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# Cloud Computing Adoption Decision Modelling for SMEs: From the PAPRIKA Perspective

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**Abstract.** The popularity of cloud computing has been growing among enterprises since its inception. It is an emerging technology which promises competitive advantages, significant cost savings, enhanced business processes and services, and various other benefits. The aim of this paper is to propose a decision modelling using Potentially All Pairwise RanKings of all possible Alternatives (PAPRIKA) for the factors that have impact in SMEs cloud computing adoption process.

**Keywords:** Potentially All Pairwise RanKings of all possible Alternatives (PAPRIKA); Cloud Services; Small and Medium Enterprises (SMEs).

## 1 Introduction

Cloud computing is an emerging technology which introduced various services and resources across the network. With all the claimed benefits for organisations; cloud computing services possess significant technical, economic, ethical, legal, and managerial issues [11]. Existing studies investigated more on the technical aspects of cloud computing, with limited focus on issues related to business perspective about the adoption of cloud computing [11]. Moreover, there is shortage of detailed studies on decision support systems and cloud computing adoption process from business view [37]. This paper identifies the relevant themes affecting SMEs (Small and Medium Enterprises) adopting cloud computing in Australia. These themes provide a glance for this research and will be the base in which the main topic is investigated, analyzed, discussed, and the researcher view is presented.

The objective of this paper is to propose and produce an initial decision model which is intended to assist its potential users (SMEs decision makers) in their prioritizing and selection process for cloud services. The constructs used in this model were derived from a review of relevant literature. This step will be followed by an exploratory qualitative phase then with an in-depth quantitative study in later stages. The exploratory study is being undertaken to empirically unfold the influential factors of the adoption of cloud computing from SMEs perspectives.

# 2 Related Work

## 2.1 Background

Decision making in adopting of any technology can be a difficult process even with its promises of various advantages and enhancement of business processes [4]. Cloud computing paradigm can have similar complications. In recent years there has been a demand for more holistic examination of the adoption of ICT (Information and Communication Technology). This is because such an approach can combine more than one theoretical framework in order to understand the phenomenon from different perspectives [25, 36]. The decision making situation is complex in this regard. A more comprehensive understanding of a decision case from different angles creates a better and more accurate final decision and therefore gives more positive benefits, outcomes, and from which results can be obtained.

With all the claimed benefits for organizations, cloud computing has significant technical, economic, ethical, legal, and managerial issues [21, 34]. Existing studies investigated more on the technical aspects of cloud computing, with limited focus on issues related to business perspective about the adoption of cloud computing [37]. Moreover, there is shortage of detailed studies on decision support systems and cloud computing adoption process from a business viewpoint [33, 37]. It is very important for the planning, assessment, and evaluation of cloud computing adoption decision to be done systematically taking into consideration the needs of the firm [18].

## 2.2 Decision Support Systems

There is an extent of variation in focus of the existing studies for cloud selection models. Han, Hassan, Yoon and Huh [14] proposed automated system for cloud selection based on tangible and easy measurable parameters such as Quality of Service (QoS) and Virtual Machine (VM) performance based on SaaS category. The study did not take into consideration other relevant variables in the context. An alternative approach was used by Li, Yang, Kandula and Zhang [20] proposed an evaluation tool based on IaaS and PaaS services such as storage, network, and processing performance as selection criteria for different cloud computing services providers. Multi-Criteria Decision Making (MCDM) techniques have been considered by other researchers like Godse and Mulik [13] using Analytical Hierarchy Process (AHP). It provided a wider dimension for studying various subjective criteria but was limited to analyze SaaS services. Hussain and Hussain [17] further advanced and developed a general and complex model which was less practical especially if it is intended to be used by SMEs with limited technical capabilities. Under Multi-Criteria Decision Analysis (MCDA), there are different preference presentations and scoring methods, all of which have their own benefits and drawbacks.

Deciding about the most appropriate cloud computing deployment model and selecting suitable cloud services for businesses is not an easy task. This is because there are many technological solutions provided by cloud computing services providers and also various direct and indirect factors that influence this decision and need to be considered carefully for efficient judgment. There are various approaches of ranking, prioritizing, and weighting selections that can be provided as tools for decision maker in their selection process for their right alternatives of services which will be discussed in the coming sections. In this research a MCDA framework is implemented by combining 1000Minds software [26] and the "Potentially All Pairwise RanKings of all possible Alternatives" (PAPRIKA) scoring method [15], to determine the factors that influence the adoption of cloud computing decision to make trade-offs between different alternatives to design a model which will help decision makers in making complex decisions. PAPRIKA is a method that uses a concept of multi-MCDM or conjoint analysis for establishing decision-makers' preferences through using pairwise rankings of alternatives [15].

The proposed model for this research was originated from a methodology that attempted to address the limitations in the previous studies. It will contribute in modelling decision making for both prioritizing and selection process in order to help enterprises make their optimal and efficient decision of the right cloud computing services that is most suitable to their business objectives. PAPRIKA arguably was selected as it closer to human logic of choice, simple, and at the same time have the complexity feature of analyzing different criteria and attributes including qualitative and quantitative data types. Moreover, PAPRIKA provides more preference comparison than most other scoring methods [15], such as direct rating [35], Simple Multi-Attribute Rating Technique (SMART) [9], Simple Multi-Attribute Rating Technique Extended to Ranking (SMARTER) [10], and the Analytical Hierarchy Process (AHP) [31]. It is implemented from 1000Minds software [www.1000Minds.com] [26]. This mechanism compares two criteria at a time which offers more accurate results in opposing to other pairwise comparison systems. This method is a useful tool for subjective and incomplete information and therefore it has the ability to produce practical solutions for real world use. The method involves prioritizing ranking of competing alternatives through evaluating all possible undominated pairs of attributes, presenting the final results in a beneficial model [15]. This will assist organizations in their decision making process.

### 2.3 Rationality of Using PAPRIKA Method

In PAPRIKA method each choice requires a decision-maker to trade-off one characteristics for the other (Fig.1). Decision-makers express a preference by choosing between two things. The software automatically changes the order of the trade-off questions for each survey. This strategy of swapping the order of questions helps in reducing or eliminating the potential order biases [6, 19, 27].

On of powerful features of PAPRIKA is it ability in surveying any number of criteria and levels; as these numbers increase, the number of potential alternatives (combinations) increases exponentially. For example, six criteria and four levels creates 4096 possible alternatives [15]. The PAPRIKA method largely reduces the number of selection the decision-maker have to make by reducing ‘dominant’ pairwise comparisons and use the transitivity feature to implicitly respond to other questions. Domination occurs when a decision is not required for certain alternatives due to the high rate of some alternatives in comparison with others. Then, the ‘undominated’ pairs are to be analyzed by the software. The ‘undominated’ pair occurs when one alternative has at least one criterion with higher rate and a least one criterion with lower rate in comparison with other alternatives. The software eliminates all the redundant choices when comparing two ‘undominated’ pairs via transitivity. For example, if choice A is ranked higher than choice B and choice B is higher than choice C, then by transitivity, choice A is ranked higher than choice C. After the two choices, the third choice becomes redundant. Then the software progress in selecting another choice and the process continues until all ‘undominated’ pairs processed and ranked.

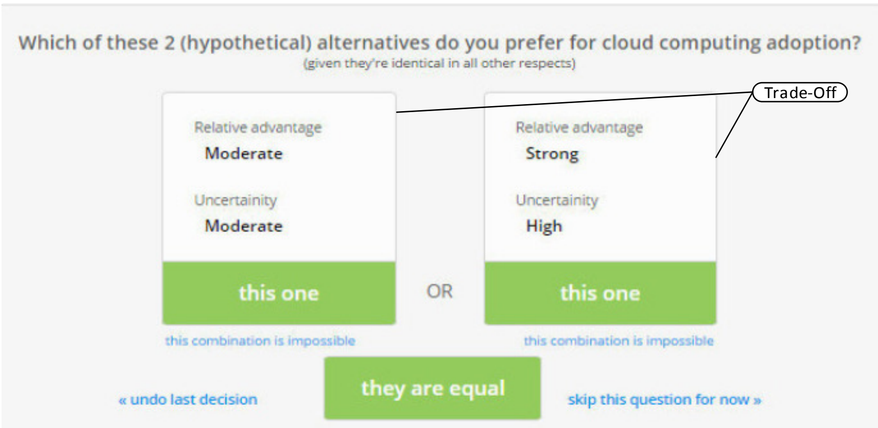



**Fig. 1.** Example of a pairwise-ranking trade-off question for scoring the value model presented in graphical user interface.

PAPRIKA method and the software have been used by researchers in different disciplines such as health-care, management, agriculture, and commerce to study various phenomena (e.g. [5, 22, 24]. This research will use PAPRIKA scoring method through its running environment 1000Minds software and not other methods for the following reasons: : (1) User friendly (2) Less complex as pairwise comparison is defined on two criteria (3) Less complex as pairwise comparison is defined on two criteria (4) Generates individual weights for every decision-maker which can be easily combined (5) Decision survey designed is clear, direct, and cost-effective (6) The survey format is robust, clear, and easy to follow.

There are numbers of decision analysis software, for more details you can visit this website link www.orms-today.org/surveys/das/das.html. 1000Minds is the only software that supports PAPRIKA method [26]. Sullivan [32] presented in his study the comparison between different scoring methods used in making decision process more easier such as SMART/SWING (Simple Multi-Attribute Rating Technique), DCEs (Discrete Choice Experiments), CA (Conjoint Analysis), ACA (Adaptive conjoint analysis), AHP (The Analytic Hierarchy Process), PAPRIKA (Potentially all pairwise rankings of all possible alternatives), and Outranking methods. All these methods are based on the simple additive model except the outranking method. MCDA methods are suitable for formulating decision maker's preferences than non-compensatory methods Baltussen and Niessen [1] . Outranking models can compensate the high performance on some criteria for poor performance on others with no consideration of the resulted differences [7]. Simplicity, predictive power, and preferences evaluation capabilities are elements that determine the effectiveness of the method [16].

PAPRIKA method uses only two criteria selection, whereas SWING/SMART, outranking, and some CA methods use ranking, direct rating, weighting to rank alternatives. In these methods, scoring the criteria is based on individuals, experts, and public opinion. Rating the criteria and alternatives by decision makers can introduce confusion in data interpretation. This is becoming obvious of the different interpretation of the rating scale by different people in a specific research focused group. Hence, Forman and Selly [12] stated that the scoring of alternatives is depending on decision maker's opinion and understanding of the scoring scale.

From the other hands, the method that provides selection system between two alternatives at a time is less complicated, less interpretation errors, and demanding less knowledge and task in ranking or scoring alternatives. The choice-based methods between two alternatives have advantage over selecting from the methods that use scale; it is more fitting to human experience situation [8]. In non-trade-off choice mechanisms; there is a possibility of equal ranking or scoring occurrence. Choice modelling, permits decision-makers to establish trade-offs between criteria.

The AHP method presents the decision-makers with framework of making pairwise comparisons at each hierarchal level for the presented criteria or alternatives. It has been argued that selecting preference based on methods other than cardinal form generates consistence and reliable results [23]. Sullivan [32] discussed in his study about three methods that elicit preference information in ordinal form namely: PAPRIKA, ACA, and DCE/CA. In ACA and DCE/CA methods, however, usually two or more choice sets are presented which can include more than two criteria for each choice set [29]. The more the number of criteria, the more complex the choice becomes. Additionally, focusing on some criteria and eliminating the other for the purpose of simplification can lead to inaccuracy in estimating criteria weights [3]. On the other hands, PAPRIKA method offers larger number of choices for decision-makers for a value model in comparing with other methods [15]. For example, DCE/CA offers smaller number of choice sets in corresponding with the number of scenarios presented [28]. The smaller number of choice sets presented by this method can be good in terms of reducing the effort that takes decision-makers for attempting to the preferences; however it can cause unreliability issues in the results. ACA method also present limited scenarios to the decision-makers which can make the preferences process of various choice sets inefficient.

The criteria weight describes the relative significance of the criteria and the intention of the decision-maker(s) (represented as individual or as a sub-group or as a complete sample) to trade off one criterion for another substitute. AHP and PAPRIKA are unique methods that produce individual criteria weights for every single decision-maker. In other methods such as SWING/SMART and outranking decision-makers determine the weight points directly to criteria. DCE/CA and ACA generates a group of weights for the whole sample. PAPRIKA method can compare criteria weights of one decision-maker with another in the trading-off the same criteria basis. However, AHP method can do the same only if decision-makers have used the same attributes and/or levels [2]. The aggregation of weight in this method depends on setup agreed by decision-makers, if it is to combine their judgement, then a geometric mean is used. Additionally, 'experts' can combine their results and geometric mean is also used and it is further can be used to rank the 'experts' themselves [30].

Selection of cloud computing providers, services, and deployment models is not an easy process for organizations. Various factors need to be considered as the decision can have a significant impact in the business. There are different approaches for rating, ranking, prioritizing, and selection of cloud computing services and its providers. One of the approaches is by using MCDA which can help decision-makers in choosing the most appropriate cloud computing deployment model and selecting suitable cloud services for their businesses. Under the category of MCDA there are various scoring and preference elicitation methods, each have its own benefits and drawbacks. In this research PAPRIKA method which is supported by 1000Minds software will be used to understand SMEs willingness in trading-off the different factors that influence them in adoption of cloud computing services.

# 3 Modelling The Cloud Adoption Process

## 3.1 Model Design

The development of a decision model for cloud adoption decision-making process was implemented based on two methods: (1) Literature review and (2) 15 semi-structured interview including 4 cloud computing services providers, 4 SMEs cloud computing adopters, 4 prospectors, and 3 not intend to adopt cloud computing. The purpose is to identify the relevant influential factors in the adoption of cloud computing. The outcome of the interview shall confirm a more solid framework of these factors. The framework will be used to form the building components of the decision model. The initial conceptual variables are illustrated in Table 1. The final conceptual framework will be developed from the outcomes of first phase of semi-structured interviews with the 15 organizations. The qualitative study will be the basis of the second quantitative study and then the decision model design and experiment will follow. This paper will present the initial model design and its simulation based on the previous studies and industrial reports.

**Table 1.** Conceptual components of the proposed model

| Variable | Definitions from cloud computing perspective |
|---|---|
| Relative Advantage | The extent to which cloud computing is perceived as being better than the idea of other computing paradigm it supersedes. |
| Complexity | The degree to which cloud computing is perceived as being relatively difficult to understand and use |
| Compatibility | The degree to which cloud computing is perceived as consistent with the existing values, past experience, and needs of potential users. |
| Uncertainty | The degree to which cloud computing is perceived as more secure than other computing paradigms |
| Security concern | The perceived security and privacy concerns of cloud computing due to the occurrence of data loss. |
| Cost savings | The extent of users perceived total cost of using cloud computing services |
| Privacy risk due to geo-restriction | The extent of privacy risk due to geo-restriction of cloud computing |
| Adoption Decision | Investigated status of cloud computing services adoption decision |

## 4 Method

The PAPRIKA method uses pairwise preferences evaluation based on trade-off process through selection one of the three options: 1- pair one is better than pair two 2- pair two is better than pair one 3- both pairs are equal. The value model or the preference values are represented by the relative importance 'weight' of the criteria which is calculated via mathematical methods (i.e. linear programming). The relative importance of each criterion is obtained from its highest ranked category, and the total of all the highest categories in each criterion is equal to 100%. Cost-benefits calculations are other useful measure that can be considered in alternatives scoring through Pareto analysis which provides an additional "value for money" evaluation tool for final selection of alternatives. PAPRIKA pointing system allows the use of criteria which can be either of quantitative nature (eg. number of employees and experience) or qualitative nature (technological, organizational, and environmental influential factors in the adoption of cloud computing). Non-categorical criteria can also be represented with different as appropriate to the case study (e.g. low rank, medium rank, and high rank).

PAPRIKA uses 'pairwise ranking' method for ranking of alternatives. This is in contrast with most other decision facilitator methods which use 'scaling' or 'ratio' measurements for ranking of preferences. For example, AHP is relying on a scaling method which is based on 1 to 9 points and valuating which of the two defined criteria are more important in this scale system. With PAPRIKA method, users are allowed to choose one alternative between just two which is easier and natural as in the human life daily decision. PAPRIKA can process any number of pairwise rankings of the hypothetical alternatives required by decision makers. Therefore, PAPRIKA method presents better confidence in decision making. Figure 2 illustrates "The Cloud Computing Decision Model Design Process". This activity involves:

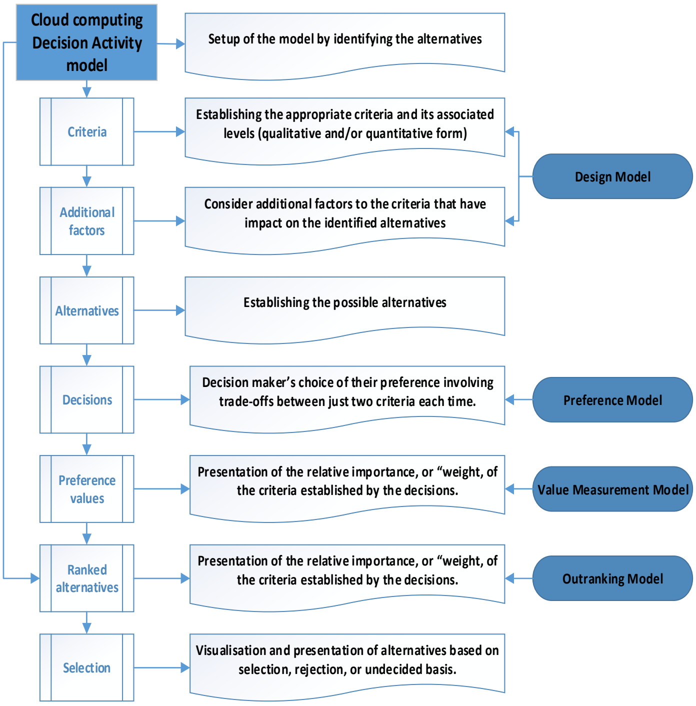



**Fig. 2.** The cloud computing 'decision model' design process

# 5 Simulation

At this stage the decisions are simulated using two cases. A preference survey was distributed to two theoretical emails for simulation. The survey was answered by the author taking into account two cases for conjoint analysis. This analysis estimates the expected values of the adoption decision associated with each cloud services. The first case was about "Decision to adopt cloud services with companies that have tendency towards low concern to security and privacy". The second case was about "Decision to adopt with high concern of security and privacy preferences". The base-case analyses ranked all the alternatives using estimates for all the best expected of the input parameters based on their intuitive judgment. The process involved elicitation the opinions of the business decision makers (imitated in this case) about the relative values of attributes within cloud services. The study also simulated a discrete choice experiment (conjoint analysis) to prioritize the cloud services criteria of the two cases by using a preference survey (answers simulated) to reveal individual's preference values, or 'weight', and the average of the group. These values were then used to rank the alternatives. In summary, for simulation the study conducted two activities: 1- Ranking of alternative survey 2- Preference survey (conjoint survey).

## 6 Results

The study started with the creation of the initial decision model and ranked the alternatives according to literature understanding and authors intuitive knowledge (the model illustrated in Appendix1-A). First of all, we have to mention that the ranking of alternatives of this study resulted from two simulation cases. The ranking results of the 11 alternatives are presented in Appendix1: B&C. The report classifies the results as followings:

**1. Preference Values and Criterion Rankings**

Preference values represent the relative importance, or 'weights', of the criteria – summarized by the criterion rankings (Tables: 2). Each criterion's weight corresponds to the % value for its highest level (Table: 2). These values – weights – sum to 100% (i.e. 1). For a given case1, the value of the highest-ranked level (Table: 3) for each criterion represents that criterion's importance relative to the other criteria. The criteria weight values in Table 3 represent the importance of the criterion to the participants. For example it can be observed that 'relative advantage' with a value of 0.267 has the highest level of importance among other criteria. Median, mean values and rankings are the average for both cases. Standard deviation (SD) used to calculate the cases values using the 'n' method. Fig: 3 visualize of the criteria mean preference values.

**Table 2.** Relative importance of criteria (mean weights); 'Marginal rate of substitution' (ratio) of the column criterion for the row criterion.

| | Relative advantage | Cost savings | Uncertainity | Compatibility | Security concerns | Complexity | Privacy risk due to geo-restriction |
|---|---|---|---|---|---|---|---|
| Relative advantage | | 1.3 | 1.7 | 1.8 | 2.7 | 4.5 | 4.7 |
| Cost savings | 0.8 | | 1.3 | 1.4 | 2.1 | 3.5 | 3.7 |
| Uncertainity | 0.6 | 0.7 | | 1.1 | 1.6 | 2.6 | 2.8 |
| Compatibility | 0.6 | 0.7 | 0.9 | | 1.5 | 2.5 | 2.6 |
| Security concerns | 0.4 | 0.5 | 0.6 | 0.7 | | 1.7 | 1.7 |
| Complexity | 0.2 | 0.3 | 0.4 | 0.4 | 0.6 | | 1.1 |
| Privacy risk due to geo-restriction | 0.2 | 0.3 | 0.4 | 0.4 | 0.6 | 0.9 | |

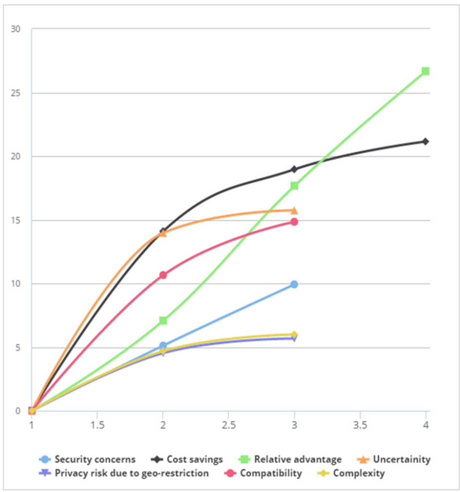



**Fig. 3.** Criterion value functions (mean preference values)

**Table 3.** Normalized criterion weights and single criterion scores (means); A more traditional, though equivalent, representation of the preference values above**.**

| Criterion | Criterion weight (sum to 1) | Level | Single criterion score (0-100) |
|---|---|---|---|
| security concerns | 0.099 | High | 0 |
| | | Medium | 51.6 |
| | | Low | 100 |
| Cost savings | 0.211 | Low | 0 |
| | | Medium | 66.7 |
| | | High | 89.7 |
| | | Very high | 100 |
| Relative advantage | 0.267 | Weak | 0 |
| | | Low | 26.5 |
| | | Moderate | 66.3 |
| | | Strong | 100 |
| Uncertainity | 0.157 | High | 0 |
| | | Moderate | 88.8 |
| | | Low | 100 |
| Privacy risk due to geo-restriction | 0.057 | High | 0 |
| | | Medium | 79.9 |
| | | Low | 100 |
| Compatibility | 0.148 | Weak | 0 |
| | | Good | 71.8 |
| | | Strong | 100 |
| Complexity | 0.06 | High | 0 |
| | | Medium | 78.3 |
| | | Low | 100 |

## 2. Rankings of Alternatives

The spearman's rank correlation coefficient (rs) measures the extent of similarity of 2 rankings of alternatives (Table: 4), and ranges between 1 and -1. The value of 0.870 for participants indicates that there is a tendency towards an identical agreement in ranking of alternatives. Below is the spearman's formula; where *i* = paired score.

$$\rho = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2 \sum_i (y_i - \bar{y})^2}} \tag{1}$$

Spearman's rank correlation coefficient = 0.870 (1 = identical rankings, 0 = unrelated rankings, −1 = identical reverse rankings).

Mid-ranks have been presented for tiered ranks (Fig. 4). The highest ranked alternates are: 1[s] Public IaaS-Systems; 2[nd]: Private IaaS; 3[rd] Public IaaS-Storage (Table.4). Hybrid PaaS and Hybrid SaaS have the same rank of number 9 in the list sharing the same mean value of 9.5 .The model also provides a result checker tool to increase confidence in the results.

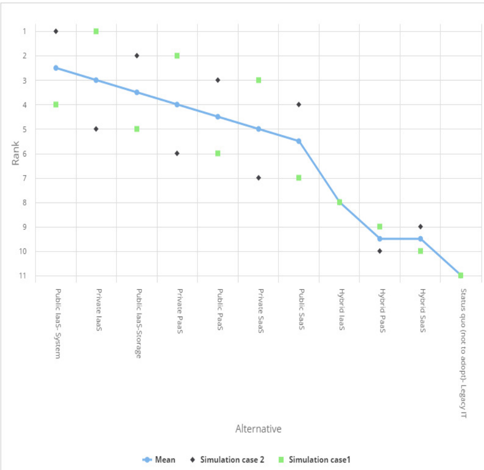



**Fig. 4.** Chart of 2 cases rankings of the 11 alternatives

**Table 4.** Rankings (mid-ranks) of the 11 alternatives

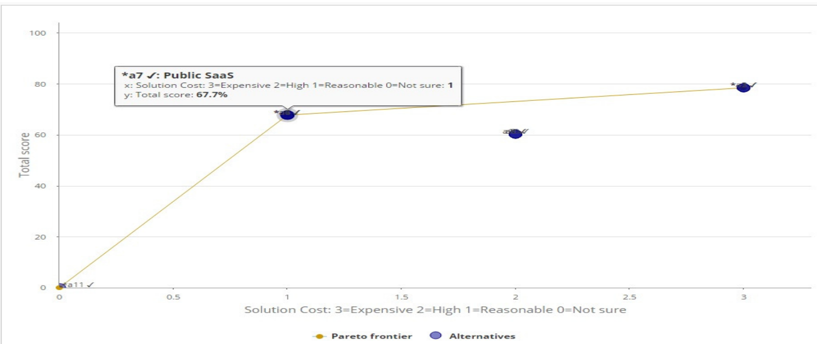
| | ranks | Cases | | |
|---|---|---|---|---|
| | | Simulation case 2 | Simulation case1 | MEAN |
| ALTERNATIVE | Public IaaS- System | -1.5 | 1.5 | 2.5 |
| | Private IaaS | 2 | -2 | 3 |
| | Public IaaS-Storage | -1.5 | 1.5 | 3.5 |
| | Private PaaS | 2 | -2 | 4 |
| | Public PaaS | -1.5 | 1.5 | 4.5 |
| | Private SaaS | 2 | -2 | 5 |
| | Public SaaS | -1.5 | 1.5 | 5.5 |
| | Hybrid IaaS | 0 | 0 | 8 |
| | Hybrid PaaS | 0.5 | -0.5 | 9.5 |
| | Hybrid SaaS | -0.5 | 0.5 | 9.5 |
| | Status quo (not to adopt)- Legacy IT | 0 | 0 | 11 |
| | Spearman's rank correlation with mean ranking | 0.870 | 0.870 | 1.000 |

## 3. The Value for Money Chart

Relevant assessment of the alternative options available to SMEs in adoption of cloud computing. The results generated are relevant in understanding how and why the alternatives were ranked and also to prioritize cloud services solutions to SMEs according to their need and based on their resources. The chart (Fig. 5) represents variables in the 2 axis and additional variables represented by bubble size and bubble color. It is a useful tool for decision makers. The model further provides a budget constraint variable as an additional parameter for evaluating between alternatives. The Pareto (efficiency) frontier line in the chart identifies alternatives that 'dominate' all others.

## 7 Discussion

This paper described a preference based method for ranking, prioritizing, and selection of cloud services and presented an initial decision model. This was achieved through simulation of two decision-making cases. At the 2nd phase of the study, the choice experiments will be conducted with real world cases of SMEs decision makers aiming to produce a collaborative web-based tool for businesses which will facilitate the cloud computing adoption decision process. The alternatives evaluation shows that Public IaaS-System, Private IaaS, Public IaaS, Private Paas are the top ranked options for SMEs to adopt in cloud services. PAPRIKA method provides a useful tool for ranking the possible decisions based on decision-maker’s judgement of the importance of the criteria to their specific situation. The tool provides a consistency mechanism checker to ensure meeting the objective. PAPRIKA approach helps in reducing the complexity of the multidimensional influential variables decisions to a simple series of trade-offs choices of only two variables at a time. Making choice between two is easier and closer to human nature of judgement and selection.




| ✓ | ✗ | ? | Label | Alternative | x: Solution Cost: 3=Expensive 2=High 1=Reasonable 0=Not sure | y: Total score | x/y ratio | Rank |
|---|---|---|---|---|---|---|---|---|
| ● | ○ | ○ | * a1 | * Private IaaS | 3 | 78.4% | 0.0382609 | 1st= |
| ● | ○ | ○ | * a2 | * Private PaaS | 3 | 78.4% | 0.0382609 | 1st= |
| ● | ○ | ○ | * a3 | * Private SaaS | 3 | 78.4% | 0.0382609 | 1st= |
| ● | ○ | ○ | * a4 | * Public IaaS- System | 1 | 67.7% | 0.0147606 | 4th= |
| ● | ○ | ○ | * a5 | * Public IaaS-Storage | 1 | 67.7% | 0.0147606 | 4th= |
| ● | ○ | ○ | * a6 | * Public PaaS | 1 | 67.7% | 0.0147606 | 4th= |
| ● | ○ | ○ | * a7 | * Public SaaS | 1 | 67.7% | 0.0147606 | 4th= |
| ● | ○ | ○ | a8 | Hybrid IaaS | 2 | 60.2% | 0.0332441 | 8th= |
| ● | ○ | ○ | a9 | Hybrid PaaS | 2 | 60.2% | 0.0332441 | 8th= |
| ● | ○ | ○ | a10 | Hybrid SaaS | 2 | 60.2% | 0.0332441 | 8th= |
| ● | ○ | ○ | * a11 | * Status quo (not to adopt)- Legacy IT | 0 | 0.0% | undefined (0/0) | 11th |

| | |
|---|---|
| Total, selected alternatives: | 19 |
| Total, rejected alternatives: | 0 |
| Total, undecided alternatives: | 0 |
| Sum: | 19 |
| Budget or constraint (optional): | < click to enter > |
| Not yet allocated: | |

✓ Select ✗ Reject ? Undecided

**Fig. 5.** Example of value for money model (simulation case1)

## 8 Limitations

The presented decision model will not be static; it has to be dynamic due to the change in socio-technical nature, business environment, etc. Therefore, the model needs to be kept in continuous review and update. There are further potential in developing decision modelling in different contexts and with different environmental characteristics.

## 9 Conclusion

Cloud computing popularity is in continues growing among SMEs. As a result, it is very useful to understand the entire scene behind the process of cloud computing adoption. Apparently, a simple, advance, and easy to use decision making tool is useful for businesses to increase their productivity and leverage country economic. This paper proposed a new method and designed an initial cloud computing decision model based on assumptions from the authors considering simulated cases of decisions. In the next stage of the research, the proposed model will be tested experimentally with several real-world scenarios of SMEs decision makers.

It is believed that more case scenarios can help in improving the model. Finally, possible expansion of the model can be investigated to include more parameters representing the influential adoption factors at the specific time and within a specific environment. The rapid advancement of technologies requires reviewing, refining, and modifying the concepts and the parameters of the model.

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# Appendix

**Appendex 1: Ranking of Alternatives**

| | Alternative | Security concerns | Cost savings | Relative advantage | Uncertainity | Privacy risk due to geo-restirction | Compatibility | Complexity | Rank | Mid-rank | Total score | Solution Cost: 3=Expensive 2=High 1=Reasonable 0=Not sure | Benefits: 3=High 2=Average 1= Low 0= No benefit | Service trust: 3=High 2=Average 1=Low 0=Not sure | Quality of Service: 3=Very High 2-High 1=Average 0=Not sure |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A. MODEL RANKING** | | | | | | | | | | | | | | | |
| | Public IaaS- System | Low | High | Moderate | High | Medium | Good | Low | 1st= | 2.5 | 79.6% | 1 | 1 | 1 | 1 |
| | Public IaaS-Storage | Low | High | Moderate | High | Medium | Good | Low | 1st= | 2.5 | 79.6% | 1 | 1 | 1 | 1 |
| | Public PaaS | Low | High | Moderate | High | Medium | Good | Low | 1st= | 2.5 | 79.6% | 1 | 1 | 1 | 1 |
| | Public SaaS | Low | High | Moderate | High | Medium | Good | Low | 1st= | 2.5 | 79.6% | 1 | 1 | 1 | 1 |
| | Hybrid IaaS | Medium | Medium | Low | Moderate | Medium | Good | Medium | 5th= | 6 | 65.9% | 2 | 2 | 2 | 2 |
| | Hybrid PaaS | Medium | Medium | Low | Moderate | Medium | Good | Medium | 5th= | 6 | 65.9% | 2 | 2 | 2 | 2 |
| | Hybrid SaaS | Medium | Medium | Low | Moderate | Medium | Good | Medium | 5th= | 6 | 65.9% | 2 | 2 | 2 | 2 |
| | Private IaaS | High | Very high | Strong | Low | High | Strong | High | 8th= | 9 | 55.7% | 3 | 3 | 3 | 3 |
| | Private PaaS | High | Very high | Strong | Low | High | Strong | High | 8th= | 9 | 55.7% | 3 | 3 | 3 | 3 |
| | Private SaaS | High | Very high | Strong | Low | High | Strong | High | 8th= | 9 | 55.7% | 3 | 3 | 3 | 3 |
| | Status quo (not to adopt)- Legacy IT | High | Low | Weak | High | High | Weak | High | 11th | 11 | 0% | 0 | 0 | 0 | 0 |
| **B - SMIULATION CASE1 RANK** | | | | | | | | | | | | | | | |
| | Alternative | | | | | | | | | | | | | | |
| | Private IaaS | High | Very high | Strong | Low | High | Strong | High | 1st= | 2 | 85.5% | 3 | 3 | 3 | 3 |
| | Private PaaS | High | Very high | Strong | Low | High | Strong | High | 1st= | 2 | 85.5% | 3 | 3 | 3 | 3 |
| | Private SaaS | High | Very high | Strong | Low | High | Strong | High | 1st= | 2 | 85.5% | 3 | 3 | 3 | 3 |
| | Public IaaS- System | Low | High | Moderate | High | Medium | Good | Low | 4th= | 5.5 | 57.5% | 1 | 1 | 1 | 1 |
| | Public IaaS-Storage | Low | High | Moderate | High | Medium | Good | Low | 4th= | 5.5 | 57.5% | 1 | 1 | 1 | 1 |
| | Public PaaS | Low | High | Moderate | High | Medium | Good | Low | 4th= | 5.5 | 57.5% | 1 | 1 | 1 | 1 |
| | Public SaaS | Low | High | Moderate | High | Medium | Good | Low | 4th= | 5.5 | 57.5% | 1 | 1 | 1 | 1 |
| | Hybrid IaaS | Medium | Medium | Low | Moderate | Medium | Good | Medium | 8th= | 9 | 53.1% | 2 | 2 | 2 | 2 |
| | Hybrid PaaS | Medium | Medium | Low | Moderate | Medium | Good | Medium | 8th= | 9 | 53.1% | 2 | 2 | 2 | 2 |
| | Hybrid SaaS | Medium | Medium | Low | Moderate | Medium | Good | Medium | 8th= | 9 | 53.1% | 2 | 2 | 2 | 2 |
| | Status quo (not to adopt)- Legacy IT | High | Low | Weak | High | High | Weak | High | 11th | 11 | 0% | 0 | 0 | 0 | 0 |
| **C - SIMULATION CASE2 RANK** | | | | | | | | | | | | | | | |
| | Alternative | | | | | | | | | | | | | | |
| | Public IaaS- System | Low | High | Moderate | High | Medium | Good | Low | 1st= | 2.5 | 77.9% | 1 | 1 | 1 | 1 |
| | Public IaaS-Storage | Low | High | Moderate | High | Medium | Good | Low | 1st= | 2.5 | 77.9% | 1 | 1 | 1 | 1 |
| | Public PaaS | Low | High | Moderate | High | Medium | Good | Low | 1st= | 2.5 | 77.9% | 1 | 1 | 1 | 1 |
| | Public SaaS | Low | High | Moderate | High | Medium | Good | Low | 1st= | 2.5 | 77.9% | 1 | 1 | 1 | 1 |
| | Private IaaS | High | Very high | Strong | Low | High | Strong | High | 5th= | 6 | 71.3% | 3 | 3 | 3 | 3 |
| | Private PaaS | High | Very high | Strong | Low | High | Strong | High | 5th= | 6 | 71.3% | 3 | 3 | 3 | 3 |
| | Private SaaS | High | Very high | Strong | Low | High | Strong | High | 5th= | 6 | 71.3% | 3 | 3 | 3 | 3 |
| | Hybrid IaaS | Medium | Medium | Low | Moderate | Medium | Good | Medium | 8th= | 9 | 67.2% | 2 | 2 | 2 | 2 |
| | Hybrid PaaS | Medium | Medium | Low | Moderate | Medium | Good | Medium | 8th= | 9 | 67.2% | 2 | 2 | 2 | 2 |
| | Hybrid SaaS | Medium | Medium | Low | Moderate | Medium | Good | Medium | 8th= | 9 | 67.2% | 2 | 2 | 2 | 2 |
| | Status quo (not to adopt)- Legacy IT | High | Low | Weak | High | High | Weak | High | 11th | 11 | 0% | 0 | 0 | 0 | 0 |