + 84 + 150 = 1230
KPIs = 72 + 140 + 124 + 16 + 72 + 141 + 21 + 36 + 54 = 676
Provider: KPIs = 72 + 140 + 124 = 336
Consumer: KPIs = 16 + 72 + 141 = 229
Regulator: KPIs = 21 + 36 + 54 = 111
Data Center: KPIs = 72 + 16 + 21 = 109
Cloud Platform: KPIs = 140 + 72 + 36 = 248
Cloud Services: KPIs = 124 + 141 + 54 = 319
KPIs of PEST (Original) = 99*(3) = 297
di: degree of importance requirement i

| Aspects | Provider (BSC) |
|---|---|
| Cloud Computing | $d_1$: very important(3) |

$R_O$=99